New Mexico Consortium
Laboratory Safety Program
2019

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A. GENERAL PRINCIPLES

The goals of the NMC Laboratory Safety Program are to:

1. Minimize the health and safety risks of those who are involved in research using hazardous materials
2. Minimize the risks to the NMC, the community, and the environment
3. Meet regulatory requirements

The Program will be reviewed and updated as needed and at least on an annual basis to reflect changes in policies and personnel.

B. RESPONSIBILITIES

NMC is responsible for maintaining a safe workplace environment through appropriate infrastructure, policy, training, and communication. A safe work environment can only be achieved through close communication and cooperation with NMC employees and other users of the NMC facilities. Employees and other users are responsible for communicating about risks and hazards in the workplace, contributing to the development of policies and training and following NMC policies.

B.1. Responsibilities of NMC

The NMC Laboratory Safety Program is established to maintain a safe laboratory work environment. The NMC Chief Operating Officer (COO) works closely with the NMC Director of Laboratory Research (DLR), the Institutional Biosafety Officer (IBO), and laboratory personnel to develop and implement environmental, health, and safety policies that comply with applicable federal, state, and local regulations. These policies and procedures are codified in this Program.

The DLR and the IBO communicate the NMC safety program and other NMC policies and procedures to laboratory workers and are the main point of contact for employees regarding safety issues. The DLR and IBO are responsible for determining the training requirements, procedures and policies for greenhouse and laboratory personnel. The COO has overall responsibility for implementation of and compliance with the safety and training plans established through this Program.

The NMC IBO is responsible for compliance with and implementation of safety and biosafety rules, regulations, guidance, and best practices. One of the most important responsibilities of the IBO is soliciting input on laboratory safety policies and procedures from managers and laboratory personnel.

NMC administrative and technical staff track and address reported safety issues and maintain a safe workplace.

B.2. Responsibilities of Laboratory Personnel

Timely communication about safety is the most important factor in maintaining a safe workplace. Lab personnel:

1. Must maintain excellent two-way communication with the DLR and IBO regarding safety on a regular basis
2. Are responsible for reading, understanding, and following all safety rules and regulations that apply to the work area

3. Must notify the DRL, IBO and/or FM of any hazardous conditions or unsafe work-related issues with the NMC laboratory, laboratory policies, and/or procedures. “Work related” means that the issue was caused by or significantly aggravated by events or exposures in the work environment.
4. Must report any incident as soon as it is safe to do so, but no more than one business day from when you observed/experienced the incident. The Incident Report Form is available on the NMC website (http://newmexicoconsortium.org/Organization/organization) and at the administrative work area. An issue or incident can also be reported through email to the IBO.

   Incidents: Report all work related incidents involving personal injury, no matter how slight, or damage to property. Personal injury includes any harm to your person, or subsequent loss of consciousness, illness, and days away from work, restricted work activity, or medical treatment.

   The Employee's Claim for Worker's Compensation Benefits Form must be completed in all cases in which an injury requiring medical attention has occurred. If you fail to report an injury, you may jeopardize your right to collect workers' compensation payments as well as health benefits.

   Near misses: Report any incident that might have caused or almost caused personal injury or damage, even if no damage occurred. Near misses are as important as incidents in managing safety.
5. Must stop work immediately if they see any imminent or potential threat or danger.
6. Have a right to know about any health hazards that might be present on the job. Should they have any questions or concerns, they should contact their manager or IBO for more information.
7. Are responsible for developing Integrated Work Documents (IWD) for their projects in consultation with the DLR and the IBO. They IWDs should identify and mitigate any risks in the work before it is started. No work may be performed in the NMC laboratory without an approved IWD. The IWD is the most important communication tool related to safety.
8. Are responsible for letting the IBO know about any conditions and/or medications that can affect their safety and/or their ability to perform their job safely in the laboratory/greenhouse (such as diabetes, epilepsy, pregnancy, insect or chemical allergy, immune status, respiratory conditions, color blindness, blood pressure medication, etc.). They should contact the NMC HR about seeing a medical care provider for appropriate counseling and guidance if needed.

The following is a list of best practices for laboratory work adopted by NMC. However, if at any time you feel that a practice is unsafe or you observe an activity you feel is unsafe, for any reason, **stop work and notify the IBO or DLR.**

- Assigned work schedules should be followed unless a deviation is authorized by the DLR
- Know and understand the bio/chemical hazardous potential of the reagents you handle
- Follow standard operating procedures at all times
- Always read the SDS and label before using a chemical
- Wear appropriate PPE at all times
- Handle all potentially hazardous materials as if the hazard is present
- Use appropriate ventilation when working with hazardous chemicals

- Laboratory refrigerators, ice chests, cold rooms, and ovens should not be used for food storage or preparation
- Use the principles of good microbiological practices when handling any biological material
- Use disinfectants with proven efficacy against the specific biohazard you are handling
- Maintain situational awareness
- Make others aware of special hazards associated with your work
- Accept full responsibility for your work
- Complete any necessary training before you work with hazards
- Report all accidents to IBO and a manager
- Dispose of hazardous waste properly
- Perform all procedures to minimize the creation of splashes and/or aerosols
- Avoid hand-to-mouth or hand-to-eye contact in the laboratory
- Handle all pathogens or materials containing pathogens in biosafety cabinets if the potential for aerosolization exists
- Decontaminate work surfaces after completion of work and after any spill or splash of potentially infectious material with appropriate disinfectant
- Decontaminate all cultures, stocks, and other potentially infectious materials before disposal using an effective method. Depending on where the decontamination will be performed, the following methods should be used prior to transport:
  - Materials to be decontaminated outside of the immediate laboratory must be placed in a durable, leak proof container and secured for transport
  - Materials to be removed from the facility for decontamination must be packed in accordance with applicable local, state, and federal regulations
- For unattended operations, laboratory lights should be left on, and signs should be posted to identify the nature of the experiment and the hazardous substances in use. Arrangements should be made, if possible, for other workers to periodically inspect the operation. Information should be clearly posted indicating whom to contact in the event of an emergency.
- Before beginning an experiment, know the facility's policies and procedures for how to handle an accidental release of a hazardous substance, a spill, or a fire. Know where emergency telephone numbers are posted.
- Know the location of all safety equipment and the nearest fire alarm and telephone. Know whom to notify in the event of an emergency. Be prepared to provide basic emergency treatment.
- Keep your co-workers informed of your activities so they can respond appropriately.
- The DLR, IBO, and FM are responsible for ensuring that all personnel are aware of the locations of fire extinguishers. After an extinguisher has been used, designated personnel must promptly recharge or replace it (29 CFR 1910.157(c)(4)).
- The DLR or IBO are responsible for ensuring proper training and providing supplementary equipment as needed.

NMC laboratory workers are personally responsible for following the safety procedures above.

C. CHEMICAL SAFETY

C.1. Introduction

A Chemical Hygiene Plan (CHP) is required by 29 Code of Federal Regulations (CFR) 1910.1450, *Labor, Occupational Safety and Health Standards, Occupational Exposure to Hazardous Chemicals in Laboratories*, which applies to facilities where multiple chemicals are used in laboratory scale quantities or Research and Development (R&D). A written Hazard Communication (HAZCOM) Plan is required by 29 CFR 1910.1200, *Labor, Occupational Safety and Health Standards, Hazard Communication,* and 29 CFR 1926.59, *Labor, Safety and Health Regulations for Construction, Hazard Communication*, which apply to employees who use chemicals in shops, maintenance activities, construction or facility work, product manufacture, laboratory analysis, environmental restoration, or decommissioning activities. This attachment covers both standards. Areas where only one standard applies will be noted in the text.

Personnel exposure to chemical agents is to be minimized, and maintained within acceptable exposure limits.

Exposures will be minimized by the use of:

1. Hazard elimination
2. hazard substitution
3. engineering controls
4. administrative controls
5. Personal Protective Equipment (PPE)

Every employee, guest, visiting scientist, student, or subcontractor working on or off-site will be familiar and comply with appropriate NMC safety standards.

This plan includes:

1. Procedures to be followed when work involves the use of hazardous chemicals
2. Criteria used to determine and implement control measures to reduce employee exposure to hazardous chemicals through the Integrated Work Management (IWM) and Worker Exposure Assessment processes
3. Methods used to inform employees of non-routine tasks and hazards associated with chemicals through the IWM process
4. Requirements for:
    - Fume hoods and other protective equipment
    - Employee information and training
    - Authorization and approval of activities through the IWM process
    - Additional employee protection for work with particularly hazardous substances in accordance with 29 CFR 1910.1450

- A hazardous chemical listing

C.2. Purpose

The purpose of this Chemical Hygiene Plan (CHP) is to provide workers with the specific requirements for chemicals used during work, the hazards involved, the forms of warning, Safety Data Sheets (SDSs), and the procedures and work practices to minimize their exposure to those chemicals.

C.3. Scope

HAZCOM applies to the use of chemicals in shops, maintenance activities, construction or facility work, product manufacture, the use of chemicals in a process in excess of 40 pounds or 5 gallons (see 40 CFR 355, *Protection of Environment, Emergency Planning and Notification*), environmental restoration, or decommissioning activities. The CHP applies to work done using small chemical quantities where multiple chemicals or chemical procedures can be safely manipulated by one person.

C.4. Chemical Hygiene Officer (CHO) (Chemical Hygiene Plan [CHP] Only)

The DLR will appoint a CHO to provide technical guidance to chemical workers (CHP only). The CHO will be an authorized chemical worker with the education and experience to determine the hazards and consequences of exposure to the chemicals found in the chemical inventory.

C.4.1. Qualifications, Education, and Training of the CHO

(Based on the National Registry of Certified Chemists-Certified Chemical Hygiene Officer [CHO]):

- Academic training (no degree) with at least 16 semester hours (24 quarter hours) in chemical, physical, biological, industrial hygiene, environmental, or health and safety sciences from an accredited institution and at least three years of experience in chemical health and safety.
- Earned associate's degree with at least 16 semester hours (24 quarter hours) in chemical, physical, biological, industrial hygiene, environmental, or health and safety sciences from an accredited institution and at least two years of experience in chemical health and safety.
- Earned bachelor's degree, master's degree, or doctor's degree with at least 16 semester hours (24 quarter hours) in chemical, physical, biological, industrial hygiene, environmental, or health and safety sciences from an accredited institution and at least one year of experience in chemical health and safety.

C.4.2. CHO Roles and Responsibilities

The CHO will (Based on 29 CFR 1910.1450, Labor, Occupational Safety and Health Standards, Occupational Exposure to Hazardous Chemicals in Laboratories, Appendix A [nonmandatory] and Prudent Practices for Handling Hazardous Chemicals in Laboratories):

1. Work with NMC staff to develop and implement appropriate chemical hygiene policies and practices.
2. Monitor procurement, use, and disposal of chemicals used in the lab.
3. Seek ways to improve the NMC chemical hygiene/chemical management program.
4. Provide assistance to NMC staff for IWDs and Standard Operating Procedures for proposed

research activities that involve hazardous materials.

5. Participate in the investigation of chemical related incidents and exposures.
6. Disseminate chemical safety information to NMC staff through e-mails, posting, and other forms of communications.
7. Provide general chemical safety guidance to NMC staff, students and support personnel.
8. Brief the NMC staff, students and support personnel on the specific Chemical Safety Plan, and ensure either electronic or hard copy availability.
9. Provide a means to ensure that each NMC staff is aware of the Chemical Safety Plan.
10. Communicate chemical safety lessons learned to NMC staff.
11. Communicate how NMC staff can access SDSs; provide hard copies of SDSs if necessary.

C.5. Chemical Management

C.5.1. Chemical Waste Management

The NMC will:

1. *Reduce waste sources:*
   Whenever possible, substitute less hazardous chemicals for a particular operation.
2. *Reuse surplus materials:*
   Only the necessary amount of material for an experiment should be purchased, and, if possible, materials should be reused.
3. *Dispose of waste properly:*
   Sink disposal is used when appropriate. When sink disposal is not appropriate, the waste is collected and handled by a chemical waste disposal contractor (Stericycle Environmental Solutions, formerly PSC).

Guidelines for the Collection and Storage of Waste:

1. Chemical waste should be accumulated at or near the point of generation by laboratory workers.
2. Each waste type must be stored in a compatible container pending transfer or disposal. Waste containers must be clearly labeled and kept sealed when not in use.
3. Incompatible waste types shall be kept separate to ensure that heat generation, gas evolution, or another reaction does not occur.
4. Waste containers will be segregated by how they will be managed. Waste containers are stored in designated locations that do not interfere with normal laboratory operations.
5. Waste containers must be clearly labeled and kept sealed when not in use. Labels must include the accumulation start date and hazard warnings as appropriate.

C.5.2. Chemical Inventory

The NMC's chemical inventory system is used to track hazardous chemicals. Specifically, this includes chemicals for which the manufacturer's SDS, or other data sheet, shows any GHS hazardous pictogram.

For NMC chemical inventory requirements, please contact the CHO.

C.5.3. Safety Data Sheets (SDSs)

Access to SDSs is provided through a link in the chemical container record in the NMC chemical inventory database and it is available on line. Manufacturer's SDSs are acquired by purchasing as part of the procurement process.

If a chemical owner has acquired the chemical through another process, the manufacturer's SDS will be provided to CHO. If an employee produces a new chemical, and plans to ship it off-site for use or distribution, an SDS must be created and shipped with the chemical. For chemicals created at the NMC, CHO will be contacted for assistance in creating an SDS.

Note: This does not apply to samples being submitted for analysis.

New chemicals developed at the NMC for internal use will be evaluated by the CHO to determine if they are hazardous (CHO only). If it is determined the chemicals are hazardous, the information will be included in the Integrated Work Document (IWD), thus allowing for the chemical workers to receive information on how to control the hazard. If the chemical produced is a byproduct whose composition is not known, the chemical will be assumed to be hazardous and handled accordingly.

If a hazardous chemical is shipped over public roads or from the NMC, the CHO will provide labels and SDSs that meet Occupational Safety and Health Administration (OSHA) HAZCOM and Department of Transportation (DOT) requirements (see 29 CFR 1910.1450, *Labor, Occupational Safety and Health Standards, Occupational Exposure to Hazardous Chemicals in Laboratories* [h] [2] [iii]). Contact the CHO for assistance in developing SDSs.

This plan is available to the employees, NMC employee representatives, and, upon request, by the Assistant Secretary for the Occupational Safety & Health Administration.

This plan is reviewed and evaluated on an annual basis and updated as necessary.

C.5.4. Labeling

All primary hazardous chemical containers must have a label with the chemical name and hazard warning. The hazard warning is a statement of the hazardous effect of the chemical (e.g., "flammable" or "causes lung damage") and the appropriate GHS pictogram.

When a hazardous material from the original manufacturer's container is transferred to other vessels, these vessels are referred to as "secondary containers." Secondary containers in HAZCOM areas will include the chemical name, creation date, hazard warning, and manufacturer. Secondary containers in CHP areas will include the name of the chemical, date created, and the owner of the container. (CHP areas only). Creation of new secondary containers should only be done by NMC approved chemical workers. These workers are responsible for labeling the container and making sure it is entered into the chemical inventory.

Portable containers into which hazardous chemicals are transferred and which are intended only for immediate use (i.e. use by one worker for one day) by the chemical worker who performed the transfer are not required to be labeled.

Contact the CHO for assistance in developing labels.

C.5.5. Methods Used to Inform Employees

Workers use the IWM process to develop IWDs for the proposed work activity. The IWD describes the scope, location, duration, hazards and environmental aspects, and controls (including PPE) to mitigate the hazards and negative environmental impact of the work. The IWD is used to authorize the work. IWDs will also be used to address non-routine tasks involving hazardous chemicals, and chemicals in unlabeled piping.

The DLR will ensure that all work involving hazardous chemicals is reviewed for security, environment, safety and health, facility or equipment, and impact on facility safety basis concerns. At a minimum, the following steps will be performed:

1. Initially categorize hazardous chemical work. If categorized as high hazard/complex work, assemble a hazard analysis review. In addition to the required members for the team, as needed include an industrial hygienist(s), and other hazardous chemical Subject Matter Experts (SMEs).
2. Create a detailed description of the work for the IWD involving hazardous chemicals that identifies the hazards associated with performing the work.
3. Specify hazard controls within the IWD using the following hierarchy of controls.
    a. Engineering Controls
    b. Administrative Controls
        1) Qualifications
        2) Formal procedures
        3) Training
        4) Work practices
    c. PPE

Note: Guidance for Preparing IWDs: Consider and understand the potential for generating new hazardous chemical-bearing waste streams. Consider substituting a less hazardous chemical and speak with the DLR or CHO before creating new waste streams.

4. Contact CHO to obtain a qualitative exposure assessment to evaluate the potential for worker exposure to hazardous chemicals. Provide the following information for each activity that involves hazardous chemicals:
    - Room
    - Description of activity
    - Hazardous chemicals involved
    - Engineering control methods employed
    - Employees

Note: The DLR and CHO will work with SMEs and subcontractor IHS personnel to ensure that the potential for subcontractor worker exposure to hazardous chemicals is evaluated before removing, remodeling, servicing, maintaining, or repairing laboratory equipment and exhaust systems.

C.6. Worker Exposure Assessments

Worker exposure assessments, including exposure monitoring, will be conducted as needed before the work commences, and periodically thereafter. If an exposure occurs, we will have a certified industrial hygienist assess the worker exposure and will have the worker follow-up with an occupational medicine healthcare provider as needed.

C.7. Use and Maintenance of Laboratory Fume Hoods

The chemical fume hoods will be certified annually or more frequently as needed. The chemical filters in the fume hoods will be replaced according to manufacturers' instructions. All additional maintenance and care will be provided as needed and according to manufacturers' instructions. If a chemical fume hood is out of order or not functioning properly do not perform any work inside that fume hood. Immediately alert the FM and IBO of a malfunctioning fume hood. The FM will take care of contacting the certified personnel for maintenance and the FM will make sure to properly label the fume hood and alert all Biolab residents not to use the malfunctioning fume hood until it is recertified for safe use.

Further details on the proper operation and use of the fume hoods are given in Section E.2.

C.8. Safety Showers and Eye Washes

Safety Showers and Eye Washes will be maintained, inspected, and tested weekly, as required by American National Standards Institute (ANSI)/International Safety Equipment Association (ISEA) z358.1-2009 *American National Standard for Emergency Eyewash and Shower Equipment* and per manufacturer's instructions for maintenance.

C.9. Other Laboratory Safety Practices and Techniques

C.9.1. Hand Washing

Hands must be washed immediately after they come in contact with potentially hazardous materials. Vigorous hand washing with a hand soap (OSHA approved, non-petroleum based, non-scented, antibiotic free) and lukewarm water for 20 full seconds is appropriate. Hands must also be washed immediately after gloves are removed and before exiting the laboratory every time.

Hand lotion (OSHA approved: non-petroleum based, non-scented) will be provided and should be used as needed to prevent skin irritation and micro-abrasions due to handwashing.

Note: hand soap and hand lotion will be compatible with the gloves used in the lab. If the scientists purchase their own gloves that are different from the ones selected by the IBO/CHO and provided by the Biolab, they will consult with the IBO/CHO to make sure they are compatible. Incompatible gloves: hand lotion/hand soap are a source of exposure to chemical and biological hazards through the skin.

C.9.2. Pipetting

Pipetting hazardous agents can lead to personnel exposures by inhalation, contact, or ingestion if not performed properly. The following are a few safety precautions to be followed when pipetting in the laboratory:

1. **Never mouth pipette**; pipetting aids must always be used
2. Pipette contents should be allowed to run down the wall of the container, making sure not to release the contents from a height
3. Place absorbent paper on bench tops to reduce the risk of aerosols being generated by accidental dripping of materials from pipette tips

C.9.3. Sharps

The use of needles, glass pipettes, glass slides and cover slips, scalpels and lancets should be kept to a minimum. Plastic ware should be used in place of glass whenever possible, such as plastic graduated cylinders, funnels, etc.

The following precautions must always be taken with sharp items:

a. Needles must never be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal.

b. Used disposable needles and syringes must be disposed of immediately by carefully placing them in OSHA approved and labeled puncture-resistant containers used for sharps disposal.

c. Non-disposable sharps must be placed in a hard-walled container for transport to a processing area for decontamination.

d. Broken glassware must never be handled directly. Instead, it must be removed using a brush and dustpan, tongs, or forceps.

C.9.4. Eating, Drinking, Smoking, Applying Cosmetics, Handling Contact Lenses

Eating, drinking, smoking, taking medicines, applying cosmetics, handling contact lenses, or in general having contact with mucous membranes is prohibited inside the laboratory. This is a common source of exposure to chemicals or infectious agents. Storing food for human consumption is forbidden in laboratory and greenhouse (GH) areas. Food must be stored outside the laboratory and GH area in cabinets or refrigerators designated and used for this purpose.

C.9.5. Clothing, shoes, and Hair

Keep long hair tied back and loose clothing confined. Avoid dangling and bulky jewelry in the laboratory. Wear shoes that completely cover the feet, to protect them from spilled chemicals or broken glass. Legs and feet should be completely covered, no skin should ever be exposed. Researchers are responsible for making sure the chemicals they are using do not react with clothing or jewelry. When working with corrosive chemicals, must wear appropriate shoes that do not absorb liquids.

C.9.6. Housekeeping

Good housekeeping in laboratories reduces the risk of accidents occurring. Workbenches should be kept free of clutter and aisles must always be free of trip hazards. Benches should be wiped down with a household disinfectant at least once a day and immediately after a spill of potentially infectious materials occurs.

Put coats in designated areas. Avoid putting them on the bench tops or back of chairs or stools. Keep other personal items (backpacks, coats, laptops, purses, etc.) outside the laboratory area.

Please refer to NMC's GREENHOUSE GOOD PRACTICES for housekeeping information inside the Greenhouse.

C.9.7. Working Alone in the Laboratory

Working alone in a laboratory is dangerous and should be strictly avoided. There have been many tragic accidents that illustrate this danger. Accidents are unexpected by definition, which is why coworkers should always be present. Workers should coordinate schedules to avoid working alone.

Never work alone when working with hazardous chemicals.

C.9.8. Compressed Gas

Compressed gases expose laboratory personnel to both chemical and physical hazards. It is essential that these are monitored for leaks and have the proper labeling. By monitoring compressed gas inventories and disposing of or returning gases for which there is no immediate need, the laboratory will substantially reduce these risks. Leaking gas cylinders can cause serious hazards that may require an immediate evacuation of the area and activation of the emergency response system. Only appropriately trained HAZMAT responders may respond to stop a leaking gas cylinder under this situation. FM or a designated lab technician will monitor compressed gas cylinders for leaks and address any issues.

Only trained personnel are allowed to handle and installed pressurized gas cylinders at the Biolab. The training will include in person hands-on training by an expert as well as general knowledge and precautions.

The following precautions must be followed when handling pressurized gas cylinders:

1. NEVER ride in an elevator with a gas cylinder
    a) place the cylinder inside the elevator and then meet it at the other floor separately or have another person receiving the cylinder
2. Ensure all cylinders are properly secured to wheeled carts designed for this purpose
    a) use chains, straps, and/or specialty clamps
3. Make sure safety caps are on the cylinder (no attached regulators during transport)
4. When moving multiple cylinders do not allow them to bang against or strike each other
5. Become familiar with the route you will travel
    a) remove all potential obstacles
    b) if lift gates or ramps are used, have a spotter or helper before moving cylinders
6. Double-check the contents to ensure the material is what you think it is and what the label says it is
7. Ensure all cylinders are secured in the work area before making connections
    a) use chains, straps, and/or specialty clamps
8. Install a proper regulator when in use, and when not in use remove the regulator and install safety caps
    a) make sure the regulator is compatible with the gas
    b) if using a highly flammable gas, you must use a spark-proof regulator
9. Maintain adequate ventilation and temperature control for the area in use
10. Close the valve and purge or release the pressure in the system as appropriate

11. Follow the written standard operating procedures (SPOs) for specific gasses and or instruments
12. Have a dedicated area for compressed gas cylinder storage
13. Segregate cylinders according to fire codes and compatibility:
    a) store by compatibility with proper separation between hazard classes
    b) check local fire codes, which specify distances and quantities allowed
14. Secure cylinders to prevent tipping, falling, and knocking together
15. Ensure regulators are removed and safety caps are installed
16. Maintain good ventilation and temperature control
17. Lock and secure the area against theft and vandalism
18. Locate the cylinder storage area away from emergency exits
19. Clearly mark all empty cylinders and segregate these from full cylinders:
    a) empty cylinders should be moved and handled with the same care as full ones and returned to the vendor promptly
20. PPE required for transport of cylinders:
    a) Lab coat
    b) Face shield, safety glasses or splash goggles
    c) Pants should be worn on the outside of steeled-toed work boots or other shoes that completely cover and protect the foot

C.10. Provisions for Additional Employee Protection

C.10.1. Work with Category 1 Chemicals

To minimize exposures to known human carcinogens, reproductive toxicants, and substances with high acute or high chronic toxicity special handling procedures are necessary. Chemicals in these hazard groups are identified in the Category 1 Chemicals list (Appendix I).

Handling procedures for these agents will be defined in laboratory or work authorization documents and approved by the DLR or CHO before initiation of work. Specific consideration will be given to the following controls, to be used as appropriate for the agent and process: establishment of designated areas; use of containment devices such as laboratory fume hoods or glove boxes; procedures for safe removal of contaminated waste; and decontamination procedures (see 29 CFR 1910.1450, *Labor, Occupational Safety and Health Standards, Occupational Exposure to Hazardous Chemicals in Laboratories* [e] [3] [viii]).

Decontamination is necessary before the affected work area can be released from “designated area” status. The type and level of decontamination will be defined by the DLR or CHO. After decontamination, the area will no longer be considered a “designated area,” and all warning and control signs will be removed. A wet mop or a vacuum cleaner equipped with a High-Efficiency Particulate Air (HEPA) filter will be used instead of dry sweeping.

C.10.2. Additional Requirements for Carcinogens

A regulated area will be established where a known human or suspected human carcinogen is manufactured, processed, used, repackaged, released, handled, or stored. All materials containing 0.1% or more of a listed carcinogen will be clearly labeled to warn of a carcinogen hazard. A list of carcinogens, located in the Category 1, chemicals can be found on the Appendix I. Less-hazardous, non-carcinogenic chemicals that can be substituted for currently used carcinogens will be substituted when

compatible with the work to be accomplished.

The following must be followed in all areas where carcinogens are used or stored:

1. Area will be clearly marked by posting signs warning of a carcinogen hazard
    - Additional signs and labels are required when OSHA-regulated carcinogens are in use
2. Absolutely no eating, drinking, gum chewing, smoking, or applying cosmetics or lip balm
3. Ventilation and hood performance will meet minimum requirements before beginning any new operations involving carcinogens
4. The DLR or CHO must re-evaluate the carcinogen hazards when the use of a carcinogen changes in quantity, concentration, frequency, or duration
5. The IWD will state the decontamination procedures for restoring equipment and facilities to uncontrolled use after carcinogen use ends and before new carcinogens are used
6. The DLR and CHO must be notified of authorized chemical workers working with carcinogens before they begin the work

C.10.3 Evaluation of Laboratory Operations

- An evaluation of the hazards to be encountered or generated must be done before laboratory tests/experiments or chemical reactions begin.
- The evaluation must include the hazards associated with the properties and the reactivity of the materials used and any intermediate and end products that can be formed. For example: hazards associated with the operation of the equipment at the operating conditions, and hazards associated with the proposed reactions, for example, oxidation and polymerization.
- When synthesizing new materials where the hazard characteristics have not yet been determined, precautions must be based on the highest possible known hazard of a similar material or of one of the reagents of the synthesis.
- When a new material has the potential for a severe explosion, initial experiments or tests must be conducted in an enclosure that is designed to protect people and property from potential explosion damage.
- Never conduct unattended experiments or use automatic laboratory operations involving hazardous chemicals, unless surveillance is in place to monitor for abnormal conditions.

C.11. Personal Protective Equipment (PPE)

The NMC requires that suitable clothing and equipment be used to protect workers and others in Laboratory spaces from hazards in the workplace. PPE is intended to protect the body (including eyes, face, feet, hands, head, hearing, skin, and respiratory system) from hazards capable of causing injury, illness, or impairment of bodily function. No protective material will provide full protection against all hazards. PPE is considered for use as a hazard control strategy only after it has been determined that elimination, substitution and engineered and administrative controls are not enough to eliminate all the risks. Proper PPE will be identified in IWD.

The level of protection and type of PPE selected must match the applicable hazards.

C.12. Emergency Procedures

See section I. Emergency Planning.

C.13. Medical Surveillance

Medical surveillance requirements will be in accordance with requirements contained in the NMC Laboratory Safety Program Section H.2 Medical Program.

C.14. Worker Information, Training and Authorization

Chemical workers who work with hazardous chemicals will receive training about those chemicals before they begin work. Chemical workers receive this training through a combination of formal training, reading assignments, and job-specific information as specified in the work authorization documentation. Chemical workers who work in areas where hazardous chemicals are used, but who do not work directly with such chemicals, will be made aware of the hazards before they begin work in those areas. Formal training will be conducted and documented in accordance with NMC training policy.

Chemical workers will be trained on chemicals in their workplace at the time of initial assignment and whenever new hazards are introduced.

C.15. Specific Chemical Guidelines

C.15.1. Compressed Gas

NFPA 55:3.3.49.1 Compressed Gas definition: A material, or mixture of materials, that (1) is a gas at 68°F (20°C) or less at an absolute pressure of 14.7 psi (101.3 kPa) and (2) has a boiling point of 68°F (20°C) or less at an absolute pressure of 14.7 psi (101.3 kPa) and that is liquefied, non-liquefied, or in solution, except those gases that have no other health or physical hazard properties are not considered to be compressed gases until the pressure in the packaging exceeds an absolute pressure of 40.6 psi (280 kPa) at 68°F (20°C).

Compressed gases expose laboratory personnel to both chemical and physical hazards. It is essential that these are monitored for leaks and have the proper labeling. By monitoring compressed gas inventories and disposing of or returning gases for which there is no immediate need, the laboratory can substantially reduce these risks. Leaking gas cylinders can cause serious hazards that may require an immediate evacuation of the area and activation of the emergency response system. Only appropriately trained HAZMAT responders may respond to stop a leaking gas cylinder under this situation. DLR or lab technician will monitor compressed gas cylinders for leaks and address any issues.

Requirement for Researchers: NMC researchers working with compressed gases **must** follow an approved IWD.

Hazard Classification: Compressed gases are classified as class I, II, III, or IV in order of decreasing hazard.***** Classes are based on the lethal concentration to 50% of test animals (rats) of each gas (LC50). Use and storage of compressed gases is strictly regulated according to hazard classification.

Compressed Gas Hazard Classifications	
Class I	LC50 (rat) ≤ 200 ppm
Class II	201 ppm LC50 (rat) ≤ 2000 ppm
Class III	2001 ppm LC50 (rat) ≤ 5000 ppm
Class IV	LC50 (rat) > 5001 ppm

Implement additional safety precautions for **particularly hazardous substances** (classes I, II, and III). Requirements are relaxed for small quantities and short-term usage.

C.15.2. Low Temperature Operations and use of Cryogenic Liquids

Requirement: NMC researchers working with liquefied gases **must** have an approved IWD for the activity before purchasing gases and beginning work.

- Low temperature operations are those conducted at temperatures below-73°C (-100° F).
- Cryogenic liquids are liquefied gases with temperatures below -73°C (-100° F). Cryogenic liquids commonly used include:
    1. Liquid Nitrogen
    2. Slush mixtures of dry ice with isopropanol or ethanol

C.15.3. Ethidium Bromide

Ethidium bromide ($C_{21}H_{20}BrN_3$) is a potent mutagen used as a nucleic acid stain. Ethidium bromide requires extra precautions during use and disposal because of its highly toxic and mutagenic properties.

Requirement: NMC researchers working with potentially mutagenic materials such as ethidium bromide **must** complete an IWD. This IWD must be preapproved by the CHO, IBO, and DLR prior to beginning any work with this material.

Never work alone when working with hazardous chemicals.

Consult safety resources:

- SDS: http://www.fishersci.com/ecomm/servlet/msdsproxy?productName=BP130210&productDescription=ETHIDIUM+BROMIDE+10ML&catNo=BP1302-10&vendorId=VN00033897&storeId=10652
- Laboratory Chemical Safety Summary: Ethidium Bromide, "Prudent Practices in the Laboratory: Handling and Disposal of Chemicals" (1995), The National Academies Press

Consider these hazards specific to ethidium bromide:

- In powder form, ethidium bromide is an irritant to the upper respiratory tract, eyes, and skin.
- Ethidium bromide is strongly mutagenic, causing mutations to the DNA. Even though there is no evidence at this time of human carcinogenicity or teratogenicity, this material should be considered a possible carcinogen or teratogen.
- If possible, use a less dangerous product that can perform the same task. New fluorescent dyes have been developed that manufacturers, such as Molecular Probes Inc. and FMC Corporation, claim are less toxic and have greater detection sensitivity than ethidium bromide. NMC is currently transitioning from ethidium bromide to the non-toxic fluorescent dyes, Gel Red and Gel Green Nucleic Acid Stains from Biotium.

Be prepared for spills:

- Ethidium bromide spills are very serious and require immediate cleanup.
- Some facilities use a hand-held ultraviolet (UV) lamp to check for residual ethidium bromide contamination following spill cleanup. A reddish-orange fluorescence can be detected under both "long" and "short" UV wavelengths.
- Use of a handheld UV lamp to detect traces of ethidium bromide may serve as an occasional check of laboratory practices, but it cannot substitute for good cleanliness and careful contamination control.

Be aware of these limitations:

- The ability of hand-held UV lamps to detect small spills is not guaranteed.
- Ease of detection depends upon a variety of factors including:
    - Chemical composition of the sample
    - Wavelength of the UV lamp
    - Intensity of the lamp

C.15.4. Flammable and Combustible Liquids

Flammable and combustible liquids present a danger of personal injury and property damage so strict storage requirements are both essential and required by law.

Facts about flammable and combustible liquids

- Flammable and combustible liquids ignite easily and burn with extreme rapidity.
- Flammability is determined by the flash point of a material.
- Flash point is the minimum temperature at which a liquid forms a vapor above its surface in sufficient concentration that it can be ignited.
- Flammable liquids have a flash point of less than 100°F. Liquids with lower flash points ignite easier.
- Combustible liquids have a flashpoint at or above 100°F.
- The vapor burns, not the liquid itself. The rate at which a liquid produces flammable vapors depends upon its vapor pressure.

- The vaporization rate increases as the temperature increases. Therefore, flammable and combustible liquids are more hazardous at elevated temperatures than at room temperature.

Restrictions and guidelines: Because their vapors ignite and burn easily, flammable and combustible liquids have strict storage requirements. The hazard classification of a liquid determines the type and size of container in which it can be stored.

Container Size and Quantity Limits: The hazard classification of a liquid determines the type and size of container it may be stored in.

Chart 1 describes the allowable total quantity of flammable or combustible liquid that may be stored in an NMC facility.

Chart 1: Maximum quantities		
Flammable liquids		
Location	**Maximum amount**	**Container size**
Open lab or shop (including safety cans)	10 gallons (37.9L)	Comply with Chart 1
Listed and approved flammable storage cabinet	60 gallons (227.4L)	
Combustible liquids		
Reasonable quantities of combustible liquids are permitted. For consultation contact the IBO.		

Flammable Liquids Storage and Combustible

- Store flammable liquids in a flammable storage cabinet. A variety of commercially manufactured cabinets are available.
- When flammable liquids must be stored outside a flammable storage cabinet, use approved safety cans whenever possible. They have spring-loaded lids and an internal screen, which prevents combustion of the contents.
- Do not use large polypropylene ("Nalgene") containers with stopcocks or valves at the bottom to store flammable liquids. These valves frequently leak and are unsafe in a fire.
- Never store flammable liquids in a standard or domestic refrigerator or freezer. Flammable liquids that must be chilled or frozen require specially designed "spark-proof" refrigerators or freezers.

C.15.5. Nanomaterials

The U.S. National Nanotechnology Initiative defines nanotechnology as the understanding and control of matter at dimensions between approximately 1 and 100 nanometers (a nanometer is 1 billionth of a meter), where unique phenomena enable novel applications.

Engineered nanoparticles are intentionally created particles with nanoscale dimensions. Nanoparticles can be spheres, rods, tubes, and other geometric shapes. They may be bound to surfaces or substrates, put into solution or suspension, attached to a polymer, or in a few cases handled as dry powder.

Limited information is currently available on the toxicity of a few types of nanoparticles. When research involves work with engineered particles for which no toxicity data is yet available, it is prudent to assume the nanoparticles may be toxic.

There are four possible routes of workplace exposure to nanoparticles:

1. **Inhalation:** Because of their tiny size, certain nanoparticles appear to penetrate deep into the lungs and may translocate to other organs following pathways not demonstrated in studies with larger particles.
2. **Ingestion:** Once ingested, some types of nanoparticles might be absorbed and transported within the body by the circulatory system.
3. **Injection:** Accidental injection or skin puncture is a potential route of exposure, especially when working with animals or needles.
4. **Skin absorption:** In some cases, nanoparticles have been shown to migrate through skin and circulate in the body. If the particle is carcinogenic or allergenic, even tiny quantities may be biologically significant.

Follow the safety guidelines below to protect yourself from possible hazards.

Safety Training: Provide appropriate, rigorous, and documented safety training.

- Ensure that:
  - A safety protocol is written into the research procedure
  - Safety Data Sheets (SDS), the manufacturer's handling instructions, and IWD procedures are carefully read
  - Note: Given the lack of extensive data on nanoparticles, SDS information may be more applicable to the properties of the bulk material.
- Be aware of fire risk when working with reactive nanomaterials. Prior to starting work, assess whether large quantities or high concentrations of nanoparticles will be generated.
  - Under certain circumstances, combustible nanomaterials may present a higher risk when exposed to air due to their large surface area and overall small size.
  - Carbonaceous and metal dusts can burn and explode if an oxidant such as air and an ignition source are present; self-heating may occur when reactive moieties, such as double bonds, are constituents of the carbonaceous material.
- Provide and train in the correct use of personal protective equipment. Wear appropriate PPE:
  - Double nitrile gloves
    Remove used outer gloves inside a fume hood or under a local exhaust ventilation and place in a sealed bag to prevent particles from becoming airborne.
  - Lab coat with sleeves fully extended to the wrist
  - Safety glasses or goggles

- A respirator with NIOSH-approved filters that are rated as N-, R-, or P-100 (HEPA) if working outside of a ventilated area with nanomaterials that could become airborne (not recommended)

Respirator Training is Required

Control Hazards:

- Handle nanoparticles whenever possible in a form that is not easily made airborne, such as in solution or on a substrate.
- Alternatively, handle nanoparticles with engineering controls such as a HEPA-filtered local capture hood or glove box.

Note: Locate HEPA-filtered, local capture systems as close to the possible source of nanoparticles as possible. Installation must be properly engineered to maintain adequate ventilation capture.

- Do not exhaust aerosols containing engineered nanoparticles inside buildings.
- Do not eat, drink, chew gum, apply cosmetics, or handle contact lenses in the laboratory. Wash hands frequently and before eating.
- Clean up spills of nanoparticles promptly.
- Wet wipe work surfaces daily. Alternatively, use disposable bench paper.
- Wet wipe lab equipment and exhaust systems used with nanoparticles and HEPA-vacuum them prior to reuse, service, or disposal.
- Place Tacki-Mat® or a similar sticky walk-off mat at the lab's exit to reduce the likelihood of spreading nanoparticles.
- Prepare for spills. Clean up only very small quantities and only if you have been properly trained.
  - Keep a chemical spill kit easily accessible.
  - Wear PPE, including double nitrile gloves and a lab coat.
  - For spills that might result in airborne nanoparticles, proper respiratory protection is required.
  - Do not brush or sweep spilled or dried nanoparticles.
  - Place Tacki-Mat® at the spill area exit to reduce the likelihood of spreading nanoparticles.
  - Dispose of spill containment materials as hazardous waste (see Hazardous Waste Disposal below).

Exposure Response: Treat any exposure seriously, no matter how slight it may seem at the moment.

- All exposures:
  - Give first aid treatment, and then seek medical attention immediately as needed.
  - Call 911 and request an ambulance, if transportation is necessary.
  - Call Poison Control, (800) 222-1222, if additional information is needed.
- Ingestion: Seek medical attention immediately.
- Skin exposure: Flush exposed skin with water for at least 15 minutes while removing any contaminated clothing.
- Eye exposure: Flush eyes with water for at least 15 minutes. Affected individuals may need help holding their eyes open under water. Seek medical attention immediately at an emergency room.

Hazardous Waste Disposal: Treat all waste engineered nanoparticles as hazardous waste unless they are known to be non-hazardous.

C.15.6. Organic Peroxide Formers

Organic peroxides are sensitive to oxygen, heat, friction, impact, light, and strong oxidizing and reducing agents. The unusual stability problems of this class of compounds make them a serious fire and explosion hazard that requires careful management.

NMC researchers working with organic peroxide formers must follow an approved IWD.

Potential peroxide formers: The following classes of chemicals include materials that form organic peroxides over time:

- Aldehydes
- Compounds containing benzylic hydrogen atoms (particularly if the hydrogens are on tertiary carbon atoms)
- Compounds containing the allylic structure, including most alkenes
- Ethers (especially cyclic ethers and those containing primary and secondary alcohol groups
  - MTBE (Methyl tert-butyl ether, also known as methyl tertiary butyl ether) is *excluded* from this policy and should be considered as a substitute for more hazardous ethers such as diethyl ether when possible.
  - Avoid diisopropyl ether when possible given how easily it forms peroxides.
  - Vinyl and vinylidene compounds

Labeling and inventory management:

- Label peroxide-forming materials clearly and promptly upon receipt or synthesis (including refillable dispensing containers). Include this **required** additional labeling on peroxide formers (always include name or initials of person recording the information):
  - Date received (ex: 1/1/2010 RCVD, initials)
  - Date opened (ex: 1/1/2010 OPND, initials)
  - Date testing history (ex: 1/1/2010 ND or 'X' PPM, initials depending on results)
  - Peroxide Testing Strips will be used for long-term storage of peroxides.
- Review your inventory frequently to prevent peroxide formers from becoming unsafe.
- Use a first in / first out inventory management system.

Hydrogen Peroxide is mostly used and stored in the headhouse.

If you discover expired or old peroxide forming materials:

- **DO NOT HANDLE ANY peroxide forming material that appears suspicious** (oily, viscous, crystal formation) OR exceeds 80ppm using the test parameters outlined below (see the "Test for peroxy compounds" section).
- Inform colleagues in the work area about the hazard.
- Contact the DLR or CHO immediately.
- Label and isolate the cabinet or area: "Do Not Handle – Dangerous Peroxide Forming Material".

C.15.7. Pyrophoric and other Highly Reactive Materials

Pyrophoric materials require extra caution during use, storage, and disposal because of severe reactive properties. These materials ignite spontaneously when exposed to air. Handle them with extreme care to avoid contact with air and moisture. Failure to handle these materials properly may result in serious injury or death.

Requirement: NMC researchers working with pyrophoric materials **must** follow an approved IWD.

Never work alone when working with pyrophoric materials.

C.15.8. Sodium Azide

Sodium azide (NaN_3) is a common preservative of samples and stock solutions in laboratories and a useful reagent in synthetic work. Sodium azide is also extremely toxic (LD50 oral [rat] 27mg/kg) and a powerful poison. Ingesting very small amounts can cause death in a short period of time.

Requirement: NMC researchers working with highly toxic materials such as sodium azide **must** have an approved IWD.

Consider these hazards specific to sodium azide:

- When mixed with water or an acid, sodium azide changes rapidly to a toxic gas with a pungent odor. However, the odor may not be sharp enough to give people sufficient warning as to the hazard.
- When heated to its decomposition temperature of ~275°C, sodium azide may undergo violent decomposition.
- Additional hazards:
  - Sodium azide also changes into a toxic gas when it comes in contact with solid metals.
  - Sodium azide reacts violently with nitric acid, bromine, carbon disulfide, dimethylsulfate, and several heavy metals including copper and lead.
    - Never flush sodium azide (solid or concentrated solution) down the drain — the azide can react with lead or copper in the drain lines and explode.
    - Do not store on metal shelves or use metal items to handle sodium azide (i.e., spatulas). Contact with metal shelves, containers, and utensils can result in formation of heavy metal azides and the risk of explosion.

Use a less dangerous product than sodium azide if one is available that can perform the same task.

DO NOT wear jewelry of any sort when working with Sodium Azide.

Consult safety resources available on:

- Laboratory Chemical Safety Summary: Sodium Azide, Prudent Practices in the Laboratory: Handling and Disposal of Chemicals (1995), The National Academies Press
- Facts About Sodium Azide, Centers for Disease Control and Prevention

D. BIOSAFETY

D.1. Introduction

The NMC Biosafety Plan identifies responsibilities, operational standards, and authorizations required to conduct research and teaching activities with regulated biological materials.

The DLR oversees use of biohazard materials by:

- Creating and enforcing policies and procedures
- Reviewing the use of biohazard materials
- Monitoring construction and use of biohazard containment facilities

NMC activities are guided by NMC policy, national guidelines, industry standards, and federal, state, and county regulations. The DLR reviews and approves all projects that involve biohazard materials before work begins.

NMC regulated biological materials covered in the NMC Biosafety Plan include:

- Recombinant DNA in vitro and in vivo
- Transgenic plants
- Releases of recombinant DNA to the environment

Researchers must have an approved IWD before beginning work with NMC regulated biological materials (see the list above).

Important: The Researcher is ultimately responsible for full compliance with policies, practices, and procedures set by the NMC.

Responsibility extends to all aspects of biosafety involving individuals who enter or work in the laboratory or under the auspices of the Researcher.

The NMC Laboratory Safety Plan is the primary reference for practices, procedures, and operational standards required for safe handling and use of biohazardous materials for research, and teaching activities at the NMC.

Biosafety Level Practices: The NMC laboratory containment requirements and practices for biosafety levels 1 and 2 are given in the chart below.

The NMC currently allows only Biosafety Level-1 and Biosafety Level-2 activities in its laboratories. The biosafety level is determined by the risk assessment of the work and organisms used:

- Degree of risk posed by the biohazardous materials
- Activities carried out with those materials

Biosafety levels (BSL)	**BSL–1**	**BSL–2** (Some agents and materials require enhanced precautions*)

A. Hazard levels		
1. Degree of hazard	Low risk: Well characterized agents not known to consistently cause disease in immunocompetent adult humans and present minimal potential hazard to lab personnel and the environment	Moderate: Agents that cause human disease of moderate hazard; not transmitted by aerosols in nature.
2. Examples	Escherichia coli (laboratory strain, K12), Bacillus subtillis, Saccharomyces cerevisiae	Listeria monocytogenes, Escherichia coli (environmental)
B. Standard microbiological practices		
1. Access to the laboratory	Access does not have to be restricted – however, doors cannot be propped open (in violation of fire code).	Doors to the laboratory are closed when BSL-2 work is being conducted to prevent public access.
2. Biohazard signage	No biohazard sign is required. (If sign posted, then agents listed, entry requirements, and emergency contacts)	Biohazard sign must be posted including BSL, supervisor's name and contact information.
3. Biohazard solid waste decontamination	Steam sterilization	Steam sterilization (with spore test)
4. Biohazardous liquid culture decontamination	10% bleach/water made fresh daily with bleach having an EPA registration number (e.g., Chlorox) for 30 minutes.	10% bleach/water made fresh daily with bleach having an EPA registration number (e.g., Chlorox) for 30 minutes or steam sterilize with DLR approval.
5. Eating, drinking, application of cosmetics or contact lenses	Prohibited in the laboratory areas	
6. Contaminated sharps (e.g., needles, blades, glass)	Safe handling practices must be implemented. Substitute plasticware for glassware whenever possible.	
7. Decontamination of work surfaces	Daily, after finishing work and following spills	
8. Pipetting	Mechanical device – no mouth pipetting	
9. Storage of biohazardous waste material	Bags held in rigid, leak-proof containers with biohazard labels on the top and side. Biohazardous waste must be under direct control of the responsible laboratory until it is placed in a DLR approved storage area.	
10. Hand washing	Required after working with potentially hazardous materials and before leaving the laboratory	

11. Training	The DLR must ensure that laboratory personnel receive appropriate training regarding their duties, the necessary precautions to prevent exposures, and exposure evaluation procedures.	
12. Medical surveillance	Recommended where personal health status may result in increased susceptibility to infection or inability to receive vaccinations or prophylactic interventions.	Recommended. Laboratory personnel must be provided with medical surveillance and offered appropriate immunizations when appropriate.
13. Equipment decontamination	Equipment must be cleaned of residues and green tagged by IBO before repair, maintenance, or removal from laboratory.	Equipment must be decontaminated and green tagged by IBO before repair, maintenance, or removal from laboratory.
14. Animals and plants not associated with the work	Not allowed in the laboratory	
15. IBO approval required for use of glassware	No	Recommended/required for some agents, which have BSL-2+ containment.
16. Lab-Specific Biosafety Manual	Lab contact information, safety information on specific hazards and research materials, serve as a training tool for personnel, readily available, contain current laboratory SOPs and practices, a copy of the current IBC registration, and a copy of the IBC approval letter.	
C. Safety equipment		
1. Class II Biological safety cabinet (with annual certification)	Recommended**	Required for all aerosol generating processes**
2. Sealed rotors or safety cups for centrifuging	Recommended**	Required for high concentrations or large volumes of infectious agents. Exception: Centrifuges without secondary containment can be operated inside a certified biosafety cabinet.
3. Laboratory coats	Required	Required. Must be decontaminated before being laundered.
4. Gloves (latex free)	Required	
5. Eye protection (safety glasses, goggles)	Required. This includes work in the biosafety cabinet.	
6. Sleeve protectors	Not required	
7. HEPA-filtered vacuum lines	Required	

D. Laboratory facilities		
1. Hand washing facilities	Required	
2. Autoclave	Required (Monthly)	Required (Bi-weekly)
3. Eyewash station	Required	
4. Doors	Required	Required. Doors should be self-closing and have locks.
5. Chairs	Chairs used in laboratory work must be covered with a non-porous material that can be easily cleaned and decontaminated with appropriate disinfectant.	
6. Cleaning and decontamination	Laboratory design should allow the facility to be easily cleaned and decontaminated. Carpets and rugs are not appropriate.	

*** Enhanced precautions (BSL-2+):** The NMC requires the use of additional practices and safety equipment for certain agents as determined by the risk assessment process.

**** Aerosol generating processes include (not extensive):**

- Centrifuging
- Grinding
- Blending / Vortexing
- Vigorous shaking or mixing
- Sonic disruption
- Opening containers with high internal pressures
- Cell sorters
- Homogenizers
- Using Needles, Syringes, and Pipettes
- Opening Pressurized vessels
- Using vacuum and aspirating equipment
- Flaming hot loops inserted into cultures and streaking inoculum
- Inoculating, picking or manipulating cultures in any way
- Harvesting tissues from animals

***** BSL-1 gloves:** The following are examples of when the use of nitrile gloves is mandatory: 1) anytime any work is being performed, 2) when there is the skin breakage or if a rash exists, 3) when hazardous materials (chemical, radioactive, etc.) or biologicals are used, 4) when an individual is immune-compromised, 5) when sharps are used. Further PPE and/or other types of gloves may be required when handling cryogenics, hot instruments or solutions, animals that bite, particularly hazardous chemicals, or when performing heavy duty work.

D.2. Biomaterials Inventory

NMC performs Biological Materials Inventory once a year in September.

For NMC Biomaterials inventory requirements, please contact IBO.

D.3. Disinfection/Decontamination

BSC Open Flames and Flammable Gases Policy: **Open flame burners are not allowed** in biological safety cabinets (BSC). Prohibition of open flame is intended to prevent fires or explosion within BSCs

and prevent workplace injuries and illnesses for all staff, students, and visitors. BSC installations will not be connected to gas lines. See alternatives to continuous flame devices below.

Alternatives to flame Bunsen burners

Electric Bunsen Burners Directs radiant heat up in one direction so user can heat items regardless of their shape.	
Glass Bead Sterilizer Glass beads in the well are maintained at 250°C for complete destruction of microorganisms and spores in seconds.	
FIREBOY (gas cartridge) Safety Bunsen Burner Safety enhanced laboratory gas burner with "Touch Free" IR-Sensor and button function or foot pedal.	
ARGOS (gas cartridge) StarFire Bunsen Burner Stainless steel body and compact size.	

Alternatives to disinfecting instruments in a BSC

Choose instruments that do not need to be disinfected in a BSC:

- Pre-sterilized inoculating loops and needles
- A glass bead sterilizer
- Pre-autoclaved forceps, scalpels, etc., in covered autoclavable plastic containers or the special sleeves manufactured for this use

Note: These items can be used individually in the BSC, and then placed in an autoclavable discard tray located in the BSC for used or contaminated utensils.

Decontamination of biological materials is a process of cleansing that removes contaminants. The purpose of decontamination is to remove biohazardous material and prevent spread of contamination.

Level of decontamination: The effectiveness of decontamination ranges from high-level sterilization to simple cleaning with soap and water. Levels of decontamination include:

- **Sterilization** (high-level decontamination) uses a physical or chemical procedure to destroy all microbial life, including highly resistant bacterial endospores.

- **Disinfection** (intermediate-level decontamination) uses a liquid chemical to eliminate virtually all pathogenic microorganisms, with the exception of bacterial spores, on work surfaces and equipment.
- **Cleaning** (low-level decontamination) uses water, detergent, and some mechanical action such as scrubbing with a gloved hand or brush. Cleaning is often a required step before sterilization or disinfection, because it removes all material such as soil or organic material and reduces the number of microorganisms on an object.

Use this Standard Operating Procedure for disinfecting tissue culture media.

How to Disinfect Tissue Culture Media:

1. **Prepare the primary vacuum flask with bleach.** Add bleach to the primary vacuum flask to equal 10% of the maximum collection volume. Maximum collection volume should be no more than two-thirds full.
2. **Label the flask as follows:** "Tissue culture media disinfected with bleach 9:1"
3. **Protect the vacuum line with a filter.** Insert an in-line hydrophobic HEPA filter **before** the vacuum outlet.

In-line HEPA filters

4. **Add the tissue culture media to be disinfected.**
   - Aspirate tissue culture media into bleach in the flask to make a final concentration of 10% bleach solution (9 parts tissue culture media: 1 part straight bleach).
   - After reaching maximum volume, allow a minimum 30-minute contact time.
   - Empty the flask into the laboratory sink.

Summary of Disinfectants: Practical requirements

Type	Practical Requirements		Inactivates			
	Dilution	Contact Time (min) *Broad Spectrum*	Vegetative Bacteria	Bacterial Spores	Lipovirus	Virus (non-lipid enveloped)
Quaternary Ammonium	0.1-2.0 %	Not effective	+	+		
Phenolics	1.0-5.0 %	Not effective	+	+	variable	
Chlorine	500 ppm	30	+	+	+	+
Iodophor	25-1600 ppm	30	+	+	+	+
Ethanol	70-85 %	Not effective	+	+	variable	
Isopropanol	70-85 %	Not effective	+	+	variable	
Formaldehyde	0.2-8.0 %	30	+	+	+	+
Glutaraldehyde	2.0 %	30	+	+	+	+

D.4. Equipment

- **Autoclaves:** Autoclaving, sometimes called steam sterilization, is the use of pressurized steam to kill infectious agents and denature proteins. This kind of "wet heat" is considered the most dependable method of sterilizing laboratory equipment and decontaminating biohazardous waste.
  - Autoclaves do not remove chemical contamination.
  - When used properly, autoclaves are safe and highly effective. For operating procedures, see section E.6
- **Bio Safety Cabinets (BSCs**), also known as tissue culture hoods, protect lab workers and the environment from aerosols or droplets that could spread biohazardous material.
  - *Caution: Make sure you are using a biological safety cabinet when you work with biohazards.*
  - Do not use fume hoods or clean benches for work involving biohazards. They look similar to a biosafety cabinet but do not provide effective primary containment for work with biohazards. Fume hoods are designed for work with chemicals; clean benches are intended to protect the research product but not the worker.
  - For operating procedures, see section E.3
- **Centrifuges:** For operating procedures, see section E.4

D.5. Regulations, Standards, and Policies

- Biosafety in Microbiological and Biomedical Laboratories (BMBL) 5th Edition, Centers for Disease Control and Prevention
- NIH Guidelines for Research Involving Recombinant DNA Molecules
- National Select Agent Registry, Centers for Disease Control and Prevention
- Primary Containment for Biohazards: Selection, Installation, and Use of Biological Safety Cabinets(PDF), Centers for Disease Control and Prevention
- Shipping - domestic
  - Code of Federal Regulations, National Archives and Records Administration
  - Research and Special Programs Administration, U.S. Department of Transportation
  - Plants and Plant Products Permits (including green Algae), USDA APHIS
- Shipping - international

  - Guidelines for the Safe Transport of Infectious Substances and Diagnostic Specimens, World Health Organization
  - Transportation of Dangerous Goods by Air, International Air Transportation Association (IATA)
  - Plants and Plant Products Permits (including green Algae), USDA APHIS
- Receiving- domestic (Receiver's Responsibility for Permits)
  - Transit Permit, USDA APHIS
- Receiving – international (Receiver's Responsibility for Permits)
  - Guidelines to Import Biological Agents or Vectors of Human Disease, Centers for Disease Control
  - Soil and Organism Permits, USDA APHIS
  - Plants and Plant Products Permits (including green Algae), USDA APHIS

D.6. Related Resources - Government and Research Institutions

- Center for Biosecurity, University of Pittsburgh Medical Center (UPMC)
- Centers for Disease Control and Prevention
  - National Center for Emerging and Zoonotic Infectious Diseases (NCEZID)
  - National Center for Immunization and Respiratory Diseases (NCIRD)
  - National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention (NCHHSTP)
- Howard Hughes Medical Institute
- National Organization for Rare Disorders
- Office of Biotechnology Activities, National Institutes of Health
- U.S. Army Medical Research Institute of Infectious Diseases
- U.S. Department of Health and Human Services
- World Health Organization

D.7. Reference Sources

- American Biological Safety Association (ABSA) - professional association that publishes and distributes a quarterly journal, "Applied Biosafety," and a number of other biosafety publications
  - Risk Group Classification for Infectious Agents, ABSA categorizes infectious agents based on their relative risk
- American Journal of Bioethics, Bioethics.net - moral issues in the fields of medical treatment and research, University of Pennsylvania School of Medicine
- Center for Bioethics, University of Pennsylvania
- Center for Infectious Disease Research and Policy, University of Minnesota - general bioterrorism information
- Medical Matrix - a project of the American Medical Association's Internet Working Group
- MEDLINE plus - health topics, drug information, medical encyclopedia, dictionary, and other resources
- Medscape from WebMD - peer-reviewed articles, color graphics, stored literature searches, and annotated links to Internet resources
- Morbidity & Mortality Weekly Reports, Centers for Disease Control and Prevention
- Multimedia Medical Reference Library - medical information resources for medical professionals, students, and patients
- National Health Information Center - toll-free information numbers, federal clearinghouses, and other resources
- National Institutes of Health Library - health information, scientific journals, and books
- National Library of Medicine - world's largest medical library
- OncoLink, University of Pennsylvania - information about specific types of cancer, updates on cancer treatments, and news about research advances
- PubMed - references and abstracts from more than 4,500 biomedical journals, National Library of Medicine

E. LABORATORY EQUIPMENT

E.1. Personal Protective Equipment (PPE)

Appropriate PPE must be worn before handling potentially hazardous biological materials and removed immediately and replaced if cross contamination occurs. PPE must be removed before exiting the laboratory.

Face Protection: When splash or splatter of chemical or biological materials is anticipated, appropriate face protection must be worn. Such equipment would include but is not limited to goggles, side-shielded safety glasses and chin length face shields.

Goggles or safety glasses with solid side shields in combination with masks or chin-length face shields, or other splatter guards, are required for anticipated splashes, sprays or splatters of hazardous materials. NMC requires the use of safety glasses at all times in their laboratories laboratory. Application or removal of contact lenses is not permitted in the laboratory setting where hazards may be present.

Lab Coats and Gowns: Laboratory clothing includes laboratory coats, smocks, scrub suits and gowns. Shorts, bare legs, and open shoes are not appropriate in a chem/biological laboratory. Long-sleeved garments must be used to minimize the contamination of skin or street clothes. In circumstances where it is anticipated that splashes may occur, the garment must be resistant to liquid penetration to protect clothing from contamination. If the garment is not disposable, it must be capable of withstanding sterilization in the event it becomes contaminated. Additional criteria for selecting clothing are: comfort, appearance, closure types and location, antistatic properties and durability. Protective clothing must be removed and left in the laboratory before leaving for non-laboratory areas. All protective clothing must be either discarded in the laboratory or laundered by the facility. Personnel must not launder laboratory clothing at home.

Gloves: Gloves should always be worn when handling hazardous chemicals or biological materials. Gloves must be selected based on the hazards involved and the activity to be conducted. Consult the IWD for appropriate gloves.

For biohazardous materials nitrile disposable gloves are recommended; **vinyl disposable gloves must not be used**. Latex gloves are discouraged for use in biological laboratories. Certain laboratory workers may develop or have allergies to latex. In addition, latex gloves may incur pinprick holes during routine procedures, and are not necessarily discernable to the worker, allowing exposure to a biological material. Compromised latex gloves readily tear and therefore allow immediate discard and change out of disposable gloves. Latex or other static electricity generating gloves must not be used when working with dry/powered biological toxins.

When working with biohazardous or other hazardous materials, glove must overlap the lower sleeve and the cuff of the laboratory garment. A long-sleeved glove or disposable arm-shield may be worn for further protection of the garment.

Temperature resistant gloves must be worn when handling hot material (e.g., working with autoclaves), or cold material, e.g., liquid nitrogen, dry ice, or containers from freezers. Delicate work requiring a high degree of precision dictates the use of thin walled gloves. Protection from contact with

toxic or corrosive chemicals may also be required. For assistance in glove selection, contact the IBO.

Wash your hands prior to leaving the laboratory. You also should:

a. Change gloves when contaminated, glove integrity is compromised, or when otherwise necessary;

b. Remove gloves and wash hands when work with hazardous materials has been completed and before leaving the laboratory;

c. Do not wash or reuse disposable gloves. Dispose of used gloves with other contaminated laboratory waste. Hand washing protocols must be rigorously followed.

Disposable Booties/ Shoe-covers: When significant splash and splatter are anticipated, booties/ shoe-covers should be considered. Prior to exiting the laboratory, these must be removed and disposed of properly.

Respirators: In certain instances, additional respiratory protection may be required. Respirator selection is based on the hazard and the protection factor required. Respirators must be carefully fitted to the individual and fit tested before confidence can be had in the respirator providing protection. Personnel who require respiratory protection must contact the IBO or DLR and have an approved IWD.

Respiratory Protection Plan. If the laboratory activity arises and requires respiratory protection equipment, NMC will provide training to the individuals and the details of use, maintenance/inspection and purchasing of the respiratory equipment will be included in the applicable IWD's that requires Respiratory Protection Plan (RPP). Current laboratory activities do not require respiratory protection.

E.2. Fume Hoods

Chemical fume hoods, when used properly, are one of the most reliable engineering controls in the laboratory. They protect workers by:

- Containing vapors, dusts, gases, and fumes generated within the hood, and removing them as air flows into the hood and then out via the laboratory exhaust system
- Contributing to laboratory ventilation as air flows through the hood
- Shielding the worker with a clear sliding window, called a sash, that contains aerosols and prevents injury from splashes, fires, or minor explosions that may occur inside the hood

Limitations: Fume hoods are not for use with biohazardous materials.

Use a biosafety cabinet to protect yourself and the environment from biological agents. In some cases, a glove box or another containment device is more appropriate for highly toxic materials.

Ductless chemical fume hoods are used by the NMC at the Entrada Biolab Facility. These hoods are approved for use for a specific set of chemicals. *Before using the hood with a new chemical or with an increased quantity obtain approval from the DLR or CHO.*

Certification: NMC's chemical fume hoods are inspected and tested semi-annually for functionality and condition. A certification sticker is placed on the front of each fume hood indicating the inspection results. Deficiencies are immediately reported to the DLR and CHO/IBO for abatement.

During certification testing, inspectors do the following:

- Remove old certification stickers
- Confirm the sash moves easily
- Test both the audio and visual alarms
- Confirm the face velocity is within the required specification of 60 linear feet per minute (lfm)
- Check overall fume hood condition

If you suspect your fume hood is not operating properly, contact the DLR, IBO, or FM immediately.

Chemical Fume Hood Use: Chemical fume hoods reliably help protect you from chemical hazards when properly used, but they do have limitations.

- Wear appropriate personal protection equipment when working with chemicals, even when work is conducted in a fume hood. At a minimum, wear the following:
  - Eye protection (safety glasses, goggles, and face shield as appropriate)
  - Gloves
  - Lab coat

Verify that the fume hood is working properly: Before beginning work in a chemical fume hood:

- Confirm the fume hood has been certified within the last 12 months.
  - If the date on the certification sticker is more than 12 months, contact the IBO or FM immediately.
  - Confirm the fume hood monitor is functioning properly - both visual and audio components indicate normal operation.
    - If either the visual or audio component appears to be in alarm mode, contact the IBO or the FM. Stop all work in the hood until the problem is corrected.
  - Confirm air is flowing into the hood before use. To check air flow:
    - Tape a strip of tissue (Kim wipe) onto the sash. It will flutter as air current blows by.
- Keep the airfoil along the front bottom edge of the fume hood in place at all times.
  - Avoid allowing electrical cords or hoses to impede the proper functioning of the bottom airfoil or sash.
- Keep hoods free of clutter and avoid using them for storage
- Avoid creating cross-drafts or air currents near the hood. They'll pull contaminated air out of the hood and into the breathing zone. Air currents can be caused by:
  - Air ventilation in the room
  - Open doors or windows
  - People walking by the hood
  - Rapid arm or body movement
- Don't modify the fume hood or exhaust system.

Practice Safe operating procedures:

- Keep the sash closed as much as practical for increased safety and for energy conservation.
- Avoid raising the sash above the arrow marking efficient operating level, except during setup
- Work at least 6 inches inside the hood to improve capture of contaminates.
- Don't use the hood to evaporate unwanted solvents or spills.
- Clean up spills immediately and dispose of waste solvents appropriately

Servicing or disposal of a chemical fume hood: Equipment that may have come in contact with radioactive, biohazardous, or chemical materials must be decontaminated before you have it serviced, repaired, moved, sent to Surplus Sales, or otherwise disposed of. Only the DLR or CHO may approve servicing of the chemical fume hoods.

E.3. Biosafety Cabinets

Overview: **Perform laboratory procedures that could create airborne biohazards in a biological safety cabinet (BSC).** BSCs, also known as biosafety cabinets or tissue culture hoods, protect lab workers and the environment from aerosols or droplets that could spread biohazardous material.

Caution: Make sure you are using a biological safety cabinet when you work with biohazards.

Do not use fume hoods or clean benches for work involving biohazards. They look similar to a biosafety cabinet but do not provide effective primary containment for work with biohazards. Fume hoods are designed for work with chemicals; clean benches are intended to protect the research product but not the worker.

E.3.1. Open Flames are Prohibited

Open flames and flammable gases are prohibited in biological safety cabinets at the NMC. Alternatives may be approved by the DLR.

E.3.2. Types of BSCs

Several kinds of BSCs are available, divided into classes (I, II, and III) and types (A, B, C). The NMC will use primarily Class II, Type A2 cabinets.

- **Class II cabinets** are designed to protect the research material as well as the worker and the environment. Both the supply air and the exhaust pass through a HEPA filter. There are 4 types of Class II cabinets.
- **Class II Type A2 cabinets** (formerly labeled Type A/B3) have a number of design features that make them more useful in research laboratories than other Class II cabinets. Also, if a Type A2 cabinet is vented to the building exhaust system via a properly functioning canopy (thimble) connection, it can be used with minute amounts of toxic chemicals.

Choose a location for the BSC away from pedestrian traffic, doors, and air currents generated by room ventilation — all of which can disrupt airflow.

Note: Class I cabinets do not protect the research material, and Class III cabinets (also called glove boxes) are completely contained cabinets that require workers to wear arm-length gloves attached to a front panel.

Certification Requirement: Semi-Annual certification is **required** for all BSCs used for work with biohazards. The certification process ensures your BSC is working as designed.

The NMC has a preferred vendor for certification and maintenance. Contact the CHO for details and contact information. Arrange for service well in advance.

Recertification after moving: Because even small moves can disturb the HEPA filter, the cabinet must be recertified after installation at a new location.

Relocation or decommissioning: BSCs must be decontaminated by a certified professional **prior** to being relocated or decommissioned. Contact the IBO for details.

E.3.3 Procedures for Safe Operation of a BSC

Improper use of a biological safety cabinet can result in contaminated cultures and expose workers to infectious organisms. When used correctly, a curtain of room air enters the grill at the front edge of the BSC work surface and acts as a protective barrier. The air mixes with the recirculating air stream and passes through a HEPA filter downward toward the work surface, creating a contamination-free zone.

Many of these guidelines aim to preserve the delicate air barrier that protects both the work products and the person working in a Class II biosafety cabinet, the type commonly used at the NMC.

Use the cabinet as intended:

- Do not use the top of the cabinet for storage; this can damage the HEPA filter.
- Keep only necessary equipment or supplies inside the BSC.

Take precautions before beginning work:

- Wear proper Personal Protective Equipment (PPE):
  - Lab coat
  - Gloves
  - Safety glasses
- Place materials in the cabinet before beginning work if possible.
- If the cabinet has an ultraviolet sterilizer, turn it off as soon as you enter the room.
- Turn on all blowers and cabinet illumination lights.
- Let the cabinet operate for about 5 minutes while you check the flow alarm system and visual alarm function (if applicable).
- Use an appropriate disinfectant to decontaminate the BSC's interior.

Ensure safe operation:

- Never have the ultraviolet light on when working at the cabinet. It can cause eye damage and skin burns.
- Avoid disrupting airflow:
  - Minimize movement (especially rapid movements) into and out of the BSC, or in areas near the BSC.
  - Don't block the front grill or rear vents with your arms or other materials.
  - Work at least 4 inches from the inside edge of the front vent.
- **Do not use Bunsen burners, other continuous flame devices, or flammable gases in a biosafety cabinet.** Safer sterilization methods exist, such as touch-plate micro burners equipped with a pilot light, small electric "furnaces," or pre-sterilized loops.
- Beware of fire hazards associated with vaporized ethanol and isopropanol disinfectants.

Take special precautions for ultraviolet (UV) lamp use:

- The NMC strongly discourages UV lamps in BSCs.
- National Institutes of Health (NIH), Centers for Disease Control and Prevention (CDC), National Science Foundation/ANSI, and the American Biological Safety Association agree that ultraviolet (UV) lamps are not recommended or necessary for decontamination in BSC's.
- If a UV lamp is used in your BSC, follow the procedures below:

Required:

- Post a warning sign on the front of the BSC indicating the presence of UV light hazards.
- The sign must say CAUTION: Turn off UV light before working.

Be aware of the hazards. Exposure to UV light can cause:

- Painful eye and skin burns
- Damaging exposure levels exist well after the output of the lamp bulb has dropped below the biocidal level.
- Deterioration of some tubing
  - This can be dangerous if you're using a touch-o-matic burner with natural gas tubing in a BSC.

Be aware of the limitations:

- Never rely on UV irradiation alone to disinfect a contaminated work area. UV is:
  - Not effective on porous materials that are opaque to the light such as wood or foam
  - Ineffective if a microbe is protected by dust, dirt, or organic matter
  - Affected by the accumulation of dust and dirt on the bulb surface
  - Effective only in direct line of site
  - UV does not work in shadowed areas, penetrate into cracks or through the grill work of a BSC
    - The spill area under the work surface of a BSC is a favorite hide out for fungal spore and hardy bacteria.
    - The UV lamp bulb remains lit long after the germicidal effectiveness is gone.

Take precautions during work:

- Turn off UV lamps while the lab is occupied. The stainless-steel interior of the BSC can reflect potentially hazardous illumination out of the opening of the cabinet.
- Never have the UV lamp on while an operator is working in the cabinet.

After work is complete:

- Turn the fan off and close the sash. Do NOT leave the UV lamp ON.

Maintenance:

- Clean UV lamp bulbs frequently by turning off the UV lamp then wiping off the surface of the room temperature lamp bulb with 70% alcohol.
- Before replacing bulbs, clear the BSC of equipment and material, and disinfect it with 10% bleach and then clean with 70% ethanol.
- Install the bulb with gloved hands to prevent oil build up.
- Disinfect lamp bulbs before disposal as universal waste.

Disinfect the cabinet after use:

When you are done:

- Decontaminate all items inside the work area
- Decontaminate the cabinet interior with an appropriate disinfectant
- Never rely on UV irradiation of the work area to disinfect a contaminated work area
- Operate the cabinet for about 5 minutes before turning off the blower

Resources:

- Decontamination and Sterilization, Office of Research Safety, Dept. of Occupational Health & Safety
- Laboratory Safety: Principles and Practices, Diane O. Fleming, Debra Hunt, 3rd ed., ASM Press
- Primary Containment for Biohazards: Selection, Installation, and Use of Biological Safety Cabinets(PDF), U.S. Dept. of Health and Human Services Public Health Services, Centers for Disease Control and Prevention and National Institutes for Health, 2000.

E.4. Centrifuge

Hazards associated with centrifuging include mechanical failure (e.g., rotor failure, tube or bucket failure) and the creation of aerosols. To minimize the risk of mechanical failure, centrifuges must be maintained and used according to the manufacturer's instructions. Users shall be properly trained, and operating instructions that include safety precautions shall be prominently posted on or near the unit. Aerosols are created by practices such as filling centrifuge tubes, removing plugs or caps from tubes after centrifugation, removing supernatant, re-suspending sediment pellets and by the very process of centrifugation. The greatest aerosol hazard is created if a tube breaks during centrifugation. To minimize the generation of aerosols when centrifuging biohazardous material, the following procedures shall be followed.

- Use sealed tubes and safety buckets that seal with O-rings. Before use, inspect tubes, O-rings and buckets for cracks, chips, erosions, bits of broken glass, etc. Do not use aluminum foil to cap centrifuge tubes because it may detach or rupture during centrifugation.

- Fill and open centrifuge tubes, rotors and accessories in a BSC. Avoid overfilling of centrifuge tubes so that closures do not become wet. After tubes are filled and sealed, wipe them down with disinfectant.
- Add disinfectant to the space between the tube and the bucket to disinfect material in the event of breakage during centrifugation.
- Always balance buckets, tubes and rotors properly before centrifugation.
- If the centrifuged specimen contains biohazardous material, open the centrifuge tubes inside a BSC with the tube pointed away from you.
- Do not decant or pour off supernatant. Use a vacuum system with appropriate in-line reservoirs and filters.
- Work in a BSC when re-suspending sediment material. Use a swirling rotary motion rather than shaking. If shaking is necessary, wait a few minutes to permit the aerosol to settle before opening the tube.
- Small low-speed centrifuges may be placed in a BSC during use to reduce the aerosol escape. High-speed centrifuges pose additional hazards. Precautions should be taken to filter the exhaust air from vacuum lines. Manufacturers' recommendations must be meticulously followed to avoid metal fatigue, distortion and corrosion.
- Avoid the use of celluloid (cellulose nitrate) tubes with biohazardous materials. Celluloid centrifuge tubes are highly flammable and prone to shrinkage with age. They distort on boiling and can be highly explosive in an autoclave. If celluloid tubes must be used, an appropriate chemical disinfectant must be used to decontaminate them.

E.5. Aerosol-creating Equipment

The use of blenders, ultrasonic disrupters, grinders and lyophilizers can result in considerable aerosol production. This equipment should be used in a BSC when working with biohazardous materials.

Safety blenders. Safety blenders are designed to prevent leakage from the bottom of the blender jar, provide a cooling jacket to avoid biological inactivation and to withstand sterilization by autoclaving. If blender rotors are not leak proof, they shall be tested with sterile saline or dye solution prior to use with biohazardous material. A towel moistened with disinfectant should be placed over the top of the blender during use. Before opening the blender jar, allow the unit to rest for at least one minute to allow the aerosol to settle and then open in a BSC. The device should be decontaminated promptly after use.

Lyophilizers and ampules. Depending on lyophilizer design, aerosol production may occur when material is loaded or removed from the lyophilizer unit. If possible, sample material should be loaded in a BSC. The vacuum pump exhaust shall be filtered to remove any biohazardous agents or, alternatively, the pump can be vented into a BSC. After lyophilization is completed, all surfaces of the unit that have been exposed to the agent shall be disinfected. If the lyophilizer is equipped with a removable chamber, it shall be closed off and moved to a BSC for unloading and decontamination. Handling of cultures shall be minimized and vapor traps shall be used wherever possible. Opening ampules containing liquid or lyophilized culture material shall be performed in a BSC to control the aerosol produced. Gloves must be worn. To open, nick the neck of the ampoule with a file. Wrap it in a disinfectant soaked towel. Hold the ampoule upright and snap it open at the nick. Reconstitute the

contents of the ampoule by slowly adding liquid to avoid aerosolization of the dried material. Mix the contents without bubbling and withdraw it into a fresh container. Discard the towel and ampoule top and bottom as biohazardous material waste.

Ampules used to store biohazardous material in liquid nitrogen have exploded causing eye injuries. The use of polypropylene tubes eliminates this hazard. These tubes are available dust-free and pre-sterilized, and are fitted with polyethylene caps with silicone washers. Heat sealable polypropylene tubes are also available.

E.6. Autoclave

Autoclaving (saturated steam under pressure of approximately 15 psi to achieve a chamber temperature of at least 250°F for a prescribed time) is the most convenient method of rapidly achieving destruction of all forms of microbial life.

- Autoclaves used for BSL-1 may be on the same floor in the general vicinity of the laboratory. BSL-2 laboratories shall either have an autoclave within the laboratory, or materials to be decontaminated in an autoclave outside the laboratory shall be placed in a durable, leak-proof container and closed for transport from the laboratory
- Each user shall complete the autoclave log for each autoclave cycle, which certifies in writing that the waste has been rendered noninfectious.
- Only trained personnel shall operate autoclaves.
- Each autoclave shall be operated as required by the operating instructions for that specific unit. Instructions shall be posted.
- A chemical indicator (e.g., autoclave tape) shall be used with each load placed in the autoclave.
- The use of autoclave tape alone is not an adequate monitor of efficacy. Autoclave sterility monitoring shall be conducted at least every 40 hours of autoclave operation using appropriate biological indicators (Bacillus stearothermophilus spore strips) placed at locations throughout the autoclave.
- Special precautions shall be taken to prevent removal of material from an autoclave before it has been sterilized, or simultaneous opening of both doors on a double door autoclave.
- Dry hypochlorites, or any other strong oxidizing material, shall not be autoclaved with organic materials such as paper, cloth or oil.
- Biohazardous waste shall be autoclaved at a minimum of 121 C (250 F) for a minimum of 30 minutes.

Guidance Note*: Geobacillus stearothermophilus* spores, which can survive at 250°F for 5 minutes but are killed at 250°F in 13 minutes, are more resistant to heat than most, thereby providing an adequate safety margin when validating decontamination procedures. Each type of container employed should be spore tested because efficacy varies with the load characteristics.

Guidance Note: Oxidizer + Organic Material + Heat = **possible violent reaction.**

Guidance Note: Biohazardous materials should not be placed in autoclaves overnight in anticipation of autoclaving the next day.

Guidance Note: Autoclave processing time used for decontamination shall produce a temperature in waste of at least 115 degrees Centigrade for 20 minutes. This may necessitate processing time of 60-90

minutes or more, depending on the loading conditions, i.e., type of waste container used, use of autoclavable waste bags, the amount of water added to the water, and the weight of the waste load. Extreme caution should be used when adding water to infectious waste so that aerosols containing infectious agents are not generated. Water, if added, should be trickled gently down the sides of the container rather than poured in directly, and any items added to the container after the water should be handled gently to avoid splashing.

- Autoclave bags and sharps containers shall be placed in an autoclavable container and loaded into the autoclave. Biohazard bags and sharps containers shall be labeled with the name. Autoclaves shall not be loaded beyond approved limits.
- If the autoclave does not attain the minimum time and/or temperature or the autoclave tape does not change color, a notation shall be made in the comment section of the autoclave log. The load then shall be re-autoclaved after placing new tape on the bags or sharps containers. If minimum time and temperature are not attained on the second cycle, users shall contact the person responsible for maintaining the unit to initiate repairs. Waste should then be treated at an alternate autoclave facility.
- After autoclave bags have cooled sufficiently to handle, they shall be disposed in a solid waste container. All sharps containers shall be collected for disposal.
- Thermometers shall be calibrated annually, and a written record shall be maintained. An authorized autoclave service company should do this during routine servicing.
- All records including logs, calibration results and *Geobacillus stearothermophilus* tests shall be kept for a minimum of three years. Logs and records storage locations shall be available upon request during inspections.
- The NMC DLR shall FAX form 4002-530-00-16.2 “Noninfectious Waste Transfer” to Los Alamos County Solid Waste Division at least annually or upon any change affecting the sterilization process. The original and the FAX confirmation shall be kept with the autoclave log data.

Operating an autoclave requires caution and adherence to strict regulatory requirements. Follow the autoclaving guidelines stated below for sterilizing equipment and research materials.

Autoclaving Guidelines for Sterilization of Lab Equipment

1. Check the autoclave’s drain screen. For efficient heat transfer, steam must flush the air out of the autoclave chamber. If the drain screen is blocked with debris, a layer of air may form at the bottom of the autoclave and prevent proper operation.
- Check the drain screen at the bottom of the chamber before using the autoclave
- Clean out any debris.

2. Prepare research materials for sterilization.
- **Glassware:**
  - Cap Pyrex bottles loosely – whether empty or filled – to prevent explosions due to expansion.
  - Cover bottles that are not made of safety glass (e.g., not Pyrex) with aluminum foil.
- **Liquids:** Fill containers only half full.
- **Combination loads:** Do not combine strong oxidizing material (such as dry hypochlorites) with organic materials (such as paper, cloth, or oil).

3. Use secondary containment for all items being autoclaved.

- Polypropylene or stainless-steel tubs are typically used for secondary containment.
- Make sure your plastic container is suitable for autoclaving. Not all plastics can be autoclaved. Plastic types can be identified by looking for initials imprinted on the container bottom.
  - Use:
    - Polypropylene (PP, recycle #5)
    - Polycarbonate (PC, no recycle number assigned)
  - Do not use:
    - Polyethylene (PE, recycle #1)
    - High-density polyethylene (HDPE, recycle #2)
  - If you're unsure about a new container, place it in an autoclave-safe container the first time.
- Select a container with the lowest sides and widest diameter possible for the autoclave.
- Leave space between items to allow steam circulation.

4. Close the autoclave door securely.

- Be sure the door is sealed before selecting the cycle.

5. Choose the correct cycle.

- For liquids, always choose the liquid or "slow exhaust" cycle.
- Ask your lab manager which cycle is recommended for sterilizing dry goods or equipment.
- There are 2 basic autoclave cycles:

Type of cycle	Appropriate material	Description
Gravity or "fast exhaust"	Dry goods, glassware, etc.	This cycle charges the chamber with steam and holds it at a set pressure and temperature for a set period of time. At the end of the cycle, a valve opens and the chamber rapidly returns to atmospheric pressure. Drying time may also be added to the cycle.
Liquid or "slow exhaust"	Liquids	This cycle prevents sterilized liquids from boiling. Steam is exhausted slowly at the end of the cycle, allowing the liquids (which will be super-heated) to cool.

Notes:

1. Never mix dry and liquid items in an autoclave cycle. Never run liquids in a gravity cycle or dry items in a liquid cycle. Always use the appropriate cycle for the items being autoclaved.
2. Never autoclave liquids in tightly capped or sealed bottles/containers. They may break and cause physical damage to the autoclave and/or to people.

- Other decontamination methods — including dry heat, ultraviolet or ionizing radiation, and liquid, gas, or vapor disinfection — are not a proper substitute for autoclaving or incineration before disposing of biohazardous material.

6. Set the appropriate time for sterilization and drying.

These guidelines contain recommended sterilization times. Always follow your lab's written operating procedures.

- **Nonhazardous dry goods:** 30 minutes of sterilization plus 20 minutes of drying time. Dry time may need to be increased for enclosed items such as pipette tips or bottles with lids.
- **Liquids** (add 10–20 minutes for crowded items):
  - Less than 500 milliliters (ml): 30 minutes
  - 500 ml – 1 liter: 40 minutes
  - 2–4 liters: 55 minutes
  - More than 4 liters: 60 minutes
- Let liquids stand for at least 10 minutes after the cycle is complete before opening the door.
- **Note:** Autoclaving new glassware for 90 minutes will partially temper it, increasing its strength.

7. Start the autoclave.

- Push the "start" button on the control panel to initiate the cycle.

8. Fill out the autoclave log.

Each machine must have an autoclave log where the operator records the date and other details.

- **Fill out the log** while the autoclave is "charging" or starting.

9. Follow the precautions when the autoclave cycle is finished.

- Wear personal protection equipment:
  - Lab coat
  - Eye protection
  - Shoes that completely cover your feet
  - Long hair should be tried back
  - Heat-resistant gloves to remove items, especially hot glassware
- Wait for the pressure gauge to drop to zero with zero time remaining before opening the door.
- Never open an autoclave set for "slow exhaust" until the cycle is complete. Superheated liquids can boil over and damage the autoclave and the operator.
- Open the door cautiously. Stand behind the door and slowly open it. Allow all steam to escape before reaching inside.
- Let liquids stand another 10–20 minutes after the autoclave is opened to avoid any movement that could cause them to boil. Remove items carefully.

Autoclaving Guidelines for Biohazardous Waste

1. Make sure the autoclave is calibrated to decontaminate biohazardous waste.
2. All autoclaves can sterilize and decontaminate laboratory materials.
3. Look for a label that reads either "Calibrated for biohazardous waste" or "Not calibrated for biohazardous waste."
4. Check the autoclave’s drain screen.
5. For efficient heat transfer, steam must flush the air out of the autoclave chamber. If the drain screen is blocked with debris, a layer of air may form at the bottom of the autoclave and prevent proper operation.
6. Check the drain screen at the bottom of the chamber before using the autoclave. Clean out any debris.
   a. Prepare and label bags of dry biohazard waste.

7. Ensure that dry waste is free of liquids and sharp objects that could puncture the waste bag. Treat biohazardous waste that could puncture the bag as sharps.
8. Fill bags only half full. Ensure adequate steam penetration by closing bags loosely, leaving a 1-inch opening.

9. Place bags in a secondary container. Polypropylene bags are tear-resistant but can still be punctured in the autoclave. Place bags in a rigid secondary container during autoclaving to eliminate the primary cause of damage to the machines and reduce downtime.
10. If the bags don't have an autoclave indicator section, cover the bag's biohazard symbol with autoclave indicator tape.
11. Autoclave the load immediately after preparation. Never leave items in the autoclave overnight.
    a. Prepare and label biohazardous sharps containers for autoclaving. Sharps are devices or objects with corners, edges, or projections capable of cutting or piercing skin or regular waste bags.

12. Cover the container's biohazard symbol with autoclave indicator tape.
13. Autoclave the load immediately after preparation**.** Never leave items in the autoclave overnight.
    a. Use secondary containment for all items being autoclaved.
14. Polypropylene or stainless steels tubs are typically used for secondary containment.
15. Make sure your plastic container is suitable for autoclaving. Not all plastics can be autoclaved. Plastic types can be identified by looking for initials imprinted on the container bottom.
    a. Use:
        - Polypropylene (PP, recycle #5)
        - Polycarbonate (PC, recycle #unavailable)
    b. Do not use:
        - Polyethylene (PE, recycle #1)
        - High-density polyethylene (HDPE, recycle #2)
    c. If you are unsure about a new container, place it in an autoclave-safe container the first time.
16. Examine containers for cracks, which may cause autoclaved biohazard waste to fall onto the operator.
17. Select a container with the lowest sides and widest diameter possible for the autoclave.
18. Leave space between items to allow steam circulation.
    a. Be sure to close door securely
    b. Be sure the door is sealed before selecting the cycle
19. Confirm temperature and set decontamination time.
20. Temperature: Decontamination requires temperatures of at least 250–255°F (121–124°C). The chamber should reach 90% of its full temperature within 5 minutes.
21. Time: The autoclave should run for at least 60 minutes.
22. If the running time or the temperature is incorrect, rerun the load. If the autoclave fails to maintain the correct time or temperature again, contact the IBO/CHO.
23. Choose the correct cycle and start the autoclave.
24. Select the liquid cycle (also called "slow exhaust" on some machines).

25. Push the "start" button on the control panel to initiate the cycle.
26. Fill out the autoclave log.
27. Fill out the log while the autoclave is "charging," or starting.
28. Each machine must have an autoclave log where the operator records the date, description of waste, and other details.
29. Follow these precautions when the autoclave cycle is finished.
30. Wear personal protection equipment:
    - Lab coat
    - Eye protection
    - Closed-toe shoes
    - Heat-resistant gloves to remove items, especially hot glassware
31. Wait for the pressure gauge to drop to zero with zero time remaining before opening the door.
32. Never open an autoclave set for "slow exhaust" until the cycle is complete. Superheated liquids can boil over and damage the autoclave and injure the operator.
33. Open the door cautiously. Stand behind the door and slowly open it. Allow all steam to escape before reaching inside.
34. Let liquids stand another 10–20 minutes after the autoclave is opened to avoid any movement that could cause them to boil (superheat). Remove items carefully.
35. Properly dispose of waste.
36. Remove autoclaved waste immediately after the cycle is completed and the appropriate waiting time for liquids has been observed. Never leave items in an autoclave overnight.
37. Place the autoclaved waste in the designated biohazardous waste collection area to be hauled for disposal. Ask the IBO for instructions.
38. Dispose of autoclaved waste as medical solid waste.

E.7. Chemical Spill Kits

NMC DLR or CHO should be contacted for instructions before cleaning up a chemical spill. All SDS and label instructions should be followed, and appropriate PPE should be worn during spill cleanup.
Chemical Spill Kits locations:
1 Large kit – Greenhouse (Lab# 103)
1 Large kit – Autoclave room (Lab# 175) behind the door
2 Small kits – PBR room (Lab# 144)
2 Small kits – Shaker room (Lab# 131)
2 Small kits – Bacterial room (Lab# 135)
Roll/packs of absorbents are located in Receiving room (# 171) and Storage room

E.8. Special Refrigerators for Flammable Liquids Storage

Never store flammable liquids of any volume in a standard or domestic refrigerator or freezer. They have numerous ignition sources that could ignite vapors.

Flammable liquids that must be chilled or frozen require special flammable storage refrigerators or freezers to minimize the risk of fire or explosion.

Flammable storage refrigerators are available from many commercial manufacturers.

Two types of flammable storage units are commercially available:

- Flammable storage refrigerators and freezers have no exposed ignition sources inside the cabinet, such as lights or switches that could ignite vapors.
- An explosion-proof refrigerator or freezer may be required in rare circumstances in hazardous locations. Explosion-proof or spark-proof units have no interior or exterior ignition sources.

Label refrigerators to avoid confusion:

- Label refrigerators used for chemical storage with a Laboratory Use Only sticker.
- Label refrigerators used for storage of non-flammable chemicals with a No Flammable Storage sticker.

Caution: Never use environmental rooms, also known as cold / warm rooms, for storage of flammable or other hazardous materials of any volume. Environmental rooms have many ignition sources and little or no air circulation from outside. Small quantities of flammable or hazardous materials (500 ml or less) may be used in these spaces, but do not store them there.

F. ELECTRICAL SAFETY

Electrical work is considered by the NMC to be a Primary Hazard Activity. Electrical work can only be performed by an Approved Electrical Worker. All electrical work needs to be preapproved by the DLR.

F.1. Approved Electrical Workers

Approved Electrical Workers will be responsible for performing authorized electrical work safely by assessing and controlling the hazards associated with performing that work, by adhering to safety-related work practices. Approval as an Electrical worker is given by the DLR based on training, experience and demonstrated performance.

Responsibilities include:

1. Maintaining qualification by maintaining formal classroom, demonstrated proficiency, and on-the-job electrical safety training.
2. Participating in the pre-job brief for each work activity, and ensuring an understanding of the hazards and controls.
3. Participating in defining the scope of work, the hazards, and hazard mitigation techniques and in the generation, review, and verification of job specific safety documents (e.g., IWDs) when requested for new work.
4. Being aware of and warning others about electrical hazards in the workplace.
5. Implementing safe work procedures when performing any task or activity that exposes the worker to an electrical hazard.
6. Not performing any unauthorized hazardous electrical work.
7. Using required PPE in accordance with NFPA 70E, Standard for Electrical Safety in the Workplace.
8. Stopping work immediately when an operation is perceived to present an imminent danger.
9. Excusing themselves from a job if they do not believe they possess the competency to perform the work safely.
10. Informing DLR of any electrical task or deficiency that exceeds the worker's resources, competence, or level of authorization.

11. Participating in electrical safety assessments when required.
12. Immediately reporting unanticipated incidents (e.g., shock, electrical flash, arcing, fire) to the DLR.
13. Reporting to the DLR immediately if an electrical injury occurs or may have occurred in cases such as arc flash to the eyes, acute noise to the ears, or shock (except for ESD shocks, e.g., **'**carpet shock**'**).
14. Ensuring all electrical equipment is NRTL-listed or approved for use by an approved Electrical Worker, prior to the use of such equipment.
15. The equipment must be approved in a manner consistent with NMC requirements.
16. The equipment may not be used outside the listing or the approval.
17. Report any concerns or issues with electrical safety to the DLR.

F.2. Purchase, Loan, or Construction of New Electrical Equipment

Electrical equipment that is purchased, loaned, or built for use at NMC must be NRTL listed or approved by the DLR before use. Purchase of NRTL-listed equipment that is used for its intended purpose does not require DLR approval. NRTL-listed equipment should be purchased and used, if available.

For all acquisition of new electrical purchased equipment, the DLR needs to approve prior to its purchase. The DLR can help determine if a listed version is available. If not, the DLR may help determine electrical safety design specifications that can be a part of the purchase process.

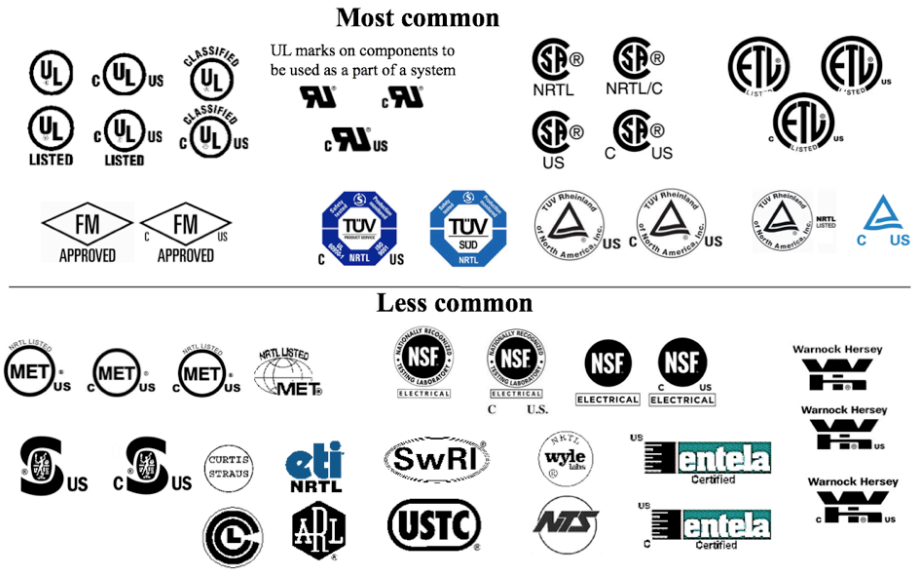
For efficient design and construction of new electrical equipment built in-house, the DLR should be involved in the design and construction phases to ensure that the correct engineering controls are incorporated. Only the DLR can approve the equipment before it can be put into use.

For subcontractor provided equipment, electrical design or vendor proposals for unlisted equipment should be approved by the DLR prior to contract award or issuance of a purchase request.

F.3. Unlisted Electrical Equipment Approval

The NMC considers unlisted electrical equipment containing electrical hazards to include electrical equipment that is not NRTL listed, and NRTL-listed equipment that has been modified or is used outside of its intended use (as stated in the listing). Such equipment must be approved by DLR prior to use. Inspection and approval for unlisted electrical equipment shall be documented in the unlisted electrical equipment database. For most pieces of equipment, the approved equipment shall be labeled with the NMC equipment approval label on the equipment. For systems composed of many components, however, how to label may not be obvious, especially if the system is distributed over an area. Approval documentation could be included in the IWD for operation.

F.4. Nationally Recognized Testing Laboratory (NRTL) Symbols



The European Union CE Mark is Not a Nationally Recognized Testing Laboratory (NRTL).

CE

F.5. Guidelines for Electrically Powered Laboratory Apparatus

Serious fire and shock hazards can result when electrical equipment is not maintained or used properly. To reduce the possibility of fire or electrical shock keep the workplace free from electrical hazards.

Wall outlets: Wall outlets are designed to provide electricity for only 2 appliances at the same time. Overloading them may result in a fire hazard.

- Do not use outlet adaptors — they can cause the circuit to become overloaded.

- Use a multiple-outlet power strip if you need to increase electrical supply in your area. These devices have an internal circuit-breaker switch that will stop electrical flow if overloading occurs.

- Report broken or uncovered outlets.

Extension Cords: Extension cords are intended for temporary use, not for supplying permanent power to tools and appliances. If you must use an extension cord, do the following:

- Select the right extension cord. Answer these 3 questions about the intended use to determine the type, wire size, and length of cord needed for the job:

  1. *Is the cord for indoor or outdoor use?*
     - Cords rated for outdoor use can be used both indoors and out, but never use an indoor cord outside.
  2. *How much electrical current (typically rated in amperes, or amps) does the tool or appliance require?* The amperage requirement determines the wire size needed.
     - Choose the right wire size for the intended use. Extension cords are rated by wire size, known as gauge. The thicker the wire, the more amps it will carry. Amperage requirements are usually given with the tool or appliance.
     - A cord's wire thickness is identified by the letters AWG followed by numbers: typically 12, 14, or 16.

On this extension cord, the AWG 12-3 means the wire gauge is 12 and there are 3 wires inside.

In this case, less is more – the lower the number, the thicker the wire.

Rule of thumb: Be sure the diameter of the extension cord is as large or larger than the cord being plugged into it.

  3. *What is the maximum distance the cord will need to extend from the permanent electrical outlet?*
     - Select the right length of cord. The ability of a wire to carry specific amperage will diminish as its length increases. If you need a lot of amps carried over a long distance, you'll need a heavier gauge wire.
     - Use the chart below as a guide for selecting an extension cord of appropriate gauge and length for the amperage required.

Ext. cord length (feet)	Amperage required (amps)					
	0-2	2-5	5-7	7-10	10-1	12-15
25	16 ga	16 ga	16 ga	16 ga	14 ga	14 ga
50	16 ga	16 ga	16 ga	14 ga	14 ga	12 ga
100	16 ga	16 ga	14 ga	12 ga	12 ga	10 ga

150	16 ga	14 ga	12 ga	12 ga	10 ga	–
200	14 ga	14 ga	12 ga	10 ga	–	–

- Inspect extension cords periodically for cracked or frayed insulation.
  - Replace cords that show signs of wear. Do not tape over them.
  - Buy UL-listed cords.
- Do not link or "daisy chain" extension cords. Select a single extension cord long enough to do the job.
- Plug extension cords directly into the wall, not into a power strip or 3-prong adaptor.
- Never run an extension cord under carpeting or through walls.
- Never tack or staple an extension cord to the wall or woodwork — it could damage the cord and create a fire hazard.

Electrical Shock Hazards: Electricity travels in closed circuits and wants to reach the ground any way it can. If you contact electricity, you become its conduit to the ground.

- Be aware of situations where you may act as a circuit ground when working near electricity.
- Never work on a "hot" (energized) circuit or electrical apparatus.
- If any of these warnings occurs, take it seriously. Disconnect power and have the equipment serviced.
  - Mild shock or tingling when in contact with an electrical machine
  - Frayed or exposed wires
  - Excessively hot motors
  - Unusual odors such as burning insulation
  - Inoperative or erratic switches; erratic equipment operation
  - Sparks or smoke

F.6. Preparation for a Power Failure in the Lab

Learn what to do before, during, and after a power failure in a lab.

Before the power fails:

- Determine the emergency contact person
- Equip the emergency/spill kit with a battery-powered flashlight.
- Do not leave open chemicals in the fume hood when the fume hood is unattended. Always safely store chemicals after use.
- Put essential equipment on emergency power circuits.
- Make a list of equipment that must be reset, reprogrammed, restarted, or recalibrated once power returns.
  - ✓ Post the list in a conspicuous place.
  - ✓ Program equipment that operates unattended to shut down safely during a power failure and not restart automatically when power returns.
- Identify an emergency source of dry ice, if you have items that must be kept cold.

- ✓ Note: Refrigerators and freezers will maintain their temperature for several hours if they are not opened.
- ✓ Do not use dry ice in walk-in refrigerators or other confined areas.

While the power is off:

- Shut down experiments that involve hazardous materials.
  - ✓ Make sure experiments are stable and won't create uncontrolled hazards.
- Check fume hoods and biosafety cabinets and take the following precautions, if applicable:
  - ✓ Stop any operations that may be emitting hazardous vapors, fumes, or infectious agents.
  - ✓ Securely cap any open containers.
  - ✓ Close fume hood and biosafety cabinet sashes.
- Check equipment on emergency power to ensure it's running properly.
  - ✓ Note: It may take 20 to 30 seconds for emergency power to activate after a power failure.
- Reduce electrical use and risk of power surges by:
  - ✓ Disconnecting from emergency outlets equipment that runs unattended, and
  - ✓ Turning off unnecessary lights and equipment.
- Transfer vulnerable items from cold rooms and refrigerators that have lost power to equipment served by emergency power.

After the power returns:

- Check equipment:
  - ✓ Reset and restart equipment
  - ✓ Confirm airflow in your fume hood is restored
  - ✓ Recalibrate and reprogram equipment as necessary
- Keep doors closed on refrigerators and freezers that failed until they have been repaired and returned to safe working temperature:
  Note: Some refrigerators and freezers require a manual restart
- If system or equipment failures create hazardous conditions, immediately notify:
  - ✓ During business hours: DLR, FM, IBO
  - ✓ After business hours: DLR, FM, IBO

G. PRESSURE SYSTEMS SAFETY

The Installation, Use and Maintenance of Pressure Systems are considered a Primary Hazard Activities by the NMC. If pressure equipment fails in use, it can seriously injure or kill people nearby and cause serious damage to property. The installation and maintenance of Pressure Systems is restricted to Approved Pressure Workers. Work that uses a pressure system at the NMC shall have an IWD and only workers approved under the IWD can use the pressure system.

Examples of pressure systems are autoclaves and equipment that use compressed gases.

Principal causes of incidents are:

- Poor equipment and/or system design
- Poor maintenance of equipment

- An unsafe system of work
- Operator error, poor training/supervision
- Poor installation
- Inadequate repairs or modifications

The main hazards are:

- Impact from the blast of an explosion or release of compressed liquid or gas;
- Impact from parts of equipment that fail or any flying debris;
- Contact with released liquid or gas, such as steam; and
- Fire resulting from the escape of flammable liquids or gases.

The level of risk from the failure of pressure systems and equipment depends on a number of factors including:

- The pressure in the system
- The type of liquid or gas and its properties
- The suitability of the equipment and pipework that contains it
- The age and condition of the equipment
- The complexity and control of its operation
- The prevailing conditions (e.g. a process carried out at high temperature)
- The skills and knowledge of the people who design, manufacture, install, maintain, test and operate the pressure equipment and systems

To reduce the risks the NMC:

- Fits suitable protective devices and ensure they function properly
- Ensures suitable protective devices are fitted to the vessels, or pipework (e.g. safety valves and any electronic devices which cause shutdown when the pressure, temperature or liquid or gas level exceed permissible limits)
- Ensures the protective devices have been adjusted to the correct settings
- If warning devices are fitted, ensures they are noticeable, either by sight or sound
- Ensures protective devices are kept in good working order at all times
- Ensures that, where fitted, protective devices such as safety valves and bursting discs discharge to a safe place
- Ensures that, once set, protective devices cannot be altered except by an authorized person.
- Carries out suitable maintenance
- Makes provision for appropriate training
- Provides safe and suitable equipment
- When installing new equipment, ensures that it is suitable for its intended purpose and that it is installed correctly
- Ensures that he pressure system is designed and manufactured from suitable materials
- Knows what liquid or gas is being contained, stored or processed, for example is it toxic/flammable?
- Knows the process conditions, such as the pressures and temperatures.

- Knows the safe operating limits of the system and any equipment directly linked to it or affected by it
- Ensures there is a set of operating instructions for all the equipment and for the control of the whole system including emergencies
- Ensures that appropriate workers have access to these instructions, and are properly trained in the operation and use of the equipment or system

H. EMPLOYEE INFORMATION AND TRAINING

H.1. Training Program

H.1.1. Blood Born Pathogens Program

OSHA Standard:

OSHA's Bloodborne Pathogens standard (29 CFR 1910.1030) as amended pursuant to the *Needlestick Safety and Prevention Act* of 2000 (Pub. L. 106-430), prescribes safeguards to protect workers against the health hazards caused by bloodborne pathogens. The standard places requirements on employers whose workers can be reasonably anticipated to contact blood or other potentially infectious materials (OPIM), such as unfixed human tissues and certain body fluids. The Act also mandated additional requirements for maintaining a sharps injury log. Some of the new and clarified provisions in the standard apply only to healthcare settings, but other provisions, particularly the requirements to update the Exposure Control Plan and to keep a sharps injury log, apply to non-healthcare as well as healthcare settings.

Training:

NMC provides a BBP Universal Precautions training to

- Lab workers (researchers and technicians) and custodians
- Employees with NMC-sponsored CPR/AED certifications.

The employees take a quiz after the training. BBP training records are kept by the NMC HR Specialist. NMC provides BBP training refreshers to previously trained employees once in 3 years and once a year for employees working on BSL2 projects.

BBP Exposure Control Plan Summary (ECP):

- The individual exposure and required procedures are determined in IWD prior start of work.
- BBP hazard is communicated to potentially exposed employees via BBP training and/or IWD.
- Universal Precautions. Posters with BBP information are placed at all locations. PPE and BBP cleanup kits are available at all locations. Engineering and work practice controls are in place; see the NMC Lab Safety Program for details.
- PPE training is provided to lab workers through the NMC Lab Safety Program and as Safety Training.
- Good housekeeping practices, including decontamination procedures and removal of regulated waste are communicated to employees via annual BBP training and the NMC Lab Safety Program.

- Exposure incidents are reported immediately and evaluated and addressed by management. Records are kept in 300 logs and internal safety incident management and recording system.
- As a research organization, NMC is exempt from maintaining a log of occupational injuries and illnesses under 29 CFR Part 1904. Hence, it is exempt from maintaining a sharps injury log. (https://www.osha.gov/doc/outreachtraining/htmlfiles/record.html)

The ECP is reviewed and updated annually (in August) to reflect new or modified tasks and procedures that affect occupational exposure and to reflect new or revised employee positions with potential exposure.

Reference: https://www.osha.gov/SLTC/bloodbornepathogens/bloodborne_quickref.html

H.1.2. Mercury Release and Spill

This training is offered to newly hired Safety Officers and Custodians whose job responsibilities include potential exposure to mercury release and spills. Refresher training is provided once in 3 years.

EPA standards are used for the training: http://www.epa.gov/mercury/spills/index.htm.

Employees are required to take a quiz after the training. The training records are kept by the HR Specialist.

Broken Bulb Cleanup

When tubular and compact fluorescent bulbs accidentally break the hazardous metal mercury in the glass bulb is released and a small amount of mercury vapor enters the air. The following cleanup plan informs workers how to avoid glass cuts and exposure to mercury releases from broken bulbs.

Before cleanup, have people leave the room. Air out the room for 5- 10 minutes. Collect materials needed to cleanup: stiff paper, sticky tape, damp paper towels and a glass jar with a metal lid or a sealable plastic bag. Put on gloves and face shields.

During cleanup, do not use brooms, brushes, or vacuum cleaners because they will increase air levels of mercury and will become contaminated. Be thorough in collecting broken glass and visible powder. Scoop up glass fragments and powder using stiff paper and damp paper towels. Pick up any remaining small glass fragments and powder with sticky tape. Never pour mercury down a drain.

After cleanup, promptly place all cleanup materials used in a sealed plastic bag and place the bag and all other waste materials from the cleanup in the 5-gallon DOT bucket from our waste disposal company for safe storage of broken glass and hazardous materials. Never wash clothing contaminated with mercury. If practicable, air out the room where the bulb was broken and leave the heating / air conditioning shut off for several hours. Stericycle Environmental Services (formerly, PSC) is NMC's chemical waste disposal contractor.

H.1.3. HAZCOM

New employees, visiting researchers, and service associates who may be exposed to hazardous chemicals under normal operating conditions are required to take the NMC HAZCOM training at the time they are assigned to work and whenever a new physical or health hazard the workers have not previously been trained about is introduced into their work area. The intent is to comply with the OSHA provision 1910.1200(h).

New employees, visiting researchers, and service associates who have been previously trained by another employer, union or other entity, may forgo the training if the DLR and COO ascertain that the previous training is sufficient to meet the standard's training requirements for the current work being performed.

Additional training is to be done whenever a new physical or health hazard is introduced into the work area, not a new chemical.

The IBO will provide each employee with initial information and training sessions before they start work in the laboratory

- The contents of the Occupational Exposure to Hazardous Chemicals in Laboratories Standard 29CFR1910.1450 and its appendices;
- The location and availability of the Chemical Hygiene Plan;
- The signs and symptoms associated with exposures to hazardous chemicals used in the laboratory;
- Information on OSHA permissible exposure limits (PELs) where they exist, and other recommended exposure limits; and
- 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, Safety Data Sheets (SDS) received from chemical suppliers

In addition to above information, employees are trained on the following:

- Methods & observations which may be used to detect the presence or release of a hazardous chemical in the work area (monitoring methods and devices, visual appearance and/or odor, etc.);
- The physical and health hazards of chemicals in laboratory work areas; and
- The measures to protect employees from these hazards, including:
  - Standard operating procedures
  - Work practices
  - Emergency procedures
  - Personal protective equipment
  - Details of the chemical hygiene plan.

H.1.4. PPE Training

This training is offered to new laboratory workers: employees, visitors, and service associates: http://www.free-training.com/osha/ppe/ppemenu.htm. PPE is also discussed in this Lab Safety Program and available as a Safety Training in our Safety Training System. A refresher is offered every 3 years.

H.1.5. Biolab Safety Program

This site-specific Safety Program is introduced to new laboratory workers: employees, visitors, and service associates. Chemical Hygiene Program, and Hood User Trainings are included in this Safety Program. Refreshers are offered every 3 years.

H.1.6. OSHA 300 Logs

NMC provides a 300 Logs training to the HR Specialist and DLR. NMC employees use the NMC internal accident reporting system to report accidents. The 300 logs are maintained onsite by the NMC HR Specialist and the DLR.

Training summary:

- Employer must orally report to OSHA the death of any employee from a work-related incident or the in-patient hospitalization of three or more employees as a result of a work-related incident within eight (8) hours.
- Employees must report to a Manager -- All work-related injuries, illnesses and 'near-misses.'
- How to report it -- in person or by email, as soon as possible.
- What to record on 300 Logs -- All work-related injuries and illnesses resulting in death, loss of consciousness, days away from work, restricted work activity or transfer, or medical treatment beyond first aid.
- 300 Logs are open to all employees.
- Who records on the 300 Log – DLR or HR Specialist, within 7 days
- Employer must post Form 300A, the Summary of Work-Related Injuries and Illnesses, in the workplace every year from February 1 to April 30

Reference: https://www.osha.gov/recordkeeping/index.html .

H.2. Medical Program

The New Mexico Consortium provides all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, for the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee is provided an opportunity to receive an appropriate medical examination. The employee shall contact the IBO to initiate the medical program.
- When exposure monitoring reveals an exposure routinely above the action level, or in the absence of an action level above the Permissible Exposure Limit (PEL), for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements. Medical Surveillance shall be established for the affected employee as prescribed by the particular OSHA Standard. (Medical Surveillance & Exposure requirements as per 29CFR1910.1001 through 29CFR1910.1052)
- Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous chemical exposure, the affected employee(s) is provided an opportunity for a medical consultation. This consultation is for the purpose of determining the need for a medical examination. An appropriate medical examination is provided as necessary.
- Before the start of BSL2 activities.

All medical examinations and consultations are performed by or under direct supervision of a licensed physician, are provided at no cost to employees without loss of pay and at a reasonable time and place.

Information Provided to Healthcare Professional

The NMC Safety Officer will provide the physician the following information:

- The identity of hazardous chemical(s) to which the employee may have been exposed to;
- A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and
- A description of the signs and symptoms of exposure the employee is experiencing, if any.

Healthcare Professional's Written Opinion

A written opinion from the examining physician for a medical examination or consultation which is required by the Standard is obtained. This opinion shall include*:*

- Any recommendation for further medical follow-up;
- The results of the medical examination and any associated tests;
- Any medical condition that may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace; and
- A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

The written opinion shall not include any findings/diagnoses which is not related to an occupational exposure.

Reproductive Hazards in the Workplace

Exposure to certain chemicals, radioisotopes, and biological agents may cause problems, such as infertility, miscarriage, and birth defects. It is important for both men and women to understand the risks of reproductive hazards. Take the following steps to protect yourself from unnecessary exposures:

The NMC researchers working with any chemical that is considered a reproductive hazard **must** include a "Reproductive Hazard" hazard control plan in the IWD.

This IWD must be preapproved by DLR **prior** to beginning any work with this material.

An employee may wish to declare her pregnancy (or intent to become pregnant) so the NMC can address possible reproductive hazards in her workplace, and provide information about safe work practices for her physician's approval.

Declaration of pregnancy is voluntary and all information relating to the pregnancy is strictly confidential.

Required: The DLR must confirm that employees receive safety training about the hazardous materials they use, and that training records are kept.

References:

12.14 Reproductive and Developmental Toxicants, III. Laboratory Chemical Hygiene, Hazard Awareness and Management Manual, Fred Hutchinson Cancer Research Center Extranet

H.3. Ergonomics

NMC is committed to providing its employees a workspace where they can work comfortably without injuries. Most workplace injuries are related to ergonomics and are caused by workstations that are not properly adjusted, ill-fitting protective gear or repetitive motion. We look for these issues as people work but ultimately, we rely on employees to raise ergonomic issues regarding their work environment or the tasks they perform. Employees are encouraged to raise these issues with their managers. If the issues are not addressed, employees may approach the HR administrator with their concern and she will work with the Executive Director until the issues are resolved.

H.4. Recordkeeping

All accident, fatality, illness, injury, and medical records and exposure monitoring records are retained by NMC for each employee in accordance with the requirements of federal regulations 29 CFR part 1904, § 1910.1020, and § 1910.1450(j). Any exposure monitoring results will be provided to affected laboratory staff within 15 working days after receipt of the results (29 CFR 1910.1450(d)(4)).

H.5. Signs

The following prominent signs are posted:

a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers
b) Location signs for safety showers, eyewash stations, other safety and first aid equipment, and exits
c) Warnings at areas or equipment where special or unusual hazards exist.

I. EMERGENCY PLANNING

I.1 Communication during Emergency

- If life-threatening emergency call 911
- If fire, pull fire alarm, call 911; Integrated Controls is our Fire Alarm Monitoring Service
- If medical emergency, call 911 or have co-worker call 911
- If evacuation required, go to staging area at the west end of Entrada Drive
- If shelter-in-place determination, go to designated area(s) selected by the DLR (room without windows)

Institutional Contacts

CEO & DLR:	Steve Buelow	505-695-4618
COO:	Irina Izvekova	505-412-4178
Institutional Biosafety Officer (IBO):	Leyma De Haro	505-850-5238
Facilities Manager:	Jaime Barber	505-500-7140
Lab Admin:	Nata Gadzhiyeva	505-431-0010

Emergency Telephones

Los Alamos Fire Department:	505-662-8301

Paramedics:		911
Ambulance:		911
Police:		911
Los Alamos Department of Utilities:		505-662-8333
Telephone Services:	Nextiva	800-983-4289

Emergency phone numbers are posted in the reception area, the head house, the main lab, and 5 lab entrance doors. Telephones are located in the following places:

- Reception area
- Head House
- Main Lab (2)
- Library 1 (room 118)
- Library 2 (room 178))

I.2. Emergency Evacuation

When the Fire Alarm sounds, everyone in the Biolab, Offices, and Greenhouse must leave the building by the exits designated on the evacuation map (Appendix II), and assemble at the West end of Entrada Drive. The IBO and Biolab Admin are designated as the fire evacuation sweepers during fire drills only *(Note: never put yourself in danger during a real emergency)*. This means that they will be responsible to check all of the spaces in the offices, laboratories, and greenhouses when there is a fire drill to make sure every person is out of the building. At all times, if either of these people are not in the office, they are responsible for designating another individual in NMC to take their place as emergency evacuation checker during fire drills.

Sweepers:

- Use master keys
- Open each room in the building and ensure no one is in there
- After all spaces have been checked, meet by the Assembly Area at the West end of Entrada Drive
- Review both layout check sheets with each other to see that all spaces have been checked

Evacuation route maps are posted in each work area.

The following information is marked on evacuation maps:

1. Emergency exits (Primary and secondary evacuation routes)
2. Locations of fire extinguishers
3. Fire alarm pull stations' location
4. Assembly points

DLR, FM, and IBO will stay to shut down critical operations during an evacuation if safe.

I.3. Fire Emergency

When fire is discovered:

- Activate the nearest fire alarm
- Notify the local Fire Department by calling 505-662-8301

- If the fire alarm is not available, notify the site personnel about the fire emergency by the following means:
  - Voice Communication
  - Phone

Fight the fire ONLY if:
- The Fire Department has been notified
- The fire is small and is not spreading to other areas
- Escaping the area is possible by backing up to the nearest exit
- The fire extinguisher is in working condition and personnel are trained to use it

Upon being notified about the fire emergency, occupants must (use the Emergency Evacuation procedure above for more detailed instructions):
- Leave the building using the designated escape routes
- Assemble in the designated area
- Remain outside until the authorized official announces that it is safe to reenter

Designated Official, Emergency Coordinator or supervisor will
- Coordinate an orderly evacuation of personnel
- Perform an accurate head count of personnel reported to the designated area
- Determine a rescue method to locate missing personnel
- Provide the Fire Department personnel with the necessary information about the facility
- Perform assessment and coordinate weather forecast emergency closing procedures

For rescue operations, New Mexico Consortium will rely on local public resources, such as the Los Alamos fire department (911) and 505-662-8301 who are trained, equipped, and certified to conduct rescues

Fire Extinguishers

Locations of fire extinguishers are marked on the map in Appendix II. To use:

- Remove extinguisher from hanger or enclosure
- Follow instructions on the fire extinguisher:
  1. Hold extinguisher upright and pull pin
  2. Stay back 8' from fire and aim at base of fire
  3. Squeeze lever and sweep side to side

Note: all the fire extinguishers are classified as "ABC", i.e., are suitable for trash–wood–paper, liquids, and electrical equipment fires.

I.4. Fire Prevention Plan

See Appendix III

I.5. Medical Emergency (Including First Aid and CPR)

First aid kits can be used for minor medical issues. If there is a more serious emergency situation, call 911. Staff members trained in first aid and CPR are identified with CPR signs on their doors or desks.

Call medical emergency phone number (911).

Provide the following information:

a. Nature of medical emergency
b. Location of the emergency (address, building, room number)
c. Your name and phone number from which you are calling.

- Do not move victim unless absolutely necessary
- Call personnel trained in CPR and First Aid (list available next to AED) to provide the required assistance prior to the arrival of the professional medical help:
- If personnel trained in First Aid are not available, as a minimum, attempt to provide the following assistance:
  1. Stop the bleeding with firm pressure on the wounds (note: avoid contact with blood or other bodily fluids)
  2. Clear the air passages using the Heimlich Maneuver in case of choking.
- In case of rendering assistance to personnel exposed to hazardous materials, consult the Safety Data Sheet (SDS) and wear the appropriate personal protective equipment. Attempt first aid ONLY if trained and qualified. Los Alamos Medical Center - handles emergency cases and provides medical and first aid services to NMC employees.

I.6. Chemical Spills

Chemical Spill Kits and SDS binders are located in the main laboratory and in the Green House.

When a Large Chemical Spill has occurred:

1. Immediately notify the IBO and a manager
2. Contain the spill with available equipment (e.g., pads, booms, absorbent powder, etc.)
3. Secure the area and alert other site personnel
4. Do not attempt to clean the spill unless trained to do so
5. Attend to injured personnel and call the medical emergency number, if required
6. Call the Los Alamos Fire Department
7. Evacuate building as necessary

When a Small Chemical Spill has occurred:

1. Notify the IBO and a manager
2. If toxic fumes are present, secure the area (with caution tapes or cones) to prevent other personnel from entering
3. Deal with the spill in accordance with the instructions described in the SDS
4. Small spills must be handled in a safe manner, while wearing the proper PPE
5. Review the general spill cleanup procedures.

I.7. Eyewashes/Safety Showers

Employees who work with hazardous chemicals, become familiar with the location and operation of the nearest eye wash and emergency shower. Learn how to use them, and be confident they're accessible and function properly.

- **Locate your eyewash and emergency shower.** An eyewash and emergency shower must be available within 10 seconds of unobstructed travel from where hazardous materials are used.
- **Keep the path to your safety equipment** clear and unobstructed.
- Never rely on sink faucets to replace an eyewash or emergency shower.
- Eyewashes and emergency showers are easy to operate and designed for hands-free use. Most eyewashes and emergency showers have either paddles, levers, or a pull-lever to operate.
- To turn off, simply reverse the action required to turn it on.
- Ask IBO for assistance, if needed.
- **Keep the area clear** at all times around your emergency shower and eyewash, including countertop-mounted eyewashes.
- **Be aware of electrical hazards.** Keep energized electrical equipment away from eyewashes and emergency showers.
- **Make sure caps cover the eyewash spouts** to keep them clean. Caps should be easy to remove in an emergency.
- **Look for a current date on the equipment's inspection tag.** Eyewashes and emergency showers are inspected monthly to ensure proper functioning.
- **Contact the IBO or FM** to report equipment problems or if your eyewash or emergency shower has not been inspected.
- **Never use safety equipment for cleaning** lab or shop equipment, personal objects, or for other non-emergency purposes.

Eyewash Operation

Use the emergency eyewash immediately if your eyes are exposed to a hazardous chemical.

Important: The first few seconds after exposure to a hazardous chemical (especially a corrosive chemical) are critical. Delaying treatment, even for a few seconds, may result in irreparable eye damage. Never hesitate to use safety equipment if needed.

To use emergency eyewash:

1. **Immediately flush eyes** for at least 15 minutes
2. **Keep the eyes open and rotate the eyeballs in all directions** to remove contamination from around the eyes. An injured person may need help holding the eyelids open.
3. Seek medical attention immediately.
4. Have someone bring or fax the SDS for the chemical to the doctor
5. **Report the injury or exposure**

Emergency Shower Operation

Use the emergency shower immediately if your skin is exposed to a hazardous chemical.

Important: The first few seconds after exposure to a hazardous chemical (especially a corrosive chemical) are critical. Delaying treatment, even for a few seconds, may result in irreparable tissue damage. Never hesitate to use safety equipment if needed.

Drains are rarely designed into floor plans to accommodate emergency shower stations. **Never let that stop you** from using the equipment if needed. Contact the IBO/CHO or FM as soon as possible to collect water where drains are not installed.

To use emergency shower:

1. **Immediately flush the affected area** with copious quantities of water for at least 15 minutes. Protect the eyes from inadvertent contamination.
2. Remove contaminated clothing, jewelry, and shoes. **Don't let modesty slow you down. Every second counts.** Use a clean lab coat to provide the victim with privacy and warmth.
3. Seek medical attention immediately.
4. Have someone bring or fax the SDS for the chemical to the doctor.
5. **Report the injury or exposure**

I.8. Severe Weather and Natural Disasters

Tornado:

- When a warning is issued by sirens or other means, seek inside shelter.
- Consider the following:
  - Small interior rooms on the lowest floor and without windows,
  - Hallways on the lowest floor away from doors and windows, and
  - Rooms constructed with reinforced concrete, brick, or block with no
  - windows.
- Stay away from outside walls and windows.
- Use arms to protect head and neck.
- Remain sheltered until the tornado threat is announced to be over.

Earthquake:

- Stay calm and await instructions from the Emergency Coordinator or the designated official.
- Keep away from overhead fixtures, windows, filing cabinets, and electrical power.
- Assist people with disabilities in finding a safe place.
- Evacuate as instructed by the Emergency Coordinator and/or the designated official.

Flood:

<u>If indoors:</u>

- Be ready to evacuate as directed by the Emergency Coordinator and/or the designated official.
- Follow the recommended primary or secondary evacuation routes.

<u>If outdoors:</u>

- Climb to high ground and stay there.
- Avoid walking or driving through floodwater.
- If car stalls, abandon it immediately and climb to a higher ground.
- Collect drinking water in appropriate containers.

Blizzard:

<u>If indoors:</u>

- Stay calm and await instructions from the Emergency Coordinator or the
- designated official.
- Stay indoors!
- If there is no heat:
  - Close off unneeded rooms or areas.
  - Stuff towels or rags in cracks under doors.
  - Cover windows at night.
- Eat and drink. Food provides the body with energy and heat. Fluids
- prevent dehydration.
- Wear layers of loose fitting, lightweight, warm clothing, if available.

<u>If outdoors:</u>

- Find a dry shelter. Cover all exposed parts of the body.
- If shelter is not available:
  - Prepare a lean-to, wind break, or snow cave for protection from the wind.
  - Build a fire for heat and to attract attention. Place rocks around the fire to absorb and reflect heat.
  - Do not eat snow. It will lower your body temperature. Melt it first.

<u>If stranded in a car or truck:</u>

- Stay in the vehicle!
- Run the motor about ten minutes each hour. Open the windows a little for fresh air to avoid carbon monoxide poisoning. Make sure the exhaust pipe is not blocked.
- Make yourself visible to rescuers.

- Turn on the dome light at night when running the engine.
- Tie a colored cloth to your antenna or door.
- Raise the hood after the snow stops falling.

- Exercise to keep blood circulating and to keep warm.

I.9. Extended Power Loss

In the event of extended power loss to a facility, certain precautionary measures should be taken:

- Unnecessary electrical equipment and appliances should be turned off in the event that power restoration would surge causing damage to electronics and effecting sensitive equipment.
- At freezing temperatures,
  - Turn off and drain the following lines in the event of a long-term power loss:
    - Fire sprinkler system
    - Standpipes
    - Potable water lines
    - Toilets
  - Add propylene-glycol to drains to prevent traps from freezing
  - Equipment that contain fluids that may freeze due to long term exposure to freezing temperatures should be moved to heated areas, drained of liquids, or provided with auxiliary heat sources.

Upon Restoration of heat and power:

- Electronic equipment should be brought up to ambient temperatures before energizing to prevent condensate from forming on circuitry.
- Fire and potable water piping should be checked for leaks from freeze damage after the heat has been restored to the facility and water turned back on.

I.10. Shelter in Place

Chemical, biological, or radiological contaminants may be released into the environment in such quantity and/or proximity to a place of business that it is safer to remain indoors rather than to evacuate employees. "Shelter-in-place" means selecting an interior room or rooms within a facility, or ones with no or few windows, and taking refuge there. Depending on circumstances and the type of emergency, the first important decision is whether you stay put or get away. In any emergency, local authorities may or may not immediately be able to provide information on what is happening and what you should do. Use available information to assess the situation. If you see large amounts of debris in the air, or if local authorities say the air is badly contaminated, you may want to "shelter-in-place."

The NMC employees will be alerted by DLR or another designated staff to shelter-in-place. If the shelter-in-place status is announced, employees should stay in the laboratory building(s) and follow instructions of the DLR or the designated staff. If you are instructed to shelter in place:

- Do not drive or walk outdoors.
- If there are visitors in the building, they will be asked to stay – not leave.
- Turn on call-forwarding or alternative telephone answering systems or services.

- If the business has voice mail or an automated attendant, change the recording to indicate that the business is closed, and that staff and visitors are remaining in the building until authorities advise it is safe to leave.
- Quickly lock exterior doors and close windows, air vents, and fireplace dampers.
- If you are told there is danger of explosion, close the window shades, blinds, or curtains.
- Gather essential disaster supplies, such as nonperishable food, bottled water, battery-powered radios, first-aid supplies, flashlights, batteries, duct tape, plastic sheeting, and plastic garbage bags.
- Select interior room(s) above the ground floor, with the fewest windows or vents. The room(s) should have adequate space for everyone to be able to sit. Avoid overcrowding by selecting several rooms if necessary. Large storage closets, utility rooms, pantries, copy and conference rooms without exterior windows will work well. Avoid selecting a room with mechanical equipment like ventilation blowers or pipes, because this equipment may not be able to be sealed from the outdoors.
- It is ideal to have a hard-wired telephone in the room(s) you select. Call emergency contacts and have the phone available if you need to report a life-threatening condition. Cellular telephone equipment may be overwhelmed or damaged during an emergency.
- Take your emergency supplies and go into the room you have designated. Seal all windows, doors, and vents with plastic sheeting and duct tape or anything else you have on hand.
- Write down the names of everyone in the room, and call your business' designated emergency contact to report who is in the room with you, and their affiliation with your business (employee, visitor, client, customer).

I.11. Emergency Training

Emergency Evacuation and Fire Drills are conducted annually. The following personnel have been trained to ensure a safe and orderly emergency evacuation of other employees:

Institutional Biosafety Officer

Facilities Manager

Administrative Assistant

Biolab Admin

Some laboratory residents/scientists

I. 12. Personal Information:

NMC Human Resources would provide all personal information on employees in an emergency. This includes their home telephone numbers, the names and telephone numbers of their next of kin, and medical information.

J. LOCKOUT/TAGOUT PROCEDURES (LOTO)

J.1. Purpose

The purpose of this procedure is to define the NMC's Hazardous Energy Control Program. This procedure is intended to meet the requirements of 29 Code of Federal Regulations (CFR) 1910.147, Subpart J, *Labor*, *Occupational Safety and Health Standards*, *General Environment Controls*, *The control of hazardous energy (lockout/tagout)*, 29 CFR 1910.333, Subpart S, *Labor*, *Occupational Safety and Health Standards*, *Electrical*, *Selection and use of work practices*, National Fire Protection Association (NFPA) 70E, *Standard for Electrical Safety in the Workplace*.

This procedure defines the requirements for affixing red locks and tags to energy isolating devices for preventing the unexpected energization or startup of machines or equipment, or the release of stored energy that could cause injury to employees during the service and maintenance of machines and equipment. This procedure is not intended to direct the use of administrative locks/tags for other purposes such as configuration control.

J.2. Applicability

This procedure applies to all NMC employees, including subcontractors, who utilize red locks/tags for control of hazardous energy for personnel safety. The requirements in this procedure apply to all sources of energy, including (but not limited to) mechanical, electrical, hydraulic, pneumatic, chemical, radiological, and thermal energy. The Lockout/Tagout (LOTO) Program applies to the control of hazardous energy during servicing and or maintenance of machines and equipment.

Note: *Red locks must be used only for personnel safety. Red locks and tags must not be used for other purposes (e.g., on lockers, toolboxes, obsolete equipment, storage bins, configuration management or other administrative uses).*

These LOTO requirements apply to work on machinery and equipment at all NMC owned or controlled properties, with the following exceptions:

- Work being performed on electric powered equipment for which the exposure to the hazard of unexpected energization and startup of the electrical equipment are controlled by unplugging the cord of the equipment from the energy source. The plug must be under the exclusive control of the person servicing or maintaining the equipment. Once unplugged, the responsible individual cannot leave the area and leave the cord unplugged and unprotected. If the responsible individual leaves the site, red LOTO requirements must be implemented to protect affected workers, i.e., the plug must be capped (locked) and tagged to prevent inadvertent plug in of the equipment or machine, thus exposing affected workers to hazardous energy.
- Equipment and facilities that generate, transmit, and distribute electrical power and are under the exclusive control of public utilities. This includes related equipment for communication, control, and metering that is an integral part of an electrical utility generating plant, substation, or control center.

J.3. Summary

The LOTO program is summarized as follows:

1. An authorized worker, as defined in this procedure, will lock and tag control point(s) to protect himself/herself or affected workers, as defined in this procedure, from the unexpected release of hazardous energy.
2. No worker will work on any machinery or equipment that has been locked and tagged out unless the worker is authorized and has affixed his/her own red lock and tag.
3. No authorized worker will apply a lock/tag for another worker(s) to perform service or maintenance work.
4. No person will remove another's red lock and/or tag unless the person who placed the lock/tag is off NMC property and unavailable. If this is substantiated, authorization for removal must be obtained from the DLR.
5. Workers who violate this procedure are subject to disciplinary measures.
6. A red lock can only have one key that will open it.
7. A red lock must have a red tag attached to it.

This procedure does not include requirements for LOTO for administrative control. Administrative control locks are used to provide special administrative controls for equipment, which, if inadvertently operated, could cause an undesirable result (e.g., uncontrolled radioactive release to the environment). Yellow caution tags are used to convey information about the status of equipment and to prevent equipment damage and/or inadvertent use.

J.4. Procedure Description

LOTO requirements for each specific job requiring LOTO must be developed and should concurrently be included in Integrated Work Documents (IWDs), if IWDs are required for the job. Inclusion of LOTO requirements in IWDs allows authorized workers and management to avoid conflicts in hazards and controls and inconsistencies between procedures.

Note: Requirements for use of IWDs is outside the purview of this procedure. Requirements for use of IWDs are determined by Director of Laboratory Research.

J.4.1. Energy Control Procedures

An energy control procedure must explain what employees must know and state what steps employees must take to effectively and safely control hazardous energy during servicing and maintenance activities. At a minimum, the energy control procedure must contain enough detail for authorized workers to have a clear understanding of energy control measures so that they may follow the procedural steps for a machine LOTO to control all types and sources of hazardous energy.

The steps of the Simple Energy Control Procedure and the Specific Written Energy Control Procedure incorporate these measures:

1. **Prepare for Shutdown**—Identify all hazardous energy, energy isolating devices, and actions required to control the hazardous energy. Each authorized worker must know the type and magnitude of the energy, the hazards of the energy to be controlled, and the means for controlling the hazards.
2. **Shutdown**—Shut down the machine or equipment in accordance with established procedures. An orderly shutdown must be utilized to avoid any additional hazards as a result of de-energization.
3. **Isolate**—Place all energy isolating devices in the appropriate position/condition to control all the

hazardous energy to the machine.

4. **Lockout**—Apply red locks to energy isolating devices so that they hold the devices in the "safe" or "off" position. Attach the required tag containing the appropriate information.
5. **Relieve**—Relieve, disconnect, restrain, or otherwise render safe all potentially hazardous stored or residual energy in the machine or equipment. If re-accumulation of hazardous energy is possible, then verification of the safe condition will be continual until the work is complete.
6. **Verify**—Verify that the steps utilized in the energy control procedure have effectively isolated the machine or equipment from the hazardous energy. Zero energy verification is required for all sources of energy to the equipment or machine. For electrical energy sources, zero voltage must be verified with the appropriate voltage detector. All authorized workers must at a minimum observe zero energy verification.

Simple Energy Control Procedure

At a minimum, a Simple Energy Control Procedure requires use of a Lockout/Tagout (LOTO) Tag, and notifying affected workers

A Simple Energy Control Procedure may be used when all of the following conditions apply:

- there is only one energy source,
- there is only one energy-isolating device that must be locked out to fully control the energy,
- the energy isolation device is readily identifiable,
- the energy isolation device can be locked,
- there is no potential for stored or residual energy in the machine,
- no shift or personnel changes will occur,
- workers performing the service or maintenance are from the same craft and organization/company, and
- the DLR does not require independent verification.

In all other cases, a Specific Written Energy Control Procedure is required.

Table 1. Simple Energy Control Procedure

Step	Actions Required by the Authorized Worker
1	Identify and evaluate hazardous energies. Consult with the owner/operator, to evaluate all possible energy sources on the equipment and identify the energy-isolating devices. Check applicable up-to-date drawings, diagrams, and identification tags or labels.
2	Obtain red locks and tags from the DLR. ***Note:*** Each lock must have only one key that will open it and must be controlled. Work is released, and workers must perform the work in strict accordance with the Integrated Work Document (IWD) (if Integrated Work Management [IWM] is required by DLR). If any unexpected conditions arise, work must be paused or stopped and reevaluated. Any changes to the Simple Energy Control Procedure as scoped and previously documented in the IWD require revision to the IWD.

3	Notify affected workers. The owner/operator will notify the affected workers or delegate the notification to the authorized worker(s) and instruct the authorized worker(s) to perform the notification(s) before the application or removal of lockout and or tagout devices.
4	Shut down the equipment using the normal shutdown procedure. A shutdown is performed by the owner operator or by the authorized worker if authorized and delegated by the owner/operator.
5	Isolate the equipment from energy sources. For electrical LOTO, this includes opening the disconnecting device and wherever possible, visually verifying that all blades of the disconnecting device are fully open or that draw-out-type circuit breakers are withdrawn to the fully disconnected position.
6	Apply locks and tags. Lock and tag out the energy-isolating device using an NMC approved red lock and tag.
7	Relieve stored energy. Relieve stored hazardous energy, such as energy in capacitors, springs, elevated machine members, rotating flywheels, and hydraulic systems by shorting, repositioning, blocking, bleeding down, or taking other appropriate action. All potentially hazardous stored or residual energy must be relieved, disconnected, restrained, or otherwise rendered safe.
8	Verify “Rendered Safe” condition Verify that the machine or equipment has been effectively isolated from the energy source and rendered safe. ▪ For nonelectrical LOTOs, this can be done by direct measurement such as by reading a gauge, cracking a downstream drain valve, proving a piece of equipment can be immobilized, or other reliable means. ▪ For electrical LOTOs, perform the following actions: – Verify that the isolation device is the correct one. – Verify zero voltage if the authorized worker can be exposed to electrical components that were electrically energized before the LOTO. – Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are deenergized. – Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. – Before and after each test, determine that the voltage detector is operating satisfactorily. – If the work to be done will not expose the authorized worker to potentially energized electrical components, then an unsuccessful attempt to start the equipment is sufficient as an alternative to the

	verification with a voltage test instrument. However, this method may be used only if it can be shown, or it is known, that no interlocks exist that would prevent a reliable indication of LOTO effectiveness. – If there is a possibility of reaccumulation of stored energy to hazardous levels, reverify until the possibility of accumulation no longer exists.
9	Perform the work (if applicable).
10	Release from LOTO.

J.4.2. Release from Lockout/Tagout (LOTO)

After the work has been completed, the equipment or machinery is released from LOTO. If an authorized worker has completed work on the equipment but he/she will not be returning the equipment to service, the authorized worker must contact the DLR/designee before removing his/her lock/tag. The authorized worker and the DLR/designee will ensure that the authorized worker's red lock and tag remain on the equipment until the return-to-service steps shown in Table 2 are completed (if the equipment will be returned to service). If the system is to be locked and tagged for configuration management before returning the equipment to service, the DLR/designee will place an administrative lock and tag on the equipment. When returning the equipment to service, the owner/operator must follow the steps in Table 2.

Table 2. Release from Lockout/Tagout (LOTO)

Step	Actions Required by the Owner/Operator
1	Check the equipment and the immediate area around it to ensure that nonessential items have been removed and that the equipment is ready for safe operation. This includes replacing any materials such as insulation or mechanical barriers removed during the work.
2	Check the work area to ensure that all affected workers are in a safe location or have been removed from the immediate area.
3	Verify that the controls are in the neutral or off position.
4	Notify the affected workers. The authorized worker (or subcontractor), must contact the equipment owner/operator or DLR/designee to notify the affected workers. The DLR usually notifies the affected workers or may delegate this responsibility to the authorized worker.

J.4.3. Tagout

If an energy-isolating device cannot physically be locked out, a tag as authorized by this procedure,

must be used with additional controls that provide complete employee protection. The level of safety must be equivalent to what would be achieved with a lock out. If the isolation point can physically be locked out, it must be locked out and a tag attached.

The energy control procedure must detail how the machine or equipment is isolated from the energy source, and rendered inoperative.

There must be a clear demonstration that an equivalent level of safety is achieved by using the tagout program as is obtained by using a lockout program. To accomplish this, full compliance with tagout procedures must be performed. Additional safety measures must be taken such as removal of an isolating circuit element, blocking of a controlling switch, opening of an extra disconnecting device, or removal of a valve handle to reduce the likelihood of inadvertent energization.

Tags are essentially warning devices affixed to energy isolating devices, and they do not provide the physical restraint on those devices that is provided by a lock. Authorized workers must be trained in the following tag-only limitations:

1. When a tag is attached to an energy isolating device, it is not to be removed without authorization of the authorized worker responsible for it, and it is never to be bypassed, ignored, or otherwise defeated.
2. Tags must be legible and understandable by all authorized and affected employees to be effective.
3. Tags and their means of attachment must be made of materials that will withstand the environmental conditions of the workplace.
4. Tags may evoke a false sense of security, and must only be used when the energy isolating device cannot physically be locked out.

J.4.4. Additional Precautions for Lockout/Tagout (LOTO) Involving Electrical Hazards

NFPA 70E, *Standard for Electrical Safety in the Workplace*, provides requirements for electrical safety-related work practices, including specific requirements for LOTOs that control exposure to hazardous electrical energy. Energized electrical authorized workers must address the following additional considerations in LOTO procedures to ensure that they will not be exposed to unexpected energization or release of stored electrical energy when working within the limited approach boundary (see NFPA 70E, Table 130.2[C]) of exposed electrical conductors or circuit parts that are or might become energized. These requirements also apply when working within the arc flash boundary determined by the analysis required in NFPA 70E, Section 130.3.

- Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
- Before working on or near exposed electrical conductors and circuit parts operating at 50 volts or more, apply LOTO devices in accordance with the requirements of this procedure.
- Do not use control circuit devices, such as push buttons, selector switches, and interlocks, as the only means for de-energizing circuits or equipment. Do not use interlocks for electric equipment as a substitute for LOTO.
- To verify zero-energy state for electricity, use an adequately rated voltage detector to test each phase conductor or circuit part. Test each phase conductor or circuit part both phase-to- phase and phase-to-ground. Before and after each test, determine that the voltage detector is operating

satisfactorily. Where there are no accessible exposed points to take voltage measurements, plan the method(s) of verification in advance.

- Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being deenergized could contact other exposed energized conductors or circuit parts, apply ground-connecting devices rated for the available fault current.
- If performing LOTO on an already deenergized circuit where energy isolation has not already been verified, verify (if you are a qualified electrical worker) or observe the verification of zero voltage and that the energy isolation device is the correct one. This may be done through signal tracing, continuity checks, visual tracing, or other tests.

J.5. Periodic Inspections

The periodic inspection of LOTO processes is conducted semi-annually under the authority and direction of the DLR. The inspection is intended to assure that employees are familiar with their responsibilities and continue to implement LOTO procedures properly. The inspector, who must be an authorized worker not involved in the LOTO procedure being inspected, must assure the following:

- The LOTO log book has all required information specific to the LOTOs being inspected.
- The information in the log book was entered by the DLR/designee.
- Employees are following steps in the LOTO energy control procedure.
- Employees involved know their responsibilities under the energy control procedure.
- The energy control procedure is adequate to provide the necessary protection and any changes that are needed. The periodic inspection must include a review of each authorized worker's responsibilities under the LOTO energy control procedure being inspected. The inspection documentation must specify the following:
  - machine or equipment on which the LOTO procedure was used
  - date of the inspection
  - names of workers included in the inspection
  - name of the person who performed the inspection

The inspection documentation must be kept on file by the DLR/designee. The Log is currently kept inside the box at the front desk, it is scanned periodically and saved in the server.

Note: Where tagout alone without the use of a lock is used, the inspector's review must also extend to affected workers because of the increased importance of their role in avoiding accidental or inadvertent activation of the machinery.

K. LABORATORY SECURITY

K.1. Purpose

The purpose of the NMC Laboratory Security Program is reducing the likelihood of some emergencies and assisting in preparation and response for others.

K.2. Overview

The New Mexico Consortium Biological Laboratory is located at 100 Entrada Drive, Los Alamos, New Mexico. The facility supports biological research primarily focused on plant biology and includes offices, research laboratories, and a research greenhouse. The facility is situated in a low traffic area at the end of cul-de-sac approximately 2 miles from the nearest fire station and 3 miles from the police station. The research involves biological and chemical activities using small quantities of reagents (typically less than 100 grams.) Hazards present in the research laboratory and greenhouse include the use or handling of flammables, corrosives, toxics, reactive material, carcinogens, pressure/vacuum systems, reproductive hazards, cryogens and hazardous wastes. This security plan takes a graded approach based on the assets, threats, risks, and vulnerabilities.

The assets that need to be protected include:

- NMC staff and visitors (expected 50-100 during working hours)
- Facilities and equipment
- Research materials (chemicals, supplies, plants, seeds, algae)
- Intellectual property (stored on computers, notebooks, bio samples)
- Data bases (mostly experimental data, limited personnel sensitive information)

K.3. Potential Threats and Mitigation

Potential threats come from both external and internal sources.

K.3.1. External Threats

It is expected that the most likely threat will be from vandals or criminals. Physical security provides the most significant mitigation. Outside doors are kept locked or under tight administrative control. Multiple locked doors and floor-to-roof walls protect the office and laboratory areas from the more open Main Lobby. Exterior windows in the office and laboratory areas are not at ground level and are not easy to access from the outside perimeter of the building. The building exterior is well lit at night and the parking lot is well lit during normal and extended work hours. Quantities of hazardous or valuable chemicals in the facility are very limited. The majority of the equipment has very little resale value outside of a research laboratory market.

The NMC often host public events in its Main Lobby area. This area includes the commons, kitchen, conference room 168, rest rooms, and the reception/administrative support desk. Public events are well supervised by trained NMC staff. In addition, the offices and laboratories are secured administratively or via cypher locks. No hazardous materials or high value equipment are located in the Main Lobby area.

K.3.2. Internal Threats

A safety and security analysis is conducted for every project using the Biological Research facility. Based on the analysis, the security threats and risks are identified and a mitigation plan is developed and incorporated into the Integrated Work Document (IWD) for the project. Mitigation actions may include: minimized amounts of hazardous materials; locked storage/limited access to hazardous or valuable materials; password protected computer and data storage systems; locked storage of notebooks and other intellectual property; alarms on high value/high risk assets; limited access to

specific laboratory rooms; enhanced surveillance; and enhanced background checks of research staff, visitors and service associates.

IWD's detail the requirements for specific projects. Below are the general security procedures to be implemented.

K.4. Site-specific Security Requirements

K.4.1. Building Access Control

Access to the building shall be limited and controlled. All exterior doors except for the door to the Main Lobby (West side) shall be locked at all times. Distribution of keys to these doors shall be limited. Based on job requirements, the Director of Laboratory Research (DLR) shall approve keys for these doors for designated laboratory staff (typically 2-4 individuals). The Main Lobby door shall remain locked during non-business hours (times outside of 8 AM to 5 PM, Monday through Friday) and during normal business hours when entrance to the Main Lobby is not under administrative control. Cypher locks secure the Main Lobby entrance, office, laboratory, and greenhouse areas. Each door lock is separately programmable to limit access to approved individuals. Access combinations for all doors shall be limited and controlled by the DLR. All keys for the facility shall be inventoried and controlled by the DLR. Extra keys shall be locked in the Telecom room. Unescorted access to the offices, laboratories and greenhouse is limited to approved individuals. The DLR is responsible for granting approval based on the individual's need, training, and background.

K.4.2. Surveillance

Video surveillance shall be used to protect high value, high-risk assets. Specific requirements shall be included in IWD's.

K. 4.3. Lighting

The exterior of the building shall be well lit all night. The parking lot area shall be well lit from 6 AM to 10 PM seven days a week.

K. 4.4. Hazardous Chemicals

The DLR shall approve the procurement of all hazardous chemicals that will be used or stored at the facility. Quantities shall be kept to a minimum and inventoried regularly. IWD's shall be developed for the specific use of hazardous materials and their use shall be controlled and monitored by the IBO/CHO.

K. 4.5. Work/Worker Control

The DLR shall be responsible for approving and monitoring all workers and work activities. Workers shall be trained in the proper storage, handling, and disposal of hazardous materials and use of high-value equipment. NMC Human Resources shall be responsible for performing all needed background checks specified by project IWD's and requested by the DLR.

K. 4. 6. Information Security

Workers shall be required to follow general NMC computer and information security procedures and specific project control procedures detailed in project IWD's.

K. 4. 7. Training

Before being allowed unescorted access to the NMC Biological Laboratory individuals shall be trained in the appropriate security procedures.

L. INSPECTION PROGRAM

1. **Fume Hoods** will be certified annually**.** Responsible manager: DLR
2. **Biosafety Cabinets** will be certified annually**.** Responsible manager: DLR
3. **Laminal flow hoods:** will be certified annually**.** Responsible manager: DLR
4. **Autoclaves and boilers** will be inspected monthly. Responsible manager: FM
5. **Safety Showers** will be inspected weekly**;** logs of the inspections are attached to the showers for employee review. Responsible manager: IBO
6. **Eyewash Fountains** will be inspected weekly; logs of inspections are for employee review. Responsible manager: IBO
7. **Compressed gas cylinders** are checked for leaks monthly. Responsible manager: FM
8. **Chemical Inventory** will be self-audited annually. Responsible manager: IBO
9. **Bio Inventory** will be conducted annually. Responsible manager: IBO
10. **OSHA Inspections**. NMC has the OSHA SHARP certification as of December 2015. This certification exempts NMC from unannounced inspections; however, OSHA consultants will be inspecting the lab upon announcement or invitation. The issues that require corrections will be documented. An inspection report containing all findings and recommendations will be prepared for management and other appropriate workers. Management will follow-up on the inspection to ensure that all corrections are implemented. Responsible manager: COO
11. **Emergency lights, exit signs, and exit doors** will be inspected monthly. Responsible manager: FM
12. **Automated External Defibrillator (AED)** will be inspected monthly; log of inspections is in a binder next to the AED for employee review. Responsible manager: FM
13. **First Aid Kits** will be inspected monthly for supplies replenishment. Responsible manager: IBO
14. **Fire extinguishers and sprinkler system** will be tested annually. Records will be kept in our approval system and the server. Responsible manager: FM
15. **Monoxide Detectors batteries** will be checked monthly. Responsible manager: FM
16. **Pipette Calibration** will be performed annually by an external company. Responsible manager: DLR

M. INTEGRATED PEST MANAGEMENT

The NMC Integrated Pest Management (IPM) program is established pursuant the BSL-1 regulations set forth in Biosafety in Microbiological and Biomedical Laboratories, 5th Edition, Appendix G, issued by the Centers for Disease Control and Prevention: http://www.cdc.gov/biosafety/publications/bmbl5/index.htm. Pest prevention and protection policies shall be communicated to NMC laboratory workers via this IPM Plan.

M.1. Purpose

The primary goal of this IPM Plan is to prevent pest problems by managing the facility environment to make it less conducive to pest infestation. Facility restrictions and operational and procedural issues, therefore, are incorporated into the IPM Plan. To control pests and minimize the use of pesticides, this Plan outlines procedures to be followed to protect the health and safety of employees and visitors

from pest and pesticide hazards. It employs a comprehensive program approach that integrates housekeeping, maintenance, and pest control services. It provides necessary information and guidelines that will assist employees in recognizing, reporting, and controlling pests.

M.2. Responsibilities

M.2.1. Management

The DLR and COO shall be responsible for implementing the IPM plan and ensuring staff compliance with IPM plan. The management shall provide adequate controls to ensure health safety in the workplace and resources and training to laboratory employees to encourage pest prevention and a safe response in the event of a pest infestation.

The DLR and/or COO shall notify employees, visitors and all individuals working in the buildings of planned and emergency applications of pesticides in the buildings and on the grounds of the Biolab.

M.2.2. IBO

The Institutional Biosafety Officer (IBO) will

- Provide support to assist DLR and COO in maintaining an IPM program that relies on minimal pesticide use. Such support will include efforts to promptly address any structural, horticultural, or sanitation changes recommended by the DLR or COO to reduce or prevent pest problems throughout the building.
- Take care of smaller issues. In case of considerable infestation, a professional exterminator must be engaged.
- Provide records of all pest control treatments to the Biolab Admin when needed.
- Make available to the public information regarding pest management activities.

M.2.3. Employees

Lab workers shall provide support to assist DLR, COO and IBO/CHO in maintaining an IPM program that relies on minimal pesticide use. Such support will include efforts to promptly address any structural, horticultural, or sanitation changes recommended by the or COO to reduce or prevent pest problems.

M.3. General IPM Strategies

An Integrated Pest Management decision at the Biolab Facility shall consist of the following steps:

- Identify pest species
- Estimate pest populations and compare to established action thresholds
- Select appropriate management tactics based on current on-site information
- Assess effectiveness of pest management
- Keep appropriate records

Decisions concerning whether pesticides should be applied in a given situation will be based on a review of all available options. Efforts will be made to avoid the use of pesticides by adequate pest proofing of facilities, good sanitation practices, selection of pest-resistant plant materials, and appropriate horticultural practices.

When it is determined that a pesticide must be used in order to meet pest management objectives, the least-hazardous material adequate for the job will be chosen.

Pesticide storage, transportation, and application will be conducted in accordance with requirement of Federal Insecticide, Fungicide, and Rodenticide Act (7 United States Code136 et seq.), Environmental Protection Agency regulations in 40 CFR, OSHA regulations, NMC's policies and procedures, and local ordinances.

No individual shall apply, store, or dispose of any pesticide on NMC-managed property without an appropriate pesticide applicator license. All pesticide applicators will be trained in principles and practices of IPM and the use of pesticides approved for use by NMC. All applicators must comply with IPM policy and follow appropriate regulations and labeling precautions when using pesticides in or around NMC facilities.

M.4. Plan Implementation

A. Monitoring : Monitoring is the central activity of an IPM program and is used to minimize pesticide use. Traps, visual inspections, and staff interviews identify areas and conditions that may foster pest activity.
B. Sanitation and Facility Maintenance: Many pest problems can be prevented or corrected by ensuring proper sanitation, reducing clutter and pest habitat, and by performing repairs that exclude pests.
C. Non-pesticide Pest Control: Pest control methods such as trapping, exclusion, caulking, washing, and freezing can be applied safely and effectively when used in conjunction with proper sanitation and structural repair.
D. Preventive applications: Preventive applications of pesticides should be discouraged, and treatments should be restricted to areas of known pest activity. When pesticides are applied, the least toxic product(s) available should be used and applied in the most effective and safe manner.
E. Program Evaluation and Quality Assurance: Quality assurance and program review should be performed to provide an objective, ongoing evaluation of IPM activities and effectiveness to ensure that the program does, in fact, control pests and meet the specific needs of the facility program(s) and its occupants. Based upon this review, current IPM protocols can be modified and new procedures implemented.
F. Technical Expertise: A qualified entomologist will be consulted for technical guidance to develop and implement an IPM program. Pest management personnel should be licensed and certified by the appropriate regulatory agency.
G. Safety: IPM minimizes the potential of pesticide exposure to the research environment and the staff by limiting the scope of pesticide treatments.

M.5. Training

Facility employees shall receive training on IPM policy at hire and during annual update training. This training will also include rationale for IPM policy and program and specific elements including use of pest-sighting log and prohibition on pesticide applications by non-certified individuals.

M.6. Record Keeping

A logbook is used to record pest activity and conditions pertinent to the IPM program. It contains procedures for IPM services in the facility and treatment records.

The logbook is maintained by FM and it is located by the Headhouse main door.

When the intervention of an external company is needed to handle big size infestations, the activities must be recorded in the logbook.

Safety Data Sheets on all products used in the Greenhouse can be found in the SDS binder located in the Headhouse. Records for all chemicals can be found in our chemical inventory system, accessed through a computer in the main laboratory and accessible to all laboratory personnel.

NOTE: Records must be maintained for at least three (3) years.

CAS #	Chemical Name	CATEGORY
13909-09-6	1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea	CARC
96-12-8	1,2-Dibromo-3-chloropropane [1910.1044]	CARC, REPRO
106-99-0	1,3-Butadiene [1010.1051]	CARC
55-98-1	1,4-Butanediol dimethylsulfonate	CARC
505-60-2	2,2'-Dichlorodiethylsulfide	CARC
53-96-3	2-Acetylaminofluorene [1910.1003]	CARC
110-80-5	2-Ethoxyethanol (EGEE or 2EE)	REPRO
109-86-4	2-Methoxyethanol (EGME or 2ME)	REPRO
91-59-8	2-Naphthylamine	CARC
99-66-1	2-Propyl Valeric Acid (valporate)	REPRO
91-94-1	3,3'-Dichlorobenzidine [1910.1007]	CARC
101-77-9	4,4'-Methylenedianiline [1910.1050]	CARC
13552-44-8	4,4 methylenedianiline Dihydrochloride	CARC
92-67-1	4-Aminobiphenyl [1910.1003]	CARC
92-67-1	4-Aminodiphenyl [1910.1050]	CARC
60-11-7	4-Dimethylaminoazobenzene	CARC
92-93-3	4-Nitrobiphenyl [1910.1003]	CARC
92-93-3	4-Nitrodiphenyl	CARC
298-81-7	8-Methoxypsoralen plus UV-A radiation	CARC
107-02-8	Acrolein	HITOX (Acute)
107-13-1	Acrylonitrile [1010.1045]	CARC
77536-66-4	Actinolite [asbestiform]	CARC
1402-68-2	Aflatoxins	CARC
134-32-7	alpha-Naphthylamine [1910.1004]	CARC
134-32-7	1-Naphthylamine [1910.1004]	CARC
91-59-8	B-Naphthylamine [1910.1004]	CARC
91-59-8	2-Naphthylamine [1910.1004]	CARC
7784-44-3	Ammonium Arsenate	CARC
7788-98-9	Ammonium Chromate, as Cr6+ [water soluble]	CARC
9/5/7789	Ammonium Dichromate, as Cr6+ [water soluble]	CARC
12172-73-5	Amosite	CARC
77536-67-5	Anthophyllite [asbestiform]	CARC
7774-41-6	Arsenic Acid Hemihydrate	CARC
1303-32-8	Arsenic Disulfide	CARC
1303-28-2	Arsenic Pentoxide	CARC
7784-33-0	Arsenic Tribromide	CARC
7784-34-1	Arsenic Trichloride	CARC
7784-35-2	Arsenic Trifluoride	CARC
7784-45-4	Arsenic Triiodide	CARC
1327-53-3	Arsenic Trioxide	CARC
1303-36-2	Arsenic Triselenide	CARC
1303-33-9	Arsenic Trisulfide	CARC
7440-38-2	Arsenic, Inorganic [1910.1018]	CARC
8024-75-9	Arsenical Dip	CARC
14060-38-9	Arsenious Acid	CARC
7784-42-1	Arsine	HITOX (Acute)
1332-21-4	Asbestos [1910.1001]	CARC
0-65-0	Auramine manufacture	CARC
446-86-6	Azathioprine	CARC

10294-40-3	Barium Chromate, as Cr6+	CARC
12000-34-9	Barium Chromate, as Cr6+	CARC
12231-18-4	Barium Chromate, as Cr6+	CARC
37235-82-8	Basic Bismuth Dichromate, as Cr6+	CARC
1308-09-4	Basic Copper (II) Chromate, as Cr6+	CARC
1344-38-3	Basic Lead Chromate, as Cr6+	CARC
18454-12-1	Basic Lead Chromate, as Cr6+	CARC
54692-53-4	Basic Lead Chromate, as Cr6+	CARC
71-43-2	Benzene [1910.1028]	CARC
1684-47-5	Benzene-1,3,5-d3	CARC
1120-89-4	Benzene-d	CARC
1076-43-3	Benzene-d6	CARC
92-87-5	Benzidine [1910.1010]	CARC
12161-82-9	Bertrandite	CARC
1302-52-9	Beryl Ore	CARC
7440-41-7	Beryllium & compounds, as Be	CARC, HITOX (Chronic)
543-81-7	Beryllium Acetate	CARC
1332-52-1	Beryllium Acetate, Basic	CARC
19049-40-2	Beryllium Acetate, Basic	CARC
10210-64-7	Beryllium Acetylacetonate	CARC
1302-52-9	Beryllium Aluminum Silicate	CARC
17440-85-6	Beryllium Borohydride	CARC
7787-46-4	Beryllium Bromide	CARC
506-66-1	Beryllium Carbide	CARC
13106-47-3	Beryllium Carbonate	CARC
66104-24-3	Beryllium Carbonate	CARC
1319-43-3	Beryllium Carbonate Basic	CARC
7787-47-5	Beryllium Chloride	CARC
7787-49-7	Beryllium Fluoride	CARC
1111-71-3	Beryllium Formate	CARC
7787-52-2	Beryllium Hydride	CARC
13327-32-7	Beryllium Hydroxide	CARC
7787-53-3	Beryllium Iodide	CARC
13597-99-4	Beryllium Nitrate	CARC
13510-48-0	Beryllium Nitrate Tetrahydrate	CARC
7787-55-5	Beryllium Nitrate Trihydrate	CARC
1304-54-7	Beryllium Nitride	CARC
1304-56-9	Beryllium Oxide	CARC
13597-95-0	Beryllium Perchlorate	CARC
13598-15-7	Beryllium Phosphate	CARC
13598-26-0	Beryllium Phosphate	CARC
35089-00-0	Beryllium Phosphate	CARC
7787-50-0	Beryllium Potassium Fluoride	CARC
53684-48-3	Beryllium Potassium Sulfate	CARC
10039-31-3	Beryllium Selenate	CARC
13598-00-0	Beryllium Silicate	CARC
15191-85-2	Beryllium Silicate	CARC
58500-38-2	Beryllium Silicate	CARC
12161-82-9	Beryllium Silicate Hydrate	CARC
13871-27-7	Beryllium Sodium Fluoride	CARC
13510-49-1	Beryllium Sulfate	CARC
7787-56-6	Beryllium Sulfate Tetrahydrate	CARC

39413-47-3	Beryllium Zinc Silicate, as Be	CARC
12770-50-2	Beryllium-Aluminum Alloy, as Be fume or dust	CARC
11133-98-5	Beryllium-Copper Alloy, as Be fume or dust	CARC
55158-44-6	Beryllium-Copper-Cobalt Alloy, as Be fume or dust	CARC
37227-61-5	Beryllium-Nickel Alloy, as Be fume or dust	CARC
91-59-8	beta-Naphthylamine [1910.1009]	CARC
57-57-8	beta-Propiolactone [1910.1013]	CARC
542-88-1	bis-Chloromethyl Ether [1910.1008]	CARC
0-52-1	Broad Spectrum Ultraviolet Radiation	CARC
7726-95-6	Bromine	HITOX (Acute)
1344-38-3	C.I. Pigment Orange 21, as Cr6+	CARC
54692-53-4	C.I. Pigment Orange 21, as Cr6+	CARC
8005-36-5	C.I. Pigment Red 104, as Cr6+	CARC
12213-61-5	C.I. Pigment Red 104, as Cr6+	CARC
12656-85-8	C.I. Pigment Red 104, as Cr6+	CARC
12709-98-7	C.I. Pigment Red 104, as Cr6+	CARC
64523-06-4	C.I. Pigment Red 104, as Cr6+	CARC
7758-97-6	C.I. Pigment Yellow 34, as Cr6+	CARC
1308-13-0	C.I. Pigment Yellow 36, as Cr6+	CARC
1328-67-2	C.I. Pigment Yellow 36, as Cr6+	CARC
13530-65-9	C.I. Pigment Yellow 36, as Cr6+	CARC
14675-41-3	C.I. Pigment Yellow 36, as Cr6+	CARC
37300-23-5	C.I. Pigment Yellow 36, as Cr6+	CARC
57486-12-1	C.I. Pigment Yellow 36, as Cr6+	CARC
10294-52-7	C.I. Pigment Yellow 45, as Cr6+	CARC
7440-43-9	Cadmium & Cd compounds [1910.1027]	CARC
543-90-8	Cadmium Acetate	CARC
7789-42-6	Cadmium Bromide	CARC
513-78-0	Cadmium Carbonate	CARC
10108-64-2	Cadmium Chloride	CARC
542-83-6	Cadmium Cyanide	CARC
14486-19-2	Cadmium Fluoborate	CARC
7790-79-6	Cadmium Fluoride	CARC
21041-95-2	Cadmium Hydroxide	CARC
7790-80-9	Cadmium Iodide	CARC
10325-94-7	Cadmium Nitrate	CARC
1306-19-0	Cadmium Oxide	CARC, HITOX (Acute)
14402-75-6	Cadmium Potassium Cyanide	CARC
13814-62-5	Cadmium Selenate	CARC
1306-24-7	Cadmium Selenide	CARC
2223-93-0	Cadmium Stearate	CARC
10124-36-4	Cadmium Sulfate	CARC
1306-23-6	Cadmium Sulfide	CARC
1306-25-8	Cadmium Telluride	CARC
7790-85-4	Cadmium Tungstate (VI)	CARC
12685-29-9	Cadmium-Copper Alloy, cadmium nonbase	CARC
37364-06-0	Cadmium-Copper Alloy, copper base	CARC
132295-56-8	Cadmium-Copper Alloy, copper alloy, base	CARC
132295-57-9	Cadmium-Copper Alloy, copper alloy, base	CARC
7778-44-1	Calcium Arsenate	CARC
10103-62-5	Calcium Arsenate	CARC
52740-16-6	Calcium Arsenite, 1:1	CARC

15194-98-6	Calcium Arsenite, 2:1	CARC
27152-57-4	Calcium Arsenite, 2:3	CARC
13765-19-0	Calcium Chromate, as Cr6+	CARC
75-15-0	Carbon Disulfide	REPRO
630-08-0	Carbon Monoxide	REPRO
13454-78-9	Cesium Chromate, as Cr6+	CARC
305-03-3	Chlorambucil	CARC
7782-50-5	Chlorine	HITOX (Acute)
10049-04-4	Chlorine Dioxide	HITOX (Acute)
7790-91-2	Chlorine Trifluoride	HITOX (Acute)
494-03-1	Chlornaphazine	CARC
107-20-0	Chloroacetaldehyde	HITOX (Acute)
78-95-5	Chloroacetone	HITOX (Acute)
75-01-4	Chloroethylene [1910.1017]	CARC
107-30-2	Chloromethylmethylether [1910.1003]	CARC
76-06-2	Chloropicrin	HITOX (Acute)
18454-12-1	Chrome Red, as Cr6+	CARC
1066-30-4	Chromic Acetate, as Cr6+ [water soluble]	CARC
1333-82-0	Chromic Acid, as Cr6+ [water soluble]	CARC
12324-05-9	Chromic Acid, as Cr6+ [water soluble]	CARC
12324-08-2	Chromic Acid, as Cr6+ [water soluble]	CARC
24613-89-6	Chromic Chromate, as Cr6+ [water soluble]	CARC
18540-29-9	Chromium (VI) & Cr 6+ compounds	CARC
29689-14-3	Chromium Carbonate, as Cr6+ [water soluble]	CARC
13007-92-6	Chromium Carbonyl, as Cr6+	CARC
13930-94-4	Chromium Carbonyl, as Cr6+	CARC
14977-61-8	Chromium Chloride, as Cr6+	CARC, HITOX (Acute)
14986-48-2	Chromium Hexachloride, as Cr6+	CARC
1333-82-0	Chromium Oxide, as Cr6+ [water soluble]	CARC
12324-05-9	Chromium Oxide, as Cr6+ [water soluble]	CARC
12324-08-2	Chromium Oxide, as Cr6+ [water soluble]	CARC
7789-04-0	Chromium Phosphate, as Cr6+ [water soluble]	CARC
1333-82-0	Chromium Trioxide, as Cr6+ [water soluble]	CARC
12324-05-9	Chromium Trioxide, as Cr6+ [water soluble]	CARC
12324-08-2	Chromium Trioxide, as Cr6+ [water soluble]	CARC
12001-29-5	Chrysotile	CARC
79217-60-0	Ciclosporin	CARC
59865-13-3	Ciclosporin	CARC
65996-93-2	Coal tar pitch volatiles (as benzene solubles)	CARC
8007-45-2	Coal tars	CARC
65996-89-6	Coal tars & extracts and high temp coal tars	CARC
7785-24-2	Cobalt (II) Arsenate, as As3+	CARC
11114-92-4	Cobalt Chromium Alloy, as Cr6+	CARC
0-39-0	Coke oven emissions	CARC
12002-03-8	Copper (II) Acetoarsenite	CARC
0-05-0	Copper (II) Dichromate, as Cr6+ [water soluble]	CARC
1308-09-4	Copper Chromate Oxide, as Cr6+	CARC
18906-50-8	Copper Chromate Oxide, as Cr6+	CARC
13548-42-0	Copper Chromate, as Cr6+	CARC
8001-58-9	Creosotes (coal)	CARC
8021-39-4	Creosotes (wood)	CARC

14464-46-1	Cristobolite {Silica (respirable)} crystalline	CARC
12001-28-4	Crocidolite	CARC
12002-03-8	Cupric Acetoarsenite	CARC
10290-12-7	Cupric Arsenite	CARC
13548-42-0	Cupric Chromate, as Cr6+	CARC
506-77-4	Cyanogen Chloride	HITOX (Acute)
50-18-0	Cyclophosphamide (anhydrous)	CARC, REPRO
6055-19-2	Cyclophosphamide (hydrated)	CARC, REPRO
79217-60-0	Cyclosporin	CARC
59865-13-3	Cyclosporin A	CARC
79217-60-0	Cyclosporine	CARC
17702-41-9	Decaborane	HITOX (Acute)
19287-45-7	Diborane	HITOX (Acute)
106-93-4	Dibromoethane (ethylene dibromide) (EDB)	REPRO
7572-29-4	Dichloroacetylene	HITOX (Acute)
75-09-1	Dichloromethane [1910.1052]	CARC
1665-00-5	Dichloromethane-d2 {CD2Cl2} [1910.1052]	CARC
56-53-1	Diethylstilbestrol (DES)	CARC
7/5/2238	Diglycidyl Ether (DGE)	HITOX (Acute)
593-74-8	Dimethyl Mercury	REPRO, HITOX (Acute)
25154-54-5	Dinitrobenzene	REPRO
122-39-4	Diphenylamine	REPRO
1937-37-7	Direct Black 38 (Technical grade)	CARC
1937-37-7	Direct Black 38 GX	CARC
2602-46-2	Direct Blue 6 (Technical grade)	CARC
7778-43-0	Disodium Arsenate	CARC
10048-95-0	Disodium Arsenate Heptahydrate	CARC
10048-95-0	Disodium Hydrogen Arsenate	CARC
62-75-9	DMN	CARC
8012-54-2	Donovan's Solution, as As3+	CARC
0-18-0	Dyes that metabolize to benzidine	CARC
66733-21-9	Erionite	CARC
12510-42-8	Erionite	CARC
50-28-2	Estradiol-17B	CARC
0-21-0	Estrogens, nonsteroidal and steroidal	CARC
53-16-7	Estrone	CARC
7280-37-7	Estropipate	CARC
57-63-6	Ethinylestradiol	CARC
75-21-8	Ethylene Oxide [1910.1047]	REPRO
110-80-5	Ethyleneglycol Monoethyl Ether	REPRO
109-86-4	Ethyleneglycol Monomethyl Ether	REPRO
151-56-4	Ethyleneimine	CARC
33419-42-0	Etoposide	CARC
10294-52-7	Ferric Chromate, as Cr6+	CARC
7782-41-4	Fluorine	HITOX (Acute)
50-00-0	Formaldehyde [1910.1048]	CARC
1327-53-3	Fowler's Solution	CARC
0-74-0	Furniture & cabinet making	CARC
1303-00-0	Gallium Arsenide	CARC
066-0	Hematite underground mining	CARC
118-74-1	Hexachlorobenzene	REPRO

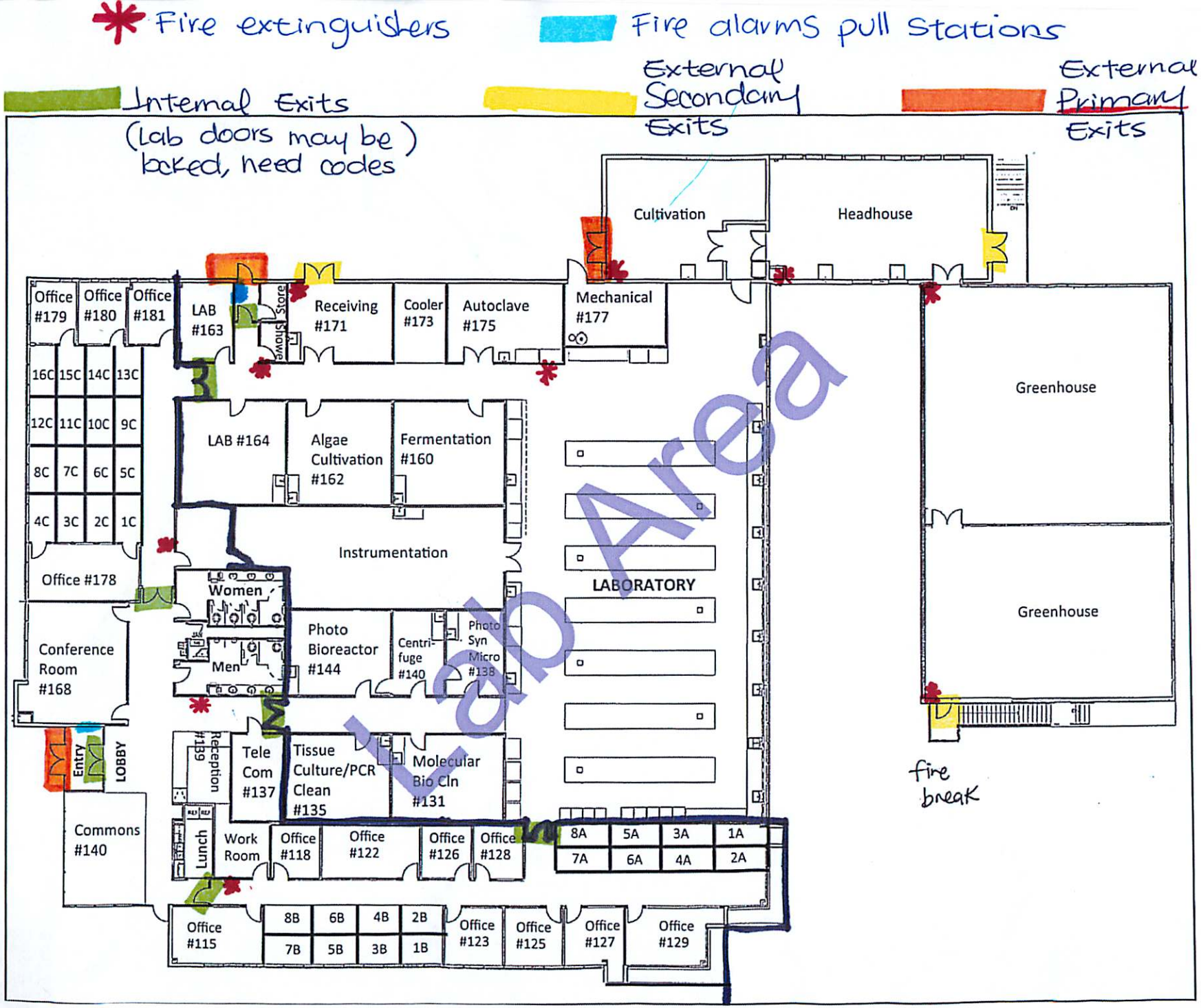
77-47-4	Hexachlorocyclopentadiene	HITOX (Acute)
7/5/7783	Hydrogen Selenide	HITOX (Acute)
7440-38-2	Inorganic Arsenic [1910.1018]	CARC
10294-52-7	Iron (III) Chromate, as Cr6+	CARC
10294-53-8	Iron (III) Dichromate, as Cr6+ [water soluble]	CARC
13463-40-6	Iron Pentacarbonyl	HITOX (Acute)
0-67-9	Iron and steel founding	CARC
0-43-0	Involutary smoking	CARC
4098-71-9	Isophorone Diisocyanate	HITOX (Acute)
0-50-9	Isopropyl alcohol manufacture (strong acid process)	CARC
7439-92-1	Lead and lead compounds, inorganic, as Pb	HITOX (Chronic), REPRO
3687-31-8	Lead Arsenate, as As3+	CARC
7645-25-2	Lead Arsenate, as As3+	CARC
7784-40-9	Lead Arsenate, as As3+	CARC
8049-64-7	Lead Arsenate, as As3+	CARC
10102-48-4	Lead Arsenate, as As3+	CARC
10031-13-7	Lead Arsenite, as As3+	CARC
18454-12-1	Lead Chromate Oxide, as Cr6+	CARC
7758-97-6	Lead Chromate, as Cr6+	CARC
8049-64-7	Lead Chromate, as Cr6+	CARC
0-80-0	Lithium Bichromate Dihydrate, as Cr6+ [water soluble]	CARC
554-13-2	Lithium Carbonate	REPRO
1/7/7789	Lithium Chromate, as Cr6+ [water soluble]	CARC
14307-35-8	Lithium Chromate, as Cr6+ [water soluble]	CARC
13843-81-7	Lithium Dichromate, as Cr6+ [water soluble]	CARC
0-68-0	Magenta manufacture	CARC
10103-50-1	Magnesium Arsenate	CARC
13423-61-5	Magnesium Chromate, as Cr6+ [water soluble]	CARC
10102-53-1	m-Arsenic Acid	CARC
13909-09-6	MeCCNU (methyl-CCNU)	CARC
148-82-3	Melphalan	CARC
7487-94-7	Mercuric Chloride	REPRO
13444-75-2	Mercuric Chromate, as Cr6+	CARC
10/8/7789	Mercuric Dichromate. As Cr6+	CARC
13444-75-2	Mercury (II) Chromate, as Cr6+	CARC
10/8/7789	Mercury (II) Dichromate, as Cr6+	CARC
72-33-3	Mestranol	CARC
75-09-2	Methane Dichloride [1910.1052]	CARC
1665-00-5	Methane-d2 Dichloride {CD2Cl2} [1910.1052]	CARC
298-81-7	Methoxsalen plus UV-A radiation	CARC
60-34-4	Methyl Hydrazine	HITOX (Acute)
624-83-9	Methyl Isocyanate	HITOX (Acute)
107-30-2	Methylchloromethylether	CARC
5124-30-1	Methylene bis(4-cyclohexylisocyanate)	HITOX (Acute)
75-09-2	Methylene Chloride [1910.1052]	CARC
1665-00-5	Methylene-d2 Chloride {CD2Cl2}[1010.1052]	CARC
5/9/8002	Mineral Oil (untreated/pporly & mildly refined/treated)	CARC
5/9/8002	Mineral Oils	CARC
150-19-6	m-Methoxy Phenol	REPRO
8005-36-5	Molybdenum Orange, as Cr6+	CARC
12213-61-5	Molybdenum Orange, as Cr6+	CARC
12656-85-8	Molybdenum Orange, as Cr6+	CARC

12709-98-7	Molybdenum Orange, as Cr6+	CARC
64523-06-4	Molybdenum Orange, as Cr6+	CARC
107-30-2	Monochlorodimethylether	CARC
505-60-2	Mustard Gas	CARC
1477-55-0	m-Xylene alpha, alpha'-diamine	HITOX (Acute)
55-98-1	Myleran	CARC
494-03-1	N,N-bis(2-Chloroethyl)-2-naphthylamine	CARC
62-75-9	N,N-Dimethylnitrosoamine	CARC
16569-87-2	Neodymium Chromate Heptahydrate, as Cr6+	CARC
16565-95-0	Neodymium Chromate, as Cr6+	CARC
13478-00-7	Nickel (II) Nitrate Hexahydrate [water soluble]	CARC
373-02-4	Nickel Acetate [water soluble]	CARC
3264-82-2	Nickel Acetylacetonate	CARC
13462-88-9	Nickel Bromide [water soluble]	CARC
3333-67-3	Nickel Carbonate	CARC
3333-39-3	Nickel Carbonate	CARC
12607-70-4	Nickel Carbonate Hydroxide	CARC
13463-39-3	Nickel Carbonyl	CARC, HITOX (Acute)
7718-54-9	Nickel Chloride [water soluble]	CARC
557-19-7	Nickel Cyanide	CARC
13478-93-8	Nickel Dimethylglyoxime	CARC
10028-18-9	Nickel Fluoride [water soluble]	CARC
6/2/3349	Nickel Formate [water soluble]	CARC
12054-48-7	Nickel Hydroxide	CARC
12125-56-3	Nickel Hydroxide	CARC
11113-74-9	Nickel Hydroxide [water soluble]	CARC
13462-90-3	Nickel Iodide [water soluble]	CARC
7440-02-0	Nickel metal powder & Ni compounds	CARC
13138-45-9	Nickel Nitrate [water soluble]	CARC
547-67-1	Nickel Oxalate	CARC
1313-99-1	Nickel Oxide	CARC
13520-61-1	Nickel Perchlorate Hexahydrate [water soluble]	CARC
10381-36-9	Nickel Phosphate	CARC
1314-06-3	Nickel Sesquioxide	CARC
12035-72-2	Nickel Subsulfide	CARC
13770-89-3	Nickel Sulfamate	CARC
7786-81-4	Nickel Sulfate [water soluble]	CARC
37227-61-5	Nickel-Beryllium Alloy, as Ni fume or dust	CARC
1271-28-9	Nickelocene	CARC
62-75-9	N-Nitrosodimethylamine [1910.1016]	CARC
7778-39-4	o-Arsenic Acid	CARC
20816-12-0	Osmium Tetroxide	HITOX (Acute)
7783-41-7	Oxygen Difluoride	HITOX (Acute)
10028-15-6	Ozone	HITOX (Acute)
30525-89-4	Paraformaldehyde	CARC
65996-93-2	Particulate polycyclic aromatic hydrocarbons [PPAH]	CARC
19624-22-7	Pentaborane	HITOX (Acute)
594-42-3	Perchloromethyl Mercaptan	HITOX (Acute)
382-21-8	Perfluoroisobutylene	HITOX (Acute)
—	Phenacetin contained in analgesic mixtures	CARC
638-21-1	Phenylphosphine	HITOX (Acute)
10025-87-3	Phosphorous Oxychloride	HITOX (Acute)

7280-37-7	Piperazine Estrone Sulfate	CARC
7784-41-0	Potassium Arsenate	CARC
13464-35-2	Potassium Arsenite	CARC
7789-00-6	Potassium Chromate, as Cr6+ [water soluble]	CARC
7778-50-9	Potassium Dichromate, as Cr 6+ [water soluble]	CARC
6423-43-4	Propylene Glycol Dinitrate	HITOX (Acute)
14808-60-7	Quartz	CARC
10043-92-2	Radon	CARC
13446-72-5	Rubidium Chromate, as Cr6+ [water soluble]	CARC
13446-73-6	Rubidium Dichromate, as Cr6+ [water soluble]	CARC
58569-17-8	Samarium Chromate Dihydrate, as Cr6+	CARC
58477-24-0	Samarium Chromate Heptahydrate, as Cr6+	CARC
16565-96-1	Samarium Chromate, as Cr6+ [water soluble]	CARC
7783-79-1	Selenium Hexafluoride	HITOX (Acute)
13909-09-6	Semustine	CARC
68308-34-9	Shale Oils	CARC
1/2/7784	Silver Chromate, as Cr6+	CARC
2/3/7784	Silver Dichromate, as Cr6+	CARC
7631-89-2	Sodium Arsenate	CARC
15120-17-9	Sodium Arsenate	CARC
7784-46-5	Sodium Arsenite	CARC
26628-22-8	Sodium Azide	HITOX (Acute)
11/3/7775	Sodium Chromate, as Cr6+ [water soluble]	CARC
10588-01-9	Sodium Dichromate, as Cr6+ [water soluble]	CARC
12018-32-5	Sodium Dichromate, as Cr6+ [water soluble]	CARC
16680-47-0	Sodium Equilin Sulfate	CARC
438-67-5	Sodium Estrone Sulfate	CARC
0-36-0	Soot extracts (containing PAHs)	CARC
0-37-0	Soots {PAH}	CARC
38455-77-5	Stannic Chromate, as Cr6+ [water soluble]	CARC
7803-52-3	Stibine	HITOX (Acute)
6/2/7789	Strontium Chromate, as Cr6+	CARC
54322-60-0	Strontium Chromate, as Cr6+	CARC
57-24-9	Strychnine	HITOX (Acute)
1395-21-7	Subtilisins	HITOX (Acute)
1/1/9014	Subtilisins	HITOX (Acute)
505-60-2	Sulfur mustard	CARC
5714-22-7	Sulfur Pentafluoride	HITOX (Acute)
7783-60-0	Sulfur Tetrafluoride	HITOX (Acute)
0-49-0	Sulfuric Acid Mist	CARC
14807-96-6	Talc (containing asbestos fibers)	CARC
0-40-0	Tars	CARC
1746-01-6	TCDO	CARC
1746-01-6	2,3,7,8-Tetrachlordibenzo-p-dioxin	CARC
107-49-3	Tetraethylpyrophosphate	HITOX (Acute)
7440-28-0	Thallium	HITOX (Chronic)
13473-75-1	Thallium Chromate, as Cr6+	CARC
15190-21-3	Thallium Chromate, as Cr6+	CARC
22534-09-4	Thallium Chromate, as Cr6+	CARC
13453-35-5	Thallium Dichromate, as Cr6+	CARC
52-24-4	Thio tepa	CARC
9/7/7719	Thionyl Chloride	HITOX (Acute)

108-98-5	Thiophenol	HITOX (Acute)
1314-20-1	Thorium Dioxide	CARC
38455-77-5	Tin (IV) Chromate, as Cr6+ [water soluble]	CARC
—	Tobacco products, smokeless	CARC
—	Tobacco smoke	CARC
584-84-9	Toluene-2,4-Diisocyanate	HITOX (Acute)
14567-73-8	Tremolite [asbestiform]	CARC
299-75-2	Treosulphan (treosulfan)	CARC
126-73-8	Tributyl Phosphate	HITOX (Acute)
15468-32-3	Tridmite {Silica (respirable) Crystalline}	CARC
52-24-4	Tris(1-aziridinyl)phosphine Sulfide	CARC
64070-83-3	Trisodium Arsenate Heptahydrate	CARC
7440-61-1	Uranium, natural [soluble & insoluble compounds]	CARC
75-01-4	Vinyl Chloride [1910.1017]	CARC, REPRO
107-13-1	Vinyl Cyanide [1910.1045]	CARC
0-46-0	Wood Dust	CARC
0-47-0	Wood Dust (beech & oak)	CARC
0-48-0	Wood Dust (birch, mahogany, walnute,& teak)	CARC
39413-47-3	Zinc Beryllium Silicate, as Be	CARC
12206-12-1	Zinc Chromate Hydroxide, as Cr6+	CARC
15930-94-6	Zinc Chromate Hydroxide, as Cr6+	CARC
66516-58-3	Zinc Chromate Hydroxide, as Cr6+	CARC
1308-13-0	Zinc Chromate, as Cr6+	CARC
1328-67-2	Zinc Chromate, as Cr6+	CARC
13530-65-9	Zinc Chromate, as Cr6+	CARC
14675-41-3	Zinc Chromate, as Cr6+	CARC
37300-23-5	Zinc Chromate, as Cr6+	CARC
57486-12-1	Zinc Chromate, as Cr6+	CARC
11103-86-9	Zinc Potassium Chromate (Hydroxide), as Cr6+	CARC
12527-08-1	Zinc Potassium Chromate (Hydroxide), as Cr6+	CARC
37809-34-0	Zinc Potassium Chromate (Hydroxide), as Cr6+	CARC
1308-13-0	Zinc Yellow, as Cr6+	CARC
1328-67-2	Zinc Yellow, as Cr6+	CARC
13530-65-9	Zinc Yellow, as Cr6+	CARC
14675-41-3	Zinc Yellow, as Cr6+	CARC
37300-23-5	Zinc Yellow, as Cr6+	CARC
57486-12-1	Zinc Yellow, as Cr6+	CARC

Congregation Area (At the end of Entrada Dr., by the "ROAD CLOSED" sign)



Appendix III

Fire Prevention Plan

Biological Laboratory and Greenhouse

100 Entrada Drive
Los Alamos, NM 87544

2019

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Fire Prevention Plan

I. OBJECTIVE

The purpose of this Fire Prevention Plan (FPP) is to eliminate the causes of fire, prevent loss of life and property by fire, and to comply with the Occupational Safety and Health Administration's (OSHA) standard on fire prevention, 29 CFR 1910.39. It provides employees with information and guidelines that will assist them in recognizing, reporting, and controlling fire hazards.

II. BACKGROUND

The NMC is committed to minimizing the threat of fire to employees, visitors, and property. The NMC's Emergency Action Plan addresses the procedures for responding to fires. This FPP serves to reduce the risk of fires at the Laboratory in the following ways:

A. Identifies materials that are potential fire hazards and their proper handling and storage procedures
B. Distinguishes potential ignition sources and the proper control procedures of those materials
C. Describes fire protection equipment and/or systems used to control fire hazards
D. Identifies persons responsible for maintaining the equipment and systems installed to prevent or control ignition of fires
E. Identifies persons responsible for the control and accumulation of flammable or combustible material
F. Describes good housekeeping procedures necessary to insure the control of accumulated flammable and combustible waste material and residues to avoid a fire emergency
G. Provides training to employees with regard to fire hazards to which they may be exposed

III. ASSIGNMENT OF RESPONSIBILITY

Fire safety is everyone's responsibility. All employees should know how to prevent and respond to fires, and are responsible for adhering to company policy regarding fire emergencies.

A. Management: The NMC's Director of Laboratory Research (DLR) and Business Operations Manager (BOM) determine the fire prevention and protection policies and communicate them to employees via this Fire Prevention Plan. Management provides adequate controls to ensure safety in the workplace and resources and training to laboratory employees to encourage fire prevention and the safest possible response in the event of a fire emergency.

B. Plan Administrator: The NMC Assistant Biosafety Officer (ABO) is responsible for overseeing the FPP administration; while the Facilities Manager (FM) is responsible for performing actual tasks related to the FPP. The ABO shall:

1. Ensure that fire control equipment and systems are properly maintained
2. Identify fuel source hazards
3. Notify management and FM when changes in operation increase the risk of fire

The FM shall:

1. Properly maintain fire control equipment and systems
2. Control fuel source hazards identified by ABO or others
3. Notify ABO and management when changes in operation increase the risk of fire

C. *Employees:* All employees shall:

1. Conduct operations safely to limit the risk of fire
2. Report potential fire hazards to management
3. Follow fire emergency procedures

IV. TYPES OF FIRE HAZARDS

The following sections address the major workplace fire hazards at the Biological Laboratory's facilities and the procedures for controlling the hazards.

A. *Electrical Fire Hazards:* Electrical system failures and the misuse of electrical equipment are leading causes of workplace fires. Fires can result from loose ground connections, wiring with frayed insulation, or overloaded fuses, circuits, motors, or outlets.

To prevent electrical fires, employees shall:

1. Make sure that worn wires are replaced.
2. Use only appropriately rated fuses.
3. Never use extension cords as substitutes for wiring improvements.
4. Check wiring in hazardous locations where the risk of fire is especially high.
5. Check electrical equipment to ensure that it is either properly grounded or double insulated.
6. Ensure adequate spacing while performing maintenance.

B. *Office Fire Hazards:* To prevent office fires, employees shall:

1. Ensure all portable heaters are approved by the SO. Portable electric heaters shall have tip-over protection that automatically shuts off the unit when it is tipped over. There shall be adequate clearance between the heater and combustible furnishings or other materials at all times.
2. Avoid overloading circuits with office equipment.
3. Keep storage areas clear of rubbish.
4. Ensure that extension cords are not placed under carpets.
5. Ensure that trash and paper set aside for recycling is not allowed to accumulate.

C. *Cutting, Welding, and Open Flame Work:*

The DLR will ensure the following:

1. Spark producing operations are performed by authorized personnel using DLR approved procedures.
2. The propane torch is Fire Marshall approved and used in a well-ventilated area.
3. Flameboys are used in laminar flow hoods for safe sterilization only with DLR approval.

4. Workers engaged in cutting and open flame work are wearing eye protection and protective clothing as appropriate.

D. Flammable and Combustible Materials: The ABO and FM will ensure that the following types of flammable substances are handled with special care:

1. Class A combustibles (wood, paper, cloth, rubber, and plastics) that can act as fuel and are found in non-specialized areas such as offices. To handle Class A combustibles safely:
   a. Dispose of waste on a regular basis.
   b. Keep work areas clean and free of fuel paths that could allow a fire to spread.
   c. Keep combustibles away from accidental ignition sources, such as hot plates, soldering irons, or other heat- or spark-producing devices.
   d. Store paper stock in metal cabinets.
   e. Do not order excessive amounts of combustibles.
   f. Make frequent inspections to anticipate fires before they start.

   Water and multi-purpose dry chemical (ABC) are approved fire extinguishing agents for Class A combustibles.

2. Class B combustibles (flammable and combustible liquids, such as oils, greases, tars, oil-based paints, and lacquers, flammable gases, and flammable aerosols). To handle Class B combustibles safely:

   a. Use only approved pumps, taking suction from the top, to dispense liquids from tanks, drums, barrels, or similar containers (or use approved self-closing valves or faucets).
   b. Do not dispense Class B flammable liquids into containers unless the nozzle and container are electrically interconnected by contact or by a bonding wire. Either the tank or container must be grounded.
   c. Store, handle, and use Class B combustibles only in approved locations where vapors are prevented from reaching ignition sources such as heating or electric equipment, open flames, or mechanical or electric sparks.
   d. Do not use a flammable liquid as a cleaning agent inside a building (the only exception is in a closed machine approved for cleaning with flammable liquids).
   e. Do not use, handle, or store Class B combustibles near exits, stairs, or any other areas normally used as exits.
   f. Do not weld, cut, grind, or use unsafe electrical appliances or equipment near Class B combustibles.
   g. Do not generate heat, allow an open flame, or smoke near Class B combustibles.

h. Know the location of and how to use the nearest portable fire extinguisher rated for Class B fire.

Water should not be used to extinguish Class B fires caused by flammable liquids. Water can cause the burning liquid to spread, making the fire worse. To extinguish a fire caused by flammable liquids, exclude the air around the burning liquid. The following fire-extinguishing agents are approved for Class B combustibles: carbon dioxide and multi-purpose dry chemical (ABC).

E. Smoking: Smoking is prohibited in all NMC buildings

V. PLAN IMPLEMENTATION

A. *Good Housekeeping:* To limit the risk of fires, employees shall take the following precautions:

1. Minimize the storage of combustible materials
2. Make sure that doors, hallways, stairs, and other exit routes are kept free of obstructions
3. Use and store flammable materials in well-ventilated areas away from ignition sources
4. Keep incompatible (i.e., chemically reactive) substances away from each other
5. Perform "hot work" (i.e., welding or working with an open flame or other ignition sources) in controlled and well-ventilated areas
6. Keep equipment in good working order
7. Ensure that heating units are safeguarded
8. Report all gas leaks immediately
9. Repair and clean up flammable liquid leaks immediately
10. Keep work areas free of dust, lint, sawdust, scraps, and similar material
11. Do not rely on extension cords if wiring improvements are needed, and take care not to overload circuits with multiple pieces of equipment

B. *Maintenance:* The NMC Facilities Manager will ensure that equipment is maintained according to manufacturers' specifications. Only properly trained individuals shall perform maintenance work.

The following equipment is subject to the maintenance, inspection, and testing procedures:

1. equipment installed to detect fuel leaks, control heating, and control pressurized systems
2. portable fire extinguishers, automatic sprinkler systems, and fixed extinguishing systems
3. detection systems for smoke, heat, or flame
4. fire alarm systems
5. emergency backup systems and the equipment they support

VI. TRAINING

The DLR through the ABO shall inform laboratory workers of the fire hazards via IWDs upon initial assignment to a job. The ABO will review with each lab worker those parts of this Plan necessary for their self-protection.

VII. PLAN REVIEW

The DLR and ABO shall review this Fire Prevention Plan annually for necessary changes.