NORTH DAKOTA STATE UNIVERSITY CHEMICAL HYGIENE PLAN

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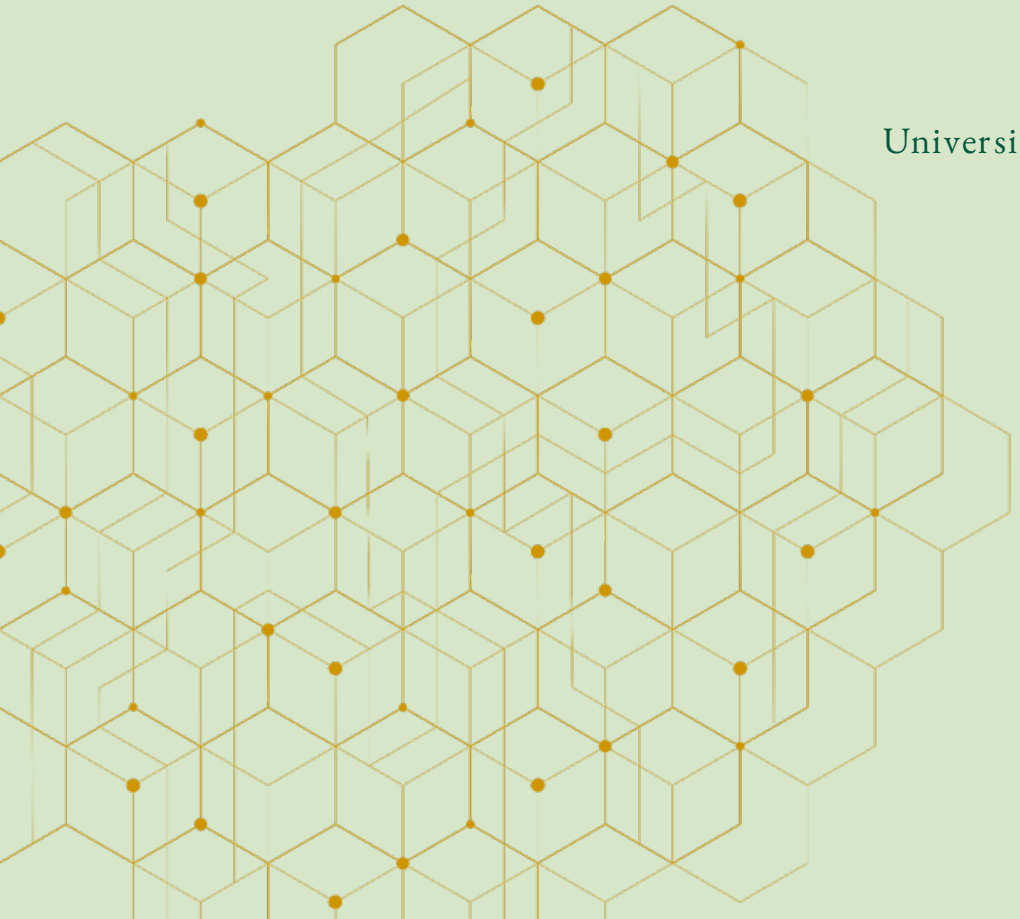
Abstract

The NDSU Chemical Hygiene Plan establishes the overall framework for safe chemical management at North Dakota State University and provides guidance to laboratory personnel in recognizing hazards, evaluating risks, implementing appropriate safety controls, and responding effectively to emergencies.



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1. CHEMICAL HYGIENE PROGRAM OVERVIEW

1.1 PURPOSE AND SCOPE

North Dakota State University (NDSU) is involved in teaching, research, and service activities that require the use, storage, and disposal of hazardous chemicals. During some phase of use, these materials may present hazards to employees, students, visitors, or the environment if not handled properly. The university therefore maintains a Chemical Hygiene Plan (CHP) to establish procedures and responsibilities for the safe use and management of hazardous chemicals in laboratories and other facilities where chemicals are used.

The purpose of this Chemical Hygiene Plan is to protect the health and safety of employees, students, and the general public by providing a framework for recognizing hazards, assessing risks, minimizing exposures, and preparing for emergencies associated with chemical use. The CHP outlines institutional policies, laboratory practices, and safety controls necessary to ensure that hazardous materials are handled in a manner that minimizes risk while supporting the university's research and educational mission.

This Chemical Hygiene Plan applies to all laboratory, research, and educational activities conducted by faculty, staff, students, or other representatives of North Dakota State University that involve the use, handling, storage, or disposal of hazardous chemicals. All personnel working with hazardous chemicals are expected to comply with both the requirements and the intent of this plan.

Failure to comply with these requirements may result in corrective actions, including restriction of laboratory access. The Chemical Hygiene Plan must be readily accessible to laboratory personnel, employee representatives, and regulatory officials upon request. The current version of the CHP is maintained electronically and is available online. Employees should always refer to the online version to ensure they are using the most up-to-date policies, procedures, and information.

North Dakota State University's Chemical Hygiene Plan follows the RAMP framework, a safety approach promoted by the American Chemical Society for managing chemical hazards in laboratories. RAMP encourages laboratory personnel to **Recognize hazards, Assess risks, Minimize risks, and Prepare for emergencies** when working with hazardous chemicals. This framework provides a systematic method for maintaining a safe laboratory environment while supporting the university's educational and research mission.

1.2 REGULATORY FRAMEWORK

North Dakota State University conducts laboratory operations in accordance with applicable federal, state, and local requirements governing the safe use and handling of hazardous chemicals. NDSU has

created a Chemical Hygiene Plan based on the Occupational Safety and Health Administration (OSHA) Laboratory Standard (29 CFR 1910.1450). This standard provides a regulatory framework for laboratory chemical safety and establishes standards for the development and implementation of a Chemical Hygiene Plan.

NDSU is using standards in 29 CFR 1910.1450 as part of its institutional Laboratory Safety Program, together with NDSU Policies 166, 166.1, and 711. The requirements of this Chemical Hygiene Plan apply to NDSU laboratory activities as specified in Section 1.3. Laboratory activities may also be subject to requirements administered by other regulatory agencies, including the Environmental Protection Agency (EPA), Department of Transportation (DOT), North Dakota Department of Environmental Quality (NDDEQ), and other applicable federal, state, or local authorities. The policies and procedures described in this plan are intended to support compliance with applicable regulatory requirements and establish institutional requirements for the safe conduct of laboratory activities.

1.3 APPLICABILITY TO LABORATORY AND ASSOCIATED WORK AREAS

This Chemical Hygiene Plan applies to educational, research, instructional, technical, and support activities involving hazardous chemicals conducted in university laboratories and associated work areas. These work areas include, but are not limited to:

- Research laboratories
- Educational laboratories
- Instrumentation laboratories
- Greenhouses and field sites
- Support areas, workshops, and maker spaces where hazardous chemicals are used or stored

Throughout this Chemical Hygiene Plan, all facilities and work areas meeting this definition are referred to collectively as laboratory spaces.

Principal investigators, instructors, and laboratory personnel are responsible for following established safety procedures when working with hazardous chemicals. Standard Operating Procedures (SOPs) specific to individual laboratories or research activities must be developed, maintained, and reviewed regularly by laboratory Principal Investigators and/or laboratory or instructional supervisors to address hazards associated with particular chemicals or experimental processes.

The requirements of this Chemical Hygiene Plan apply to the laboratory and associated work areas identified above. NDSU is using the OSHA Laboratory Standard (29 CFR 1910.1450) as the

framework for its Laboratory Safety Program and may apply its standards more broadly as institutional safety requirements.

1.4 RELATIONSHIP TO OTHER SAFETY PROGRAMS

The Chemical Hygiene Plan is one component of the university's overall Environmental Health and Safety program. Certain hazards encountered in laboratories are governed by separate institutional programs or regulatory frameworks and are addressed in specialized policies and manuals.

Examples include:

- **Biological Safety:** Biological hazards are managed through the Institutional Biosafety Committee and associated biosafety policies and procedures.
- **Radiation Safety:** Radiation hazards are managed under the Radiation Safety Program and overseen by the Radiation Safety Committee.
- **Environmental Health and Safety Programs:** Additional safety programs administered by the University Police and Safety Office address areas such as hazardous waste management, respiratory protection, and emergency preparedness.

Certain research activities may also be subject to oversight by Research Integrity, Security, and Compliance (RISC) within the Office of Research and Creative Activity (RCA).

The Chemical Hygiene Plan establishes the overall framework for safe chemical management at North Dakota State University and provides guidance to laboratory personnel in recognizing hazards, evaluating risks, implementing appropriate safety controls, and responding effectively to emergencies.

2. CHEMICAL HYGIENE PROGRAM ADMINISTRATION

2.1 LABORATORY AND CHEMICAL SAFETY COMMITTEE

The Laboratory and Chemical Safety Committee (LCSC) supports the safe use of hazardous chemicals and materials in laboratories and related educational and research environments at the university. The committee provides oversight and guidance related to the implementation of the university's Chemical Hygiene Plan (CHP) and laboratory safety programs.

The Laboratory and Chemical Safety Committee responsibilities include:

- Maintain and review the university's Chemical Hygiene Plan at least annually to ensure compliance with applicable regulations.
- Recommend revisions to laboratory safety policies, procedures, and programs.

- Advise university administration on laboratory and chemical safety matters.
- Review significant laboratory safety incidents and recommend corrective actions, training, or policy changes when appropriate.
- Promote safe laboratory practices through education, outreach, and guidance to departments and research groups.
- Provide recommendations regarding laboratory safety training programs.
- Review trends in laboratory inspections, incidents, or near-miss reports to identify opportunities for improvement.
- Support University Police and Safety Office (UPSO) Environmental Health and Safety (EHS) personnel in maintaining compliance with laboratory safety regulations.

The LCSC is an institutional committee established by NDSU Policy 166.1. The committee serves in an advisory capacity to university administration and UPSO EHS personnel.

2.2 CHEMICAL HYGIENE OFFICER AND SAFETY OFFICE

The University Police and Safety Office is responsible for administering the Chemical Hygiene Program and supporting departments in implementing the Chemical Hygiene Plan.

The Associate Director of Environmental Health and Safety serves as the Chemical Hygiene Officer (CHO). The CHO provides technical expertise and oversight related to laboratory chemical safety.

Responsibilities of the Chemical Hygiene Officer include:

- Providing guidance on the safe use, handling, storage, and disposal of hazardous materials.
- Maintaining and updating laboratory safety training resources.
- Assisting departments and laboratories in implementing safety practices required by the Chemical Hygiene Plan.
- Conducting or coordinating periodic laboratory safety inspections, annually at a minimum, to evaluate compliance with this plan and applicable regulations.
- Advising the Laboratory and Chemical Safety Committee on regulatory changes or safety concerns.
- Promoting adherence to the provisions of this Chemical Hygiene Plan.

The Chemical Hygiene Officer has the authority to suspend laboratory activities that present an imminent danger to employees, students, the public, or the environment until appropriate corrective actions are implemented. The CHO may restrict laboratory operations that do not comply with this Chemical Hygiene Plan.

2.3 ROLES AND RESPONSIBILITIES

The safe use of hazardous chemicals in laboratories requires cooperation among university administration, academic departments, laboratory supervisors, and laboratory personnel. Each group has specific responsibilities for ensuring that laboratory operations are conducted safely and in accordance with this Chemical Hygiene Plan.

2.3.1 UNIVERSITY ADMINISTRATION

University administration provides overall support and oversight for the Chemical Hygiene Program. University administration will designate a representative at the level of Dean, Vice President, or equivalent to the Laboratory and Chemical Safety Committee and support the implementation of the Chemical Hygiene Plan across campus.

2.3.2 DEANS, DEPARTMENT CHAIRS, AND DEPARTMENT HEADS

The Dean of each College and the Chair or Head of each department are responsible for ensuring that the Chemical Hygiene Plan is implemented and followed within their units.

Department leadership may designate a department safety representative to assist with laboratory safety activities. Responsibilities of department leadership include:

- Ensuring that laboratory personnel receive appropriate safety training.
- Supporting the implementation of safety procedures required by this Chemical Hygiene Plan.
- Ensuring that corrective actions are taken to address identified safety deficiencies.
- Promoting a culture of safety within laboratories and research facilities.

2.3.3 PRINCIPAL INVESTIGATORS AND INSTRUCTIONAL SUPERVISORS

Principal Investigators (PIs) and instructional supervisors have primary responsibility for the safe operation of laboratories and the safe use of hazardous materials in laboratories, teaching laboratories, and other spaces under their supervision. PIs and instructional supervisors are responsible for ensuring that laboratory activities are planned and conducted using the RAMP framework: Recognize hazards, Assess risks, Minimize risks, and Prepare for emergencies.

Responsibilities include:

Recognizing Hazards

- Identifying hazards associated with research and educational activities.
- Maintaining Safety Data Sheets (SDS) for hazardous chemicals and ensuring they are accessible to laboratory personnel.

- Ensuring hazardous chemicals in their possession are properly identified, labeled, inventoried, stored, and managed.
- Recognizing when activities may require additional review or oversight, including work with particularly hazardous substances—select carcinogens, reproductive toxins, and substances with a high degree of acute toxicity—as well as highly reactive materials, select agents and toxins, radioactive or biological materials, lasers, and export-controlled items.

Assessing Risks

- Evaluating spaces based on intended activities, chemical hazards, storage conditions, and experimental procedures.
- Determining whether required emergency safety equipment is present and accessible, including eyewash stations, safety showers, fume hoods, fire safety equipment, spill response materials, and emergency communication systems.
- Assessing whether work requires laboratory-specific SOPs, additional PPE, engineering controls, designated work areas, special storage conditions, or additional Safety Office consultation.
- Reviewing risks when new materials, equipment, procedures, personnel, or hazards are introduced.

Minimizing Risks

- Developing and maintaining laboratory-specific Standard Operating Procedures (SOPs) addressing hazards associated with chemicals, equipment, and experimental procedures.
- Providing laboratory personnel with training in safe laboratory practices, SOPs, PPE, emergency procedures, and hazards relevant to their work.
- Requiring personnel to follow established safety procedures and use appropriate protective equipment.
- Ensuring hazardous chemicals are stored, handled, transported, and disposed of properly.
- Correcting safety and compliance deficiencies identified during laboratory inspections or through other safety reviews.
- Ensuring laboratory personnel are supervised appropriately based on their experience, training, and the hazards of the work.

Preparing for Emergencies

- Ensuring personnel know the location and proper use of emergency equipment, including eyewashes, safety showers, fire extinguishers, spill materials, emergency communication systems, and emergency exits.

- Ensuring laboratory personnel understand emergency procedures for spills, exposures, injuries, fires, equipment failures, and other incidents.
- Maintaining current emergency contact and hazard information for laboratory spaces.
- Notifying the Safety Office of spills, exposures, injuries, releases, equipment failures, near misses, or other incidents involving hazardous chemicals.
- Cooperating with the Safety Office and other university officials during incident review, corrective action, and follow-up.

A PI may designate a laboratory supervisor. Laboratory supervisors may assist the PI with day-to-day laboratory safety oversight and implementation of safe work practices. However, assigning or designating a laboratory supervisor does not remove the PI's responsibility for ensuring that appropriate safety practices, training, supervision, and hazard controls are in place for work conducted under the PI's direction.

2.3.4 LABORATORY PERSONNEL AND STUDENTS

All employees, students, and other individuals working in laboratories share responsibility for maintaining a safe working environment.

Laboratory personnel are expected to:

- Follow the safety procedures and requirements described in this Chemical Hygiene Plan and in laboratory-specific safety procedures.
- Participate in required safety training before working with hazardous chemicals.
- Perform only those laboratory activities for which they have received appropriate training, instruction, and authorization.
- Use hazardous chemicals only in approved facilities.
- Use laboratory equipment only as intended and in accordance with manufacturer instructions, laboratory procedures, and training.
- Use appropriate personal protective equipment and safety controls.
- Stop work and report unsafe conditions, near misses, accidents, spills, equipment malfunctions, potential exposures, or unanticipated hazards to their supervisor and University Police and Safety Office.
- Conduct laboratory work in a manner that minimizes hazards to themselves, other personnel, and the environment.

2.4 CHEMICAL HYGIENE PLAN MAINTENANCE AND REVIEW

The Laboratory and Chemical Safety Committee, in collaboration with the Safety Office, will review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and revise it as necessary to reflect changes in regulatory requirements, university practices, laboratory operations, and recognized laboratory safety practices.

The current version of the CHP is maintained electronically and is available online. Laboratory personnel should always refer to the online version to ensure they are using the most up-to-date policies, procedures, and information.

2.5 RECORDKEEPING

NDSU shall maintain records necessary to document implementation and evaluation of the Laboratory Safety Program and this Chemical Hygiene Plan. Records may include, as applicable, training, laboratory inspections, exposure monitoring, medical consultations or examinations, incidents and corrective actions, hazardous waste activities, risk assessments, and other safety-related activities.

Records shall be maintained in accordance with applicable regulatory requirements, NDSU policies, and established Safety Office or departmental procedures.

3. RECOGNIZE HAZARDS

Recognizing hazards is the first step in protecting laboratory personnel from chemical exposure. Laboratory personnel must be able to identify hazardous chemicals, understand the potential risks associated with them, and recognize situations where exposures could occur.

Hazards associated with chemicals may arise from their physical properties, their toxicological effects, or the conditions under which they are used. Laboratory personnel are responsible for becoming familiar with the hazards of the chemicals and processes they use and understanding the precautions necessary to minimize exposure.

Hazard information is communicated through Safety Data Sheets (SDS), chemical labels, laboratory signage, Standard Operating Procedures (SOPs), and training provided by PIs, laboratory supervisors, and the Safety Office.

3.1 CHEMICAL HAZARD CLASSIFICATION

Hazardous chemicals are defined as chemicals present in the workplace that are capable of causing harm to individuals or the environment. Hazardous chemicals include materials that may present health or physical hazards during their use, storage, or disposal.

Understanding both the health and physical hazards associated with hazardous chemicals is essential for determining appropriate laboratory practices and protective measures.

3.2 HAZARD COMMUNICATION

Hazard communication ensures that laboratory personnel have access to information necessary to understand chemical hazards and implement appropriate precautions.

3.2.1 SAFETY DATA SHEETS (SDS)

Safety Data Sheets provide detailed information about the hazards, handling procedures, and emergency response measures associated with hazardous chemicals. Principal Investigators and laboratory supervisors are responsible for ensuring that SDS for all hazardous chemicals used in the laboratory are readily available to laboratory personnel. Laboratory personnel must review the SDS for chemicals prior to use to understand hazards, exposure risks, and appropriate safety controls.

Each laboratory shall hold a current file of Safety Data Sheets (SDS) for all the materials used in that laboratory. This file should be visible from the entrance to the laboratory so that Emergency Services personnel can find relevant information quickly if they are called to an accident or incident. The SDSs must be organized in a manner that allows for quickly locating a specific SDS. The Safety Office supplies specially marked, green three-ring binders for this purpose.

Hazardous chemicals created or synthesized at NDSU must be labeled with contents, date of synthesis, owner, and appropriate hazard information. National Fire Protection Association (NFPA) hazard information must be provided at minimum; Globally Harmonized System (GHS) labeling must be used where appropriate.

3.2.2 CHEMICAL LABELING

All containers of hazardous chemicals must be properly labeled to identify the contents and associated hazards. Labels must clearly indicate the identity of the chemical and provide sufficient information to alert users to potential hazards. Secondary containers must be labeled with the chemical identity and hazard information sufficient for safe handling.

Proper labeling ensures that individuals handling chemicals can quickly recognize potential hazards and take appropriate precautions.

3.2.3 LABORATORY HAZARD SIGNAGE

Laboratory work areas where hazardous substances are used or stored must be clearly identified. Entrances to laboratories must display hazard and emergency contact information, including the name and contact number of the Principal Investigator or laboratory supervisor responsible for the laboratory, and at least one alternate contact. An emergency contact must be reachable after hours. Labs must update Emergency Information posters annually and as hazards or personnel change.

Posting hazard information helps alert personnel, visitors, and emergency responders to potential hazards within the laboratory.

3.3 LABORATORY HAZARD IDENTIFICATION

Hazard identification in laboratories is supported through several mechanisms, including chemical inventories, Standard Operating Procedures (SOPs), and hazard assessments conducted by PIs or laboratory supervisors.

3.3.1 CHEMICAL INVENTORIES

Maintaining an accurate inventory of hazardous chemicals is an important component of laboratory hazard recognition and risk management. Chemical inventories allow laboratories and the university to identify hazards, manage chemical storage, and respond effectively to emergencies.

Every Principal Investigator or other authorized laboratory supervisor is responsible for maintaining accountability for hazardous chemicals under their control from the time the material is received until it is used, transferred, or properly disposed of. Accountability includes understanding the hazards associated with the materials used in the laboratory and ensuring that appropriate safety procedures are followed.

Principal Investigators must review Safety Data Sheets (SDS) and chemical labels to determine the hazards and toxicity of materials procured and maintained in their laboratories. This information should be used to support hazard assessments and the development of laboratory-specific Standard Operating Procedures (SOPs).

Chemicals of unknown identity or known chemicals whose toxicity, carcinogenicity, or stability is unknown cannot be used until their current SDS or other hazard information has been received and understood.

Each laboratory must maintain a current inventory of hazardous chemicals that includes, at a minimum:

- Chemical name

- Quantity or approximate amount
- Hazard classification or hazard information
- Inventory Date

The inventory must include all hazardous substances that are stored or used within the laboratory. Maintaining accurate inventories also allows employees to have access to information about hazardous chemicals present in their workplace. Chemical inventories should be reviewed at minimum annually to identify aging chemicals, peroxide-forming compounds, unknown materials, surplus chemicals, and opportunities for chemical redistribution or reduction.

3.3.2 ONLINE CHEMICAL INVENTORY SYSTEM

Each laboratory is expected to maintain an up-to-date chemical inventory within the university's chemical inventory management system. Laboratories must update this inventory when chemicals are received, transferred, or removed from the laboratory.

Chemical inventories must also be consistent with maximum allowable quantities (MAQs) established by the currently adopted International Fire Code. Maintaining accurate inventory records helps ensure that chemical quantities within laboratories remain within permitted limits.

3.3.3 HAZARD ASSESSMENTS

Hazard assessments must be conducted before beginning new laboratory activities and reviewed whenever procedures, equipment, chemicals, scale, personnel change, or after an incident or near miss. Before beginning new experiments or procedures involving hazardous chemicals, principal investigators must evaluate the hazards associated with the chemicals, equipment, and procedures involved. This evaluation helps determine appropriate control measures, safety precautions, and standard operating procedures (SOPs).

3.3.4 STANDARD OPERATING PROCEDURES (SOPS)

Standard Operating Procedures must be developed and maintained for laboratory activities involving hazardous materials. SOPs describe the hazards associated with specific chemicals or processes and outline procedures necessary to perform the work safely. SOPs should be based upon a documented hazard and risk assessment of the activity being performed.

Standard Operating Procedures for recurring hazardous tasks unique to a particular lab should be written and approved by the Principal Investigator or Instructional Supervisor. PIs and laboratory supervisors are responsible for ensuring that SOPs are available to personnel working in the laboratory and that personnel are trained in the procedures relevant to their work. Each laboratory must maintain a current file containing all the relevant SOPs.

3.4 PARTICULARLY HAZARDOUS SUBSTANCES

For purposes of this Chemical Hygiene Plan, NDSU defines Particularly Hazardous Substances (PHS) as chemicals or materials that present elevated health or physical hazards and therefore require additional planning, controls, training, or oversight before use. This NDSU definition incorporates the types of substances identified as particularly hazardous under the OSHA Laboratory Standard and extends the designation to other chemicals and materials that present significant physical or reactive hazards.

Particularly Hazardous Substances may include:

- Carcinogens
- Reproductive toxins
- Chemicals with high acute toxicity
- Chemicals readily absorbed through the skin that may cause systemic toxicity
- Pyrophoric materials
- Water-reactive chemicals
- Explosive or potentially explosive compounds
- Organic peroxides
- Self-reactive substances
- Shock-sensitive materials
- Highly reactive chemicals capable of runaway reactions
- Chemicals capable of generating significant heat, pressure, fire, or toxic gas releases
- Other substances identified through hazard or risk assessment as presenting a significant health or physical hazard

Work involving Particularly Hazardous Substances must be carefully evaluated before use. Laboratory personnel must review available hazard information and ensure that appropriate controls are implemented to minimize the potential for exposure, fire, explosion, uncontrolled reaction, or other serious consequences.

Depending on the material and activity, additional protective measures may include designated work areas, specialized engineering controls, laboratory-specific Standard Operating Procedures, enhanced personal protective equipment, specialized training, restricted access, decontamination procedures, waste-management requirements, or additional review by the Principal Investigator, laboratory supervisor, or Safety Office.

3.4.1 DESIGNATED WORK AREAS

Work involving Particularly Hazardous Substances must be conducted in areas appropriate for the hazards associated with the material and activity. Where necessary, designated areas must be clearly identified and maintained to prevent unintended exposure or contamination of other laboratory spaces. Designated areas may include chemical fume hoods, glove boxes, containment systems, or other controlled locations where exposure or physical hazards can be minimized.

Equipment and work surfaces used with Particularly Hazardous Substances must be clearly labeled or otherwise identified when necessary to communicate the presence of hazardous materials or prevent unintended exposure.

3.4.2 STANDARD OPERATING PROCEDURES

Laboratories working with Particularly Hazardous Substances must develop laboratory-specific Standard Operating Procedures (SOPs) when necessary to address the hazards or complexity of the work. SOPs should address, as applicable:

- Required engineering controls, such as fume hoods, glove boxes, or containment systems
- Personal protective equipment requirements
- Safe handling and storage procedures
- Incompatible materials and conditions to avoid
- Spill, fire, reaction, and other emergency procedures
- Waste disposal requirements
- Required training or authorization

Laboratory personnel must be trained on applicable procedures before working with Particularly Hazardous Substances.

3.4.3 CONTAMINATION CONTROL AND DECONTAMINATION

Work surfaces, equipment, and protective equipment that may become contaminated with Particularly Hazardous Substances must be properly cleaned, decontaminated, or otherwise managed in accordance with laboratory procedures. Contaminated materials must be handled and disposed of in accordance with university hazardous waste management procedures.

Laboratory personnel must remove contaminated protective equipment before leaving designated work areas and follow appropriate personal hygiene practices to prevent unintended exposure or contamination of other areas.

3.4.4 SAFETY OFFICE CONSULTATION

Principal Investigators and laboratory supervisors should consult with the Safety Office when planning work involving Particularly Hazardous Substances, particularly when the work involves unusual, highly reactive, or significant health or physical hazards. The Safety Office can assist with evaluating hazards and identifying appropriate controls, procedures, training, and other safeguards.

3.5 CHEMICAL SPECIFIC REGULATORY REQUIREMENTS

Certain chemicals may be subject to additional federal or state requirements beyond the general provisions of this Chemical Hygiene Plan. These requirements may include exposure monitoring, regulated or designated areas, written exposure control plans, specialized training, PPE or respiratory protection, recordkeeping, use restrictions, or other controls.

Principal Investigators and laboratory supervisors must contact the Safety Office before beginning or significantly modifying work with a chemical known or suspected to be subject to additional substance-specific regulatory requirements. The Safety Office will assist in determining applicable requirements and necessary controls.

3.6 PEROXIDE FORMING CHEMICALS

Certain chemicals can react with oxygen in the air or light over time to form unstable peroxide compounds in solution or crystals. These peroxide crystals or concentrated peroxides may be highly sensitive to heat, light, friction, shock, or impact and can present a significant explosion hazard. Many peroxide-forming chemicals are common laboratory solvents and reagents, including ethers, tetrahydrofuran (THF), dioxane, and other organic compounds.

Peroxide formation may occur even in unopened containers and is often accelerated after a container is opened and exposed to air. As peroxide concentrations increase, routine activities such as opening a container, moving a bottle, or concentrating a solvent through evaporation or distillation may create serious hazards.

Laboratories that possess peroxide-forming chemicals must:

- Maintain an inventory of peroxide-forming chemicals.
- Label containers with the date received and date opened.
- Periodically inspect containers for signs of peroxide formation.
- Follow recommended storage, testing, and disposal practices.
- Dispose of peroxide-forming chemicals before expiration or when peroxide formation is suspected.

Laboratory personnel must not open, move, or handle containers that exhibit signs of peroxide formation, including visible crystals, precipitates, discoloration, cloudiness, or deposits around caps, lids, or container threads. Suspect containers must be isolated and reported to the Safety Office immediately.

Additional requirements and management procedures for peroxide-forming chemicals are provided in the Safety Office Guide for Peroxide-Forming Chemicals.

3.7 COMPRESSED GASES AND CRYOGENIC MATERIALS

Compressed gases and cryogenic materials present significant physical and chemical hazards, including high pressure, fire and explosion risk, oxygen displacement, and extreme temperature hazards. Laboratory personnel must recognize these hazards and implement appropriate controls to ensure safe handling and use.

Compressed gas cylinders must be:

- Handled only by trained personnel
- Clearly labeled with the contents of the cylinder
- Stored, transported, and used in an upright position
- Secured at all times using appropriate restraints (e.g., chains, straps, or stands) to prevent tipping
- Certified for their contents
- Kept away from incompatible materials and ignition sources

Cylinders must not be moved by dragging or rolling and must be transported using appropriate cylinder carts with protective caps in place. Damaged, leaking, or unlabeled cylinders must not be used and must be removed from service.

Cryogenic materials (e.g., liquid nitrogen) present additional hazards due to extremely low temperatures and rapid expansion of gases, which may displace oxygen in confined or poorly ventilated spaces. Oxygen-deficient atmospheres created by compressed gases or cryogenic materials can rapidly cause unconsciousness and death without warning. Appropriate personal protective equipment (PPE), including insulated gloves and eye protection, must be used when handling cryogenic materials. Contact with cryogenic liquids or surfaces cooled by cryogenic liquids may cause severe tissue damage similar to thermal burns.

Laboratory personnel must follow manufacturer recommendations and applicable university procedures when working with compressed gases and cryogenic materials. Additional guidance is provided in the NDSU Compressed Gas Cylinder Safety Standard Operating Procedure.

3.8 EMERGING HAZARDS

Some research activities involve materials whose hazards may not be fully understood. In these situations, precautionary approaches should be used to minimize potential risks.

3.8.1 NANOMATERIALS

Nanotechnology involves the manipulation of materials at the nanoscale level, typically between one and one hundred nanometers in size. Materials at this scale may exhibit physical, chemical, or biological properties that differ from those of larger particles of the same substance.

Nanomaterials may present exposure risks through inhalation, skin contact, or ingestion. Due to their small size and increased surface area, nanoparticles may interact with biological systems differently than conventional materials.

When hazards associated with nanomaterials are not well understood, they should be treated as potentially hazardous materials and handled with appropriate precautionary controls. Laboratory personnel working with nanomaterials must receive appropriate training and follow laboratory-specific procedures designed to minimize exposure. Additional guidance is available in Appendix C – Nanomaterial Safety.

4. ASSESS RISKS

After hazards have been identified, the next step in the RAMP framework is to assess the level of risk associated with laboratory work. Risk assessment involves evaluating the likelihood and potential severity of exposure to hazardous chemicals and determining whether additional safety controls or precautions are necessary.

The level of risk depends on several factors, including the inherent hazards of the chemical, the quantity used, the procedures performed, and the effectiveness of available control measures. Laboratory personnel must consider how chemicals are used, how exposures could occur, and whether the existing laboratory controls are sufficient to protect personnel.

Principal Investigators, instructional supervisors, and laboratory personnel share responsibility for evaluating risks associated with laboratory activities and ensuring that appropriate safety measures are implemented before work begins.

4.1 LABORATORY RISK ASSESSMENT PROCESS

Laboratory personnel should evaluate potential hazards before beginning new experiments or procedures involving hazardous chemicals. Principal Investigators and laboratory supervisors are responsible for ensuring that hazards associated with laboratory procedures are evaluated and that appropriate safety precautions are established.

This evaluation should consider:

- Whether elimination or substitution are feasible to reduce hazards.
- The physical and health hazards associated with the chemical.
- The quantity and concentration of the material.
- The experimental procedure being conducted.
- The potential for exposure through inhalation, ingestion, skin contact, or accidental injection.
- The availability and effectiveness of engineering controls, administrative controls, and personal protective equipment.

Risk assessments may be documented through laboratory Standard Operating Procedures (SOPs), hazard assessments, or other laboratory safety documentation. Risk assessment is an ongoing and iterative process and must not be limited to the initial planning of an experiment. Principal Investigators and laboratory personnel are expected to continuously evaluate hazards and risks as work progresses, particularly when procedures change, new chemicals are introduced, unexpected conditions arise, or after an incident or near miss.

4.2 EXPOSURE PATHWAYS

Assessing risk requires understanding the ways in which hazardous chemicals may enter the body. The primary routes of chemical exposure include:

- **Inhalation:** Breathing vapors, aerosols, dusts, or gases
- **Dermal contact:** Absorption through the skin or eyes
- **Ingestion:** Accidental swallowing of contaminated materials
- **Injection:** Entry through cuts, punctures, or other injuries

Laboratory procedures must be designed to minimize the potential for exposure through any of these pathways. When evaluating risks, laboratory personnel should consider whether the procedure could generate airborne contaminants, produce splashes, or involve materials capable of penetrating the skin.

4.3 RISK CATEGORIES FOR LABORATORY ACTIVITIES

Laboratory work may involve varying levels of risk depending on the chemicals used and the procedures performed. Risk categories can be used to help determine appropriate safety controls.

4.3.1 LOW-RISK ACTIVITIES

Low-risk activities typically involve small quantities of chemicals with relatively low toxicity and minimal potential for exposure. These activities may include routine laboratory procedures conducted under normal laboratory conditions using standard safety practices.

4.3.2 MODERATE-RISK ACTIVITIES

Moderate-risk activities may involve chemicals with greater toxicity, procedures that could generate vapors or aerosols, or operations involving larger quantities of hazardous chemicals. Additional safety precautions, such as the use of engineering controls or enhanced personal protective equipment, may be necessary.

4.3.3 HIGH-RISK ACTIVITIES

High-risk activities involve chemicals or procedures that present a significant potential for exposure or severe consequences if exposure occurs. Examples may include work with particularly hazardous substances, or procedures capable of generating hazardous conditions.

Work involving high-risk materials or procedures should be carefully evaluated prior to initiation, and additional safety controls will likely be required to ensure adequate protection of laboratory personnel.

4.4 PRIOR APPROVAL REQUIREMENTS

Certain laboratory activities require review and approval before work begins. The level of approval must be appropriate to the hazards and may involve the Principal Investigator, laboratory supervisor, Safety Office, or another applicable university oversight program.

Prior review and approval are required when:

- Conducting unattended hazardous operations as specified in this Plan;
- Initiating laboratory work in a new or newly assigned space;
- Significantly changing the scale, concentration, temperature, pressure, equipment, or conditions of a procedure when the change may increase risk;
- Introducing a high-risk procedure for which adequate controls have not previously been established;
- Proposed work requires engineering controls, emergency equipment, PPE, or other safeguards that may not be available or adequate in the assigned space;

- Another university safety or research oversight program requires approval; or
- The Principal Investigator, laboratory supervisor, or Safety Office determines through risk assessment that additional review is necessary.

Principal Investigators and laboratory supervisors are responsible for determining when laboratory activities require prior review and approval. Depending on the activity and hazards involved, additional review or approval may be required by the Safety Office or another applicable university oversight program. Work requiring prior approval must not begin until the required review is complete and appropriate controls have been established.

4.5 EXPOSURE EVALUATION AND MONITORING

In some situations, it may be necessary to evaluate potential chemical exposures through monitoring or other forms of exposure assessment. Exposure monitoring may be conducted when:

- Required by regulation
- Exposures may exceed occupational limits
- The Safety Office determines that monitoring is necessary based on observed conditions, reported symptoms, or the nature of the work.

Monitoring may include area surveys, air sampling, or other methods designed to evaluate the presence of hazardous conditions in the workplace.

PIs and/or Laboratory supervisors should consult with the Safety Office when:

- Chemical exposures are suspected
- New or unusual chemical processes are introduced
- Monitoring is necessary to evaluate potential hazards
- Additional hazard evaluation is required

Applicable occupational exposure limits should be considered when evaluating chemical exposure risks. OSHA Permissible Exposure Limits (PELs) and other recognized occupational exposure guidelines are typically identified in Section 8 of the Safety Data Sheet. Laboratory personnel should also review available hazard information for signs and symptoms associated with exposure. Contact the Safety Office when exposure limits are unavailable, uncertain, or may be exceeded.

The Safety Office may assist laboratories in conducting exposure assessments and determining whether additional safety controls are necessary.

4.6 LABORATORY INSPECTIONS AND COMPLIANCE MONITORING

Routine laboratory inspections help identify potential hazards and ensure that laboratory practices remain consistent with the requirements of this Chemical Hygiene Plan.

Laboratory inspections may be conducted by:

- Department safety representatives
- Principal Investigators or laboratory supervisors
- Safety Office personnel
- External regulatory agencies

Inspections evaluate laboratory practices, chemical storage, waste management, and compliance with safety requirements. When deficiencies are identified, they will be reported to the responsible department, PI, or laboratory supervisor, along with a timeframe for corrective action.

Follow-up inspections may be conducted to verify that deficiencies have been corrected. If deficiencies are not addressed within the specified timeframe, the issue may be escalated through departmental leadership and university administration until corrective actions are implemented.

In situations involving particularly hazardous conditions, immediate corrective action may be required to ensure the safety of laboratory personnel.

4.7 HAZARDOUS WASTE INSPECTIONS

Hazardous waste inspections are conducted to ensure that hazardous waste generated in laboratories and other applicable areas is managed in accordance with university requirements and applicable regulations.

The Safety Office conducts hazardous waste handling inspections in laboratories and other spaces where hazardous or other regulated waste may be generated. Inspections evaluate waste containers and accumulation areas to verify proper labeling, container condition, closure of containers, segregation of incompatible materials, and general housekeeping.

If deficiencies are identified, the Safety Office shall provide written notification to the Principal Investigator (PI) or designated laboratory contact listed on the Emergency Contact poster at the entrance to the laboratory and the Department Chair. The responsible laboratory or department shall provide a written response to the violation notification within three calendar days of receipt. The response shall identify the corrective actions taken or planned to address each deficiency. If no

response is received within 48 hours of the notification, the Safety Office shall send one reminder email to the responsible laboratory or department.

Laboratories may be re-inspected to verify that deficiencies have been corrected. Any deficiency that remains uncorrected or has not been adequately addressed at the time of the next inspection shall be considered an unresolved deficiency and shall be escalated through the corrective-action process described in this plan. Repeated or unresolved deficiencies may be reported to department leadership, including the Dean, Provost, and Vice President for Research.

If deficiencies remain unresolved, the laboratory may be temporarily restricted from operation, and personnel with access to the laboratory may be required to complete additional hazardous waste handling training.

If necessary, the Safety Office may determine that a qualified hazardous materials contractor must be engaged to address hazardous waste conditions. Any costs associated with cleanup or corrective actions will be the responsibility of the department(s) responsible for the laboratory space.

5. MINIMIZE RISKS – HIERARCHY OF CONTROLS

After hazards have been identified and risks assessed, appropriate control measures must be implemented to reduce the likelihood of exposure and prevent accidents. Laboratory personnel must follow established safety practices and use appropriate control measures when working with hazardous chemicals.

Risk reduction in laboratories is achieved through the application of the hierarchy of controls, which prioritizes eliminating/substituting hazards, engineering controls, administrative controls, and personal protective equipment. These controls work together to reduce hazards associated with chemical handling, storage, and disposal.

Principal Investigators and instructional supervisors are responsible for ensuring that appropriate safety controls are implemented within their laboratories. Laboratory personnel must follow these controls and perform work in a manner that minimizes risk to themselves and others.

Hazard control measures should be implemented according to the hierarchy of controls, which emphasizes controlling hazards at their source whenever possible.

5.1 ELIMINATION AND SUBSTITUTION

The most effective way to reduce risk from hazardous chemicals is to eliminate the hazard entirely or substitute a less hazardous chemical or process whenever possible. Elimination involves removing a

hazardous chemical or procedure from the laboratory, while substitution involves replacing a hazardous substance with a less hazardous alternative. During experimental design and hazard assessment, Principal Investigators and laboratory personnel should evaluate whether hazardous chemicals or processes can be avoided, reduced in scale, or replaced with safer alternatives. Implementing elimination or substitution strategies can significantly reduce the potential for chemical exposure and is considered the most effective method for controlling laboratory hazards.

5.2 ENGINEERING CONTROLS

Engineering controls play an essential role in minimizing exposure to hazardous chemicals in laboratory environments. Procedures involving volatile chemicals, toxic vapors, aerosols, or other airborne contaminants must be conducted in appropriate containment systems such as laboratory fume hoods or other ventilation devices.

5.2.1 LABORATORY VENTILATION

A laboratory fume hood shall serve as the primary hazard control device while working with toxic or other hazardous chemicals. Each laboratory in which volatile hazardous chemicals are used shall have a functional fume hood with adequate face velocity and ventilation according to laboratory standards and building codes. Ventilation should be sufficient to remove all vapors to the exterior of the building and not endanger people outside the building.

Local exhaust ventilation systems such as a snorkel or canopy hood should be used to capture hazardous vapors or aerosols at the point of generation when necessary. Analytical instruments or other equipment that generate hazardous emissions must be equipped with appropriate exhaust ventilation or containment systems.

Laboratory ventilation systems must be maintained in proper working condition.

The NDSU Safety Office conducts performance testing of laboratory fume hoods at least annually to verify proper operation and adequate containment of hazardous vapors. Fume hoods that are found to be out of compliance will be reported to Facilities Management for repair or corrective action. Fume hood performance testing criteria, including acceptable operating ranges and response to failed tests, will be maintained by the Safety Office in accordance with applicable standards, manufacturer specifications, and institutional procedures.

Laboratory personnel are responsible for ensuring that fume hoods are properly prepared prior to inspection, maintenance, or repair activities. Preparation includes:

- Removing all chemicals, containers, and unnecessary materials from the fume hood

- Removing or securing glassware and equipment
- Stopping all active experiments or processes
- Cleaning and wiping down interior surfaces and the sash
- Ensuring the area surrounding the fume hood is clear and accessible

Facilities Management personnel will not perform repairs or maintenance on fume hoods that have not been properly prepared. If a fume hood is not in a safe and serviceable condition for work, Facilities Management will notify the Safety Office and the responsible laboratory.

5.2.2 HANDWASHING FACILITIES

A handwashing sink must be available within or immediately accessible to the laboratory work area. Laboratory personnel must have the ability to wash hands immediately after handling hazardous materials or before leaving the laboratory.

Liquid soap and appropriate hand-drying materials must be available at handwashing stations.

5.3 ADMINISTRATIVE CONTROLS

Safe laboratory work practices are essential for minimizing the risks associated with hazardous chemicals.

5.3.1 GENERAL LABORATORY CONDUCT

Laboratory personnel must conduct all work in a safe and responsible manner.

- Eating, drinking, smoking, chewing gum or tobacco, and applying cosmetics are prohibited in laboratories where hazardous chemicals are used or stored.
- Food and beverages must not be stored in laboratory refrigerators, freezers, or cabinets used for chemical storage.
- Personal items such as backpacks, coats, and other belongings should be kept outside laboratory work areas whenever possible to prevent contamination.
- Horseplay, practical jokes, or behavior that may distract laboratory personnel is prohibited.
- Personnel must remain alert to unsafe conditions and must promptly correct and report hazards to their supervisor and the Safety Office.
- Laboratory personnel must not perform work for which they have not been trained or authorized.

5.3.2 PERSONAL HYGIENE

Proper hygiene practices are necessary to reduce the risk of exposure.

- Hands must be washed thoroughly with soap and water after handling chemicals, after removing gloves, and before leaving the laboratory.
- Hands must be washed before eating, drinking, touching the face, or using electronic devices.
- Personnel should avoid touching the face, mouth, eyes, or nose while working with hazardous chemicals.
- Individuals with open wounds or broken skin must properly cover the affected area and wear appropriate protective coverings before working with hazardous chemicals.

5.3.3 LABORATORY ACCESS AND SECURITY

Laboratories where hazardous chemicals are used or stored must be secured to prevent unauthorized access.

- Laboratories must be locked and secured when unattended.
- Laboratory doors must not be propped, blocked, or taped open in a manner that compromises laboratory security or containment of hazards.
- Access should be limited to individuals with laboratory responsibilities or authorized maintenance personnel.
- Laboratory doors must remain closed while hazardous chemical operations are in progress.
- Individuals whose access to the laboratory has not been previously authorized or coordinated should be asked to identify the purpose of their visit. Laboratory personnel may deny or delay access until the individual's identity, purpose, and authorization to enter can be verified.

5.3.4 LABORATORY ENTRY REQUIREMENTS

Individuals who are not assigned to a laboratory, including visitors, Facilities Management personnel, Information Technology (IT) staff, contractors, and other support personnel, may encounter hazards when entering laboratory spaces. Entry into laboratories must be controlled to ensure that all individuals are aware of potential hazards and follow appropriate safety precautions.

All individuals entering laboratory spaces must:

- Comply with laboratory-specific safety requirements and posted hazard signage.
- Wear appropriate minimum attire, including:
    - Closed-toe shoes
    - Long pants or equivalent leg coverage
    - Eye protection when required by posted signage or laboratory conditions
    - Gloves when handling surfaces or equipment

- Follow instructions provided by laboratory personnel regarding hazards and safe work practices.

Maintenance and support personnel must follow established laboratory entry procedures, including:

- Communicating with laboratory personnel regarding the purpose, scope, and duration of work prior to entering the space.
- Determining whether work may interrupt active or hazardous operations.
- Identifying any specific hazards or additional PPE requirements before beginning work.
- Avoiding handling or moving chemicals, samples, or experimental equipment unless coordinated with laboratory personnel.
- Stopping work immediately and notifying the laboratory supervisor and Safety Office if unsafe conditions are identified.

Laboratory personnel are responsible for coordinating access to their laboratory spaces and ensuring that visitors and support personnel are informed of relevant hazards and safety requirements.

Advance coordination is required for maintenance, repair, or service work that may impact laboratory operations. Laboratories must be properly prepared prior to scheduled work to ensure that hazards are controlled and that work can be completed safely.

5.3.5 LABORATORY EXIT REQUIREMENTS

Individuals leaving laboratory spaces must take appropriate precautions to prevent the transfer of hazardous materials or contamination to hallways, offices, vehicles, shops, common areas, or other non-laboratory spaces.

Before leaving a laboratory:

- Ensure chemicals, samples, waste, equipment, and ongoing laboratory operations are left in a safe and secure condition before leaving the space.
- Inspect tools, equipment, carts, ladders, and other items used during the work. Items that may have contacted hazardous materials or potentially contaminated surfaces must be cleaned or decontaminated, as appropriate, before being removed from the laboratory.
- Do not touch door handles, phones, keyboards, elevator controls, or other common surfaces with contaminated gloves, PPE, tools, or equipment.
- Remove disposable gloves, laboratory coats, and other potentially contaminated personal protective equipment before exiting the laboratory or designated work area.

- Dispose of single-use PPE in the appropriate waste container. Reusable PPE must be placed in its designated storage, cleaning, or decontamination location.
- Wash hands thoroughly with soap and water after removing gloves, after handling hazardous materials or potentially contaminated equipment or surfaces, and whenever required by laboratory-specific procedures.
- Report spills, contamination, damaged equipment, or other unsafe conditions identified during the work.

Facilities Management personnel, Information Technology staff, contractors, visitors, and other support personnel must follow any laboratory-specific exit instructions provided by laboratory personnel. When work involves potentially contaminated equipment, surfaces, plumbing, ventilation systems, or other laboratory infrastructure, personnel should confirm that the work area and any tools or equipment being removed are safe to leave the laboratory.

If contamination is suspected and the appropriate cleaning or decontamination method is unclear, work should stop and the laboratory supervisor, Principal Investigator, or Safety Office should be contacted for guidance.

5.3.6 MINORS IN LABORATORIES

Minors may be present in laboratories only as part of an approved university program, educational activity, tour, research activity, or other authorized circumstance. Minors must comply with all applicable laboratory safety requirements and university policies, as well as applicable state and federal laws and regulations. Any required university authorization and parental or legal guardian consent must be obtained before participation.

A minor permitted to enter or participate in activities within a laboratory must be under the supervision of the Principal Investigator (PI), laboratory supervisor, or other university employee specifically designated to supervise the minor. The PI or laboratory supervisor accepting a minor into the laboratory is solely responsible for evaluating and approving the minor's laboratory activities and for ensuring appropriate training, supervision, and safety while the minor is under their direction. Responsibility for supervising the minor may not be transferred to graduate students, undergraduate students, or other laboratory personnel unless specifically authorized by the PI or laboratory supervisor and permitted by university requirements.

Before a minor performs laboratory activities, the PI or laboratory supervisor must evaluate the hazards associated with the laboratory and the proposed activities and determine which activities the minor may safely and legally perform. The PI or laboratory supervisor must ensure that the minor

receives appropriate safety training, understands applicable laboratory rules and emergency procedures, is provided required personal protective equipment, and receives a level of direct supervision appropriate to the hazards and activities involved.

Minors shall not perform any activity prohibited by applicable federal or state law, regardless of the level of supervision provided. This includes work prohibited for minors because of exposure to radioactive substances or ionizing radiation and other legally restricted hazardous occupations or activities. Additional restrictions may apply based on the minor's age and must be considered when determining permissible laboratory activities.

As a matter of prudent laboratory safety, minors should not work with or be intentionally exposed to particularly hazardous substances, including select carcinogens, reproductive toxins, and substances with a high degree of acute toxicity. Minors should also not perform work involving highly reactive or explosive chemicals, pyrophoric materials, highly toxic gases, or other operations having the potential for serious injury or exposure.

Activities involving compressed gases, cryogenic materials, biological agents, hazardous machinery or equipment, or other higher-risk laboratory operations should be avoided unless participation is necessary for an approved educational or research program, the activity is not prohibited by law or university requirements, and the PI or laboratory supervisor has determined that the activity can be performed safely with appropriate controls and direct supervision.

When there is uncertainty regarding whether an activity is appropriate or legally permissible for a minor, the activity shall not be performed until it has been reviewed by the Safety Office.

5.3.7 VOLUNTEERS IN LABORATORIES

Volunteers participating in laboratory activities must be approved through applicable university processes and must be under the supervision of a Principal Investigator, laboratory supervisor, or other authorized university representative.

Volunteers are subject to the same safety requirements as employees and students performing similar work. Prior to beginning laboratory activities, volunteers must receive appropriate safety training, instruction on applicable laboratory procedures, and information regarding laboratory hazards and emergency response procedures.

Volunteers shall not perform laboratory work independently unless specifically authorized by the Principal Investigator or laboratory supervisor and appropriately trained for the work being conducted.

5.3.8 LABORATORY HAZARD AND EMERGENCY INFORMATION SIGNAGE

Laboratories containing hazardous chemicals must display appropriate hazard and emergency information signage at laboratory entrances.

- Signage must identify the primary hazards present in the laboratory and provide appropriate emergency contact information.
- Special entry requirements or restrictions must be clearly identified when applicable, including required personal protective equipment (PPE), access restrictions, or other precautions that must be followed before entering the laboratory.
- Signage must include the name and after-hours contact information of the Principal Investigator (PI) or laboratory supervisor and at least one alternate emergency contact.
- Hazard and emergency information signage must be reviewed for accuracy at least annually and updated whenever laboratory hazards, emergency contacts, or other information displayed on the signage changes.
- Signage must be readily visible and legible and must not be removed, covered, or otherwise obscured.

5.3.9 WORK SURFACES AND HOUSEKEEPING

Good housekeeping practices are an important administrative control for preventing chemical exposure, contamination, spills, fires, and unintended chemical reactions. Laboratory personnel are responsible for maintaining clean and orderly work areas and promptly addressing unsafe conditions.

- Laboratory work areas must be maintained in a clean and orderly condition and kept free of unnecessary equipment, chemicals, waste, and other materials.
- Aisles, exits, doorways, and walking and working surfaces must be kept clear of obstructions and trip hazards.
- Access to emergency equipment, including eyewashes, safety showers, fire extinguishers, spill response equipment, and emergency shutoffs, must not be obstructed.
- Work surfaces used for procedures involving hazardous chemicals must be appropriate for the work being performed. Trays, absorbent materials, secondary containment, or other protective coverings must be used when necessary to contain spills, leaks, or contamination.
- Work surfaces and equipment must be cleaned or decontaminated when contamination occurs, following work that may leave hazardous residues, and before maintenance, repair, or removal from the laboratory when contamination may be present.
- Spills and releases must be addressed promptly in accordance with laboratory spill response procedures. Laboratory personnel must not attempt to clean up a spill for which they are not trained or adequately equipped.

- Chemical containers must be properly labeled, maintained in good condition, and kept closed when not in use, except when necessary for the procedure being performed.
- Chemical waste and contaminated materials must be properly identified, contained, and managed in accordance with university hazardous waste procedures. Waste must not be allowed to accumulate unnecessarily in laboratory work areas.
- Broken glass, needles, and other sharps must be placed in containers appropriate for the material and associated hazards and must not be disposed of in ordinary laboratory trash when doing so could create an injury or exposure hazard.
- Food, beverages, cosmetics, medications, and other items intended for personal consumption or use must not be stored, prepared, or consumed in areas where hazardous chemicals are used or stored.
- Laboratory personnel must wash their hands after handling hazardous chemicals, removing gloves, and before leaving the laboratory or entering areas where food or beverages are consumed.

5.3.10 CHEMICAL HANDLING PRACTICES

Laboratory procedures must be designed to minimize the potential for chemical exposure.

- Procedures should be designed to minimize the generation of vapors, aerosols, or other airborne contaminants.
- Equipment must be used only for its intended and designed purpose. Laboratory equipment must not be modified or used in a manner that could create unsafe conditions.
- Toxic or volatile substances should be handled in laboratory fume hoods or other appropriate containment systems whenever possible.
- Mechanical pipetting devices must be used for all pipetting procedures. Oral pipetting is strictly prohibited.
- Analytical equipment that becomes contaminated with hazardous chemicals must be clearly labeled and properly decontaminated before maintenance, servicing, reuse, or disposal. Toxic vapors or aerosols produced by analytical instruments must be captured through local exhaust ventilation or appropriate trap at the site of their production.

5.3.11 STANDARD OPERATING PROCEDURES (SOPS)

Standard Operating Procedures (SOPs) are written documents that describe how to safely perform laboratory processes or experiments. SOPs are a critical component of laboratory safety and must be used to communicate hazards, control measures, and safe work practices.

Principal Investigators and laboratory supervisors are responsible for ensuring that SOPs are developed, maintained, and followed for laboratory activities involving hazardous materials, equipment, or processes.

SOPs must:

- Identify the hazards associated with the procedure
- Describe required control measures, including engineering controls, administrative controls, and personal protective equipment
- Include safe handling, storage, and disposal practices
- Describe emergency procedures and response actions
- Be readily accessible to laboratory personnel

SOPs must be reviewed and approved by the Principal Investigator or laboratory supervisor prior to use. Laboratory personnel must be trained on applicable SOPs and must follow SOP requirements when performing laboratory work.

SOPs must be reviewed and updated as necessary, particularly when: procedures change, new hazards are introduced, and when incidents or near misses occur.

5.3.12 UNATTENDED LABORATORY OPERATIONS

Laboratory processes that are left unattended may pose increased risks due to the potential for equipment failure, loss of utilities, or unexpected reactions. Unattended operations must be carefully evaluated and controlled to prevent hazardous conditions.

Principal Investigators and laboratory supervisors are responsible for ensuring that unattended operations are conducted safely and only when appropriate.

Before conducting unattended laboratory operations:

- A hazard assessment must be performed to evaluate the risks associated with the process
- The procedure must be reviewed and approved by the Principal Investigator or laboratory supervisor
- Appropriate safeguards must be implemented to prevent or mitigate hazardous conditions

Unattended operations must not be conducted for processes involving:

- Particularly hazardous substances
- Highly reactive or unstable materials

- Operations that may generate significant heat, pressure, or hazardous vapors
- Any process where failure could result in significant injury, fire, or environmental release

Laboratory personnel must ensure that emergency contact and hazard information is readily available through the use of unattended process signage and that other laboratory occupants are aware of unattended operations.

5.3.13 WORKING ALONE IN LABORATORIES

Working alone in laboratories may increase the risk associated with hazardous chemical operations because assistance may not be immediately available in the event of an accident or emergency. Working alone in laboratories should be avoided whenever possible.

- Principal Investigators and laboratory supervisors are responsible for establishing laboratory policies regarding working alone and ensuring that laboratory personnel understand any restrictions associated with hazardous operations.
- A hazard assessment must be conducted by the PI before allowing personnel to work alone.
- Laboratory personnel shall evaluate the hazards of the work being performed before conducting laboratory activities alone.
- Laboratory personnel must not work alone when performing procedures that involve particularly hazardous substances, highly reactive chemicals, or other operations that present a significant risk of injury or exposure.

When laboratory work must be performed outside normal working hours or when only one individual is present in the laboratory, appropriate precautions must be taken to ensure assistance can be obtained if necessary. These precautions must include, but are not limited to:

- Informing another person of the location and expected duration of work.
- Maintaining communication with coworkers.
- Ensuring emergency contact procedures are readily available.

Laboratory personnel must be familiar with emergency procedures, the location of emergency equipment, and emergency contact information prior to conducting laboratory work alone.

5.3.14 SHARED LABORATORY AND COMMON-USE SPACES

Shared laboratories, common-use instrument rooms, core facilities, shared chemical storage areas, and other spaces used by multiple laboratories or departments require clear coordination to ensure that hazards are appropriately managed.

Departments or units responsible for shared spaces should designate a primary responsible individual(s) for the space. The responsible individual(s) should be clearly identified on the laboratory emergency information signage, along with current contact information and at least one alternate contact. Emergency contact information should make it clear who has authority and responsibility for coordinating safety matters within the shared space.

Hazards, procedures, and conditions that may affect other users of the space must be communicated and coordinated before work begins. Users of shared spaces must be made aware of significant hazards introduced by other users and must have access to information necessary to safely conduct their own work in the space. Communication should include any precautions, restrictions, or changes in normal practices that may be necessary to protect other users. Users of shared spaces are responsible for becoming familiar with significant hazards communicated for the space and following applicable precautions, restrictions, and procedures.

Chemicals, equipment, samples, and waste in shared spaces must be clearly identified and associated with a responsible laboratory, Principal Investigator, or department so that responsibility for the material can be readily determined. Materials must be managed in accordance with this Chemical Hygiene Plan and applicable university requirements.

Shared spaces must be maintained so that emergency equipment, exits, and other safety systems remain accessible, and that housekeeping, storage, labeling, and emergency information are appropriate for the hazards present. Unknown, abandoned, or unneeded materials should not be allowed to accumulate. Responsible laboratories or departments should establish reasonable time frames for reviewing and removing materials that are no longer needed, based on the nature and hazards of the materials and the needs of the shared space. Materials that may become more hazardous, unstable, or otherwise unsuitable for storage over time must be subject to appropriate time limits, inspection, or other controls and removed or managed before the material presents an increased hazard. Examples include peroxide-forming chemicals, unstable or time-sensitive reactive materials, and other chemicals for which age, storage conditions, or changes in condition may increase the hazard.

When work in a shared space introduces new or significant hazards, affects other users, or involves Particularly Hazardous Substances, the responsible individual(s) for the shared space must be consulted before work begins to determine appropriate coordination and controls. The Safety Office should be consulted when the hazards, controls, or circumstances warrant additional review.

5.4 PERSONAL PROTECTIVE EQUIPMENT

Laboratory personnel must wear appropriate laboratory attire and personal protective equipment (PPE) when working with hazardous chemicals or when entering areas where chemical hazards are

present. PPE must be selected based on the hazards associated with the chemicals, equipment, and procedures involved.

Principal Investigators and laboratory supervisors are responsible for determining PPE requirements for their laboratories, ensuring required PPE is available, and ensuring laboratory personnel are trained in the proper use, limitations, maintenance, and disposal of PPE.

Minimum laboratory attire and PPE may include:

- Safety glasses with side shields, chemical splash goggles, or other required eye protection.
- Laboratory coats or other protective clothing when handling hazardous chemicals.
- Gloves compatible with the chemicals and procedures being used.
- Full-length pants or clothing that completely covers the legs.
- Closed-toe shoes made of materials that provide protection from chemical exposure.

Clothing must completely cover the legs when performing laboratory work involving hazardous chemicals. Shorts or other clothing that leaves the legs exposed is not permitted. Dresses or skirts may only be worn if full leg coverage is provided.

Closed-toe shoes that fully cover the foot must be worn in laboratory areas where hazardous materials are used or stored. Sandals, open-toed shoes, and perforated shoes are not permitted.

Safety glasses meeting ANSI Z87.1 standards must be worn in laboratory areas where chemical hazards are present. Additional eye or face protection, such as chemical splash goggles or face shields, must be used when operations involve splash hazards, pressurized systems, vacuum systems, or other elevated risks.

Gloves must be selected based on the chemicals being handled, the task being performed, and the expected type and duration of contact. Disposable gloves must be removed and discarded when contaminated, damaged, or compromised, and before leaving the laboratory work area.

Contaminated protective clothing must be decontaminated or disposed of in accordance with applicable procedures.

Respiratory protection may be required when airborne exposures cannot be adequately controlled through engineering controls, administrative controls, or work practices. Respirators may only be used in accordance with the university's Respiratory Protection Program. Personnel must be enrolled in the program and complete required medical clearance, training, and fit testing before respirator use.

Laboratory personnel must also maintain good personal hygiene practices, including washing hands after handling hazardous materials, after removing gloves, and before leaving the laboratory. PPE must be removed before leaving the lab and stored in the lab.

5.5 LABORATORY TRAINING REQUIREMENTS

Proper training is essential to ensure that laboratory personnel understand chemical hazards and the safety practices necessary to minimize risk. Laboratory personnel must complete all applicable training before working with hazardous materials and must maintain training as required by university policy.

Laboratory safety training is developed by the University Police and Safety Office and made available to employees through NDSU's learning management system, which is administered by Human Resources.

All students, staff, faculty, and other personnel working in laboratory environments must complete training that is relevant to the hazards present in their laboratory and as assigned by their department chair or head. Departments or laboratory PIs or supervisors must maintain documentation that laboratory personnel have reviewed applicable CHP requirements, laboratory-specific SOPs, and hazard-specific procedures before beginning work.

Principal Investigators and laboratory supervisors must complete the same training required for personnel working in their laboratories, in addition to training related to their supervisory responsibilities including, Principal Investigator/Supervisor Training Online.

Additional safety training may be required depending on work requirements and responsibilities. Training in specific work practices must be provided by the Principal Investigator or department designee.

Completions of these training requirements fall under policy 166, 3.4.3 "Direct individuals, including but not limited to principal investigators, supervisors, regular part time and temporary employees, visiting professors, and students, to obtain any required safety training before they work with hazardous chemicals, biohazardous agents, radiation, or physical/mechanical hazards in their working or learning environments."

5.5.1 HAZARDOUS WASTE HANDLING TRAINING

Students, staff and faculty who generate or handle hazardous waste as part of their responsibilities, as well as anyone who supervises someone who generates hazardous waste must complete Initial Waste Handling Training. Initial Waste Handling Training is conducted in person and is required once.

New students and employees must be supervised while handling hazardous waste until completing Initial Waste Handling Training, and must complete this training within 6 months of start date.

After completing the in-person course, personnel must complete an online Waste Handling Refresher Training each semester.

5.5.2 TRAINING FREQUENCY

Laboratory safety training courses must be completed annually and are valid for the fiscal year (July 1 through June 30). Additional training may be required when:

- New hazards or procedures are introduced into the laboratory.
- Personnel begin work with new materials or equipment.
- Safety procedures or regulatory requirements change.
- Directed by the Department Chair or Head, Principal Investigator, laboratory supervisor, or Safety Office.

5.5.3 LABORATORY SAFETY INFORMATION AND TRAINING MUST INCLUDE, AS APPLICABLE:

- This Chemical Hygiene Plan
- The OSHA Laboratory Standard for reference;
- The physical and health hazards of chemicals present in the work area;
- Applicable occupational exposure limits;
- Signs and symptoms associated with chemical exposure;
- Methods and observations that may be used to detect the presence or release of hazardous chemicals, including odors, visible releases, monitoring devices, ventilation alarms, or exposure monitoring;
- Measures personnel can take to protect themselves, including safe work practices, engineering controls, PPE, and emergency procedures; and
- The location and availability of Safety Data Sheets and other reference information concerning the safe handling, storage, and disposal of hazardous chemicals.

5.5.4 LABORATORY-SPECIFIC TRAINING

In addition to institutional training requirements, Principal Investigators and laboratory supervisors are responsible for providing laboratory-specific safety training. This training must address:

- Laboratory hazards and chemical risks

- Standard Operating Procedures (SOPs)
- Engineering controls and personal protective equipment
- Emergency procedures and spill response
- Hazardous waste handling procedures

Laboratory personnel must be trained on applicable procedures before performing laboratory work independently.

5.5.5 TRAINING RECORDS

Principal Investigators or laboratory supervisors must ensure that laboratory personnel complete all required training before performing applicable laboratory activities. Documentation of required university training and laboratory-specific training must be maintained or otherwise readily available within the laboratory. Training completion may be documented using certificates, LMS completion records, laboratory training logs, or another method established by the Principal Investigator or laboratory supervisor.

5.6 CHEMICAL STORAGE AND TRANSPORT

5.6.1 CHEMICAL PROCUREMENT AND RECEIVING

Laboratories should evaluate chemical hazards and facility requirements before purchasing or otherwise acquiring hazardous chemicals. Principal Investigators and laboratory supervisors are responsible for ensuring that appropriate storage, engineering controls, emergency equipment, PPE, and disposal options are available before hazardous chemicals are introduced into the laboratory.

Chemicals should be purchased in the smallest practical quantity needed for the intended work. Upon receipt, chemicals must be added to the laboratory chemical inventory and stored according to applicable compatibility and hazard requirements.

Donated, transferred, inherited, or otherwise acquired chemicals should only be accepted when there is a legitimate need for the material and the laboratory can safely store, use, and ultimately dispose of it. Laboratories should consult the Safety Office before acquiring unusual, highly hazardous, unstable, or difficult-to-dispose materials.

Personnel who routinely receive, unpack, handle, or distribute hazardous chemical shipments must receive training appropriate to their responsibilities and potential exposures.

5.6.2 CHEMICAL STORAGE

Hazardous chemicals must be stored in a manner that minimizes the potential for spills, reactions, or accidental exposure. All laboratories are subject to maximum allowable quantities established by applicable fire and building codes.

Laboratories must have appropriate, purpose-built storage facilities based on the chemicals present. Chemical storage areas must be clearly identified, appropriately secured, and provided with required hazard signage. Chemicals must be segregated and stored according to compatibility and hazard classification to prevent dangerous reactions between incompatible materials.

Locked chemical storage areas, cabinets, rooms, or other secured enclosures must remain accessible to authorized Safety Office staff and emergency response personnel because immediate access may be necessary. Laboratories using locked chemical storage must establish an appropriate means of emergency access. When necessary, Principal Investigators or laboratory supervisors should coordinate with Facilities Management, including the Lock Shop, and the Safety Office to establish an appropriate access method.

5.6.3 TRANSPORTING CHEMICALS

When transporting chemicals within or between buildings, containers must be properly closed, labeled, and secured to prevent spills, breakage, or accidental exposure. Secondary containment must be used when appropriate.

When hazardous chemicals are transported between campus buildings as part of laboratory activities, faculty, staff, and students must:

- Use interior campus roads whenever transportation can be completed without entering a public roadway.
- Use an authorized university or State Fleet vehicle, or transport the material by foot when appropriate.
- Secure chemicals during transport to prevent tipping, shifting, breakage, or release.
- Not use public transportation to transport hazardous chemicals.

Transportation involving public roads may be subject to additional U.S. Department of Transportation (DOT) requirements, including requirements for packaging, marking, labeling, documentation, vehicles, and training.

Personnel conducting transportation under another regulatory program are responsible for ensuring that required licenses, certifications, training, packaging, documentation, and transportation requirements are met.

Contact the Safety Office before transporting hazardous chemicals on public roads if the applicable transportation requirements have not already been established.

5.6.4 SHIPPING HAZARDOUS CHEMICALS

The shipment of chemicals and other research materials may be subject to federal, state, international, carrier, or other regulatory requirements. Depending on the material and method of shipment, applicable requirements may include those established by the U.S. Department of Transportation (DOT), International Air Transport Association (IATA), U.S. Department of Agriculture (USDA), North Dakota Department of Agriculture, and other regulatory agencies.

Personnel are responsible for determining whether materials they intend to ship are regulated and for complying with all applicable requirements. Individuals who prepare, package, document, or offer regulated materials for shipment must have the training and authorization required for those activities.

Shipping requirements vary based on factors such as the material, quantity, concentration, packaging, destination, mode of transportation, and intended use.

Personnel who have questions about whether a material is regulated or what shipping requirements apply are encouraged to contact the Safety Office or the appropriate university subject-matter expert for guidance.

5.7 HAZARDOUS WASTE MANAGEMENT

Proper management of hazardous chemical waste is necessary to minimize risks to laboratory personnel and the environment. Principal Investigators or laboratory supervisors are responsible for identifying and labeling hazardous chemical waste generated in their laboratories and ensuring that laboratory personnel follow appropriate waste management procedures.

Hazardous waste must be stored in compatible containers that are kept closed except when adding waste. Containers must be properly labeled with the contents, primary hazard class, and accumulation start date.

Hazardous waste pickup services are provided through the Safety Office. Laboratory personnel should contact the Safety Office for guidance on proper disposal procedures or to request waste removal.

Laboratories must take reasonable steps to minimize chemical waste. Waste reduction practices should include purchasing only quantities needed, using chemicals before they expire or become unusable, sharing or redistributing usable chemicals when appropriate, and incorporating waste minimization into laboratory procedures whenever feasible.

Additional information and requirements are outlined in Appendix B: Hazardous Waste Management.

5.8 LABORATORY STARTUP, MODIFICATION, AND RENOVATIONS

Laboratory startup, construction, modification, and renovation activities must be coordinated to ensure that hazards are properly identified and controlled, and that regulatory and institutional safety requirements are met.

5.8.1 LABORATORY STARTUP

Prior to initiating research activities in a new or newly assigned laboratory space, Principal Investigators must coordinate with the Safety Office to ensure that the laboratory is prepared for safe operation.

This includes:

- Identifying anticipated hazards associated with planned research activities.
- Verifying that appropriate engineering controls (e.g., fume hoods, ventilation) are available and functioning.
- Ensuring required safety equipment (e.g., eyewash stations, safety showers, fire extinguishers) is present and accessible.
- Establishing a chemical inventory and hazard communication system.
- Developing laboratory-specific Standard Operating Procedures (SOPs).
- Ensuring all personnel complete required safety training prior to beginning work.

Laboratory work must not begin until appropriate safety controls are in place and personnel are trained.

5.8.2 LABORATORY MODIFICATIONS AND RENOVATIONS

Laboratory renovations, equipment installations, or modifications to laboratory spaces must be planned and coordinated to prevent the introduction of new hazards or the disruption of existing safety systems.

Principal Investigators must:

- Notify and coordinate with the Safety Office and/or Facilities Management prior to modifications that may impact laboratory safety systems or hazard profiles.
- Evaluate how proposed changes may affect ventilation, chemical storage, electrical systems, or emergency equipment.
- Ensure that hazardous materials are secured or removed as necessary prior to construction or maintenance activities.
- Coordinate with Facilities Management and other relevant personnel to ensure work is conducted safely.

Laboratory operations may need to be temporarily suspended during renovations or maintenance activities if hazards cannot be adequately controlled.

5.9 LABORATORY CLOSEOUT AND RESEARCHER DEPARTURE

All instructional, administrative, and research personnel are responsible for properly managing and disposing of laboratory chemicals and other hazardous materials under their control prior to leaving employment or transferring to another institution. Before leaving North Dakota State University, personnel must ensure that all chemicals and hazardous materials for which they are responsible have been reviewed and appropriately managed. Materials that are no longer needed must be disposed of in accordance with the procedures described in Section 5.7 – Hazardous Waste Management.

Personnel must also complete any required university exit procedures, verify that laboratory spaces have been properly cleared of hazardous chemicals, and submit a Lab Closeout Form. Employees may not complete their departure from the university until required exit documentation has been properly executed.

If hazardous materials are left behind by individuals departing the University, responsibility for those materials transfers to the laboratory supervisor, Principal Investigator, or department leadership overseeing the laboratory space.

If hazardous materials are discovered in a laboratory after a researcher has left the university, the Safety Office will evaluate the situation and determine the appropriate corrective action. In some cases, this may include engaging a qualified hazardous materials contractor to properly remove or dispose of the materials. Any costs associated with the cleanup or disposal of hazardous materials left behind in laboratory spaces will be the responsibility of the department overseeing the laboratory or workspace.

6. PREPARE FOR EMERGENCIES

Despite careful planning and adherence to safety procedures, laboratory emergencies may still occur. Laboratory personnel must be prepared to respond appropriately to incidents involving hazardous chemicals in order to protect personnel, property, and the environment.

Laboratory emergencies may include chemical spills, fires, explosions, personal injuries, or accidental exposures to hazardous chemicals. The primary objective during an emergency is to protect human health and safety. Emergency response actions should focus first on addressing immediate hazards and ensuring that affected personnel receive appropriate assistance.

Laboratory personnel must be familiar with emergency procedures, emergency equipment locations, and reporting requirements before beginning work with hazardous materials. Laboratories must post emergency information signage at entrances, including contact information and hazard identification.

6.1 EMERGENCY RESPONSE PRINCIPLES

In the event of an emergency involving hazardous chemicals, the immediate priority is to address the situation safely and protect personnel from harm.

General principles for responding to laboratory emergencies include:

- Evacuate and alert nearby personnel and notify responsible individuals as soon as possible.
- Contact emergency services when necessary.
- Notify the University Police and Safety Office.
- Avoid taking actions that could place additional personnel at risk.
- Laboratory personnel must not attempt to respond to emergencies beyond their level of training.

Because laboratory operations vary widely, it is not possible to establish detailed procedures for every potential emergency. The guidance provided in this Chemical Hygiene Plan is intended to assist laboratory personnel in establishing emergency procedures appropriate to their work environments. Additional information for emergency response at NDSU is available in the NDSU Emergency Action Guide, available online.

Principal Investigators and laboratory supervisors should ensure that laboratory personnel are familiar with emergency procedures relevant to their laboratory activities.

6.2 FACILITY MINIMUM REQUIREMENTS AND EMERGENCY EQUIPMENT

Laboratories that use hazardous chemicals must be equipped with appropriate safety infrastructure to protect personnel and allow rapid response to exposures, spills, fires, or other laboratory emergencies. The type and placement of emergency equipment must be appropriate for the hazards present and comply with applicable safety standards and building codes. Principal Investigators and laboratory supervisors are responsible for assessing the intended use of laboratory spaces and the hazards present to determine whether required emergency equipment is available, appropriate, accessible, and maintained for the work being conducted.

6.2.1 EMERGENCY SHOWERS AND EYEWASH STATIONS

Emergency drench showers and eyewash stations must be available in laboratories where hazardous chemicals are used or stored. These devices must be clearly marked, readily accessible, and kept free of obstructions so they can be used immediately in the event of an exposure.

The NDSU Safety Office conducts inspections and functional testing of emergency eyewash stations and safety showers at least annually to verify proper operation and accessibility. Lab personnel must test eyewash stations on a weekly basis, and ensure any bottled eyewash stations are not expired.

Any eyewash or safety shower found to be malfunctioning or otherwise not operational will be clearly marked with a notice indicating that the equipment is out of service. The issue must be reported immediately to Facilities Management for repair. Laboratory operations may need to cease, and hazards must be evaluated prior to continuing work if emergency equipment is out of service.

Facilities Management is responsible for initiating and completing repairs necessary to restore the equipment to proper working condition. Costs associated with repair or replacement may be charged to the department responsible for the laboratory space.

6.2.2 LABORATORY FUME HOODS AND VENTILATION

Laboratories where volatile, toxic, or other hazardous chemicals are used in a manner that may generate harmful vapors, gases, fumes, mists, or aerosols shall have access to appropriate engineering controls, such as a laboratory fume hood or other local exhaust ventilation.

Laboratory fume hoods shall meet the performance, testing, and maintenance requirements specified in Section 5.2.

6.2.3 FIRE SAFETY EQUIPMENT

Laboratories must have appropriate fire safety equipment based on the hazards present in the laboratory. Fire safety equipment may include fire extinguishers or other fire protection equipment

appropriate for the hazards present. Personnel who are expected or authorized to use fire safety equipment must receive appropriate training on their use.

Fire safety equipment must be clearly marked, readily accessible, and maintained according to applicable fire safety codes and institutional procedures.

6.2.4 EMERGENCY COMMUNICATION

Laboratories must have immediate (e.g., direct or unimpeded) access to a reliable means of emergency communication capable of summoning appropriate assistance. The means of communication may include a building telephone, area or hallway telephone, two-way radio, or other reliable communication system appropriate for the location and hazards.

Laboratory personnel must be familiar with the location and use of the nearest available emergency communication device, as well as the appropriate emergency telephone numbers and procedures for reporting fires, injuries, chemical releases, and other emergencies.

Personal cell phones may be used as an additional means of emergency communication but should not be relied upon as the sole means of emergency communication where a reliable alternative is reasonably available.

6.2.5 SPILL RESPONSE MATERIALS

Laboratories must provide and maintain spill response materials appropriate for the hazards present in the laboratory.

Spill kits must be readily accessible and capable of addressing spills involving the chemicals used in the laboratory. Laboratory personnel must be familiar with the location and proper use of spill response materials.

6.2.6 VISITOR SAFETY EQUIPMENT

Laboratories must maintain appropriate personal protective equipment, including eye protection, for visitors entering laboratory areas where chemical hazards are present.

Visitors must follow the same safety requirements as laboratory personnel when entering laboratory work areas.

6.2.7 FIRST AID KITS

First aid supplies should be available in or near laboratory areas as appropriate for the activities performed. First aid kits must be maintained in a stocked and accessible condition. Chemical

exposures, injuries requiring medical evaluation, or incidents beyond minor first aid must be reported in accordance with Section 6.6 and addressed under Section 6.8.

6.3 CHEMICAL SPILL RESPONSE

Chemical spills may present hazards depending on the type and quantity of material involved. Laboratory personnel must evaluate the severity of a spill before attempting cleanup.

6.3.1 MINOR SPILLS

Minor spills involving small quantities of chemicals that do not present significant hazards may be cleaned up by trained laboratory personnel using appropriate spill response materials.

Personnel responding to minor spills should:

- Wear appropriate personal protective equipment.
- Prevent the spread of the spilled material.
- Use appropriate absorbent materials or spill control equipment.
- Dispose of cleanup materials as hazardous waste if necessary.

6.3.2 MAJOR SPILLS

Major spills involving large quantities of hazardous materials, highly toxic chemicals, or situations where the hazards are not fully understood should not be handled by laboratory personnel.

In these situations:

- Evacuate the affected area
- Alert nearby personnel
- Contact emergency services or the Safety Office for assistance
- Restrict access to the affected area until trained personnel respond

The Safety Office will coordinate spill response activities when assistance is required.

6.3.3 HAZARDOUS AIRBORNE CONDITIONS

Hazardous airborne conditions may result from spills, gas leaks, ventilation failures, equipment malfunctions, or chemical reactions that release vapors, gases, aerosols, or fumes. If personnel detect strong or unusual odors, visible vapors, irritation, dizziness, difficulty breathing, or fume hood/ventilation alarms, work must stop and the area must be evacuated. Laboratory personnel must not attempt to investigate or respond to airborne chemical releases beyond their level of training. The Safety Office or emergency responders must be contacted for assistance.

6.4 FIRE AND EXPLOSION RESPONSE

Certain chemicals used in laboratories present fire or explosion hazards. If a fire occurs in a laboratory, personnel must prioritize personal safety.

Small fires may be extinguished by trained personnel if the fire can be controlled safely and if toxic hazards are not present. Personnel should only attempt to extinguish fires if they are trained, and when doing so does not place them at risk.

If a fire cannot be safely controlled:

- Evacuate the area immediately
- Activate building fire alarms
- Contact emergency services by dialing 9-1-1

Following a fire or explosion, the affected area must be evaluated and decontaminated before laboratory operations resume.

6.5 UTILITY FAILURES

Utility failures affecting ventilation, power, water, gas, vacuum, or other laboratory systems must be evaluated for safety impact. Laboratory personnel should stop work and secure experiments if it is safe to do so. Work involving hazardous chemicals must not continue when ventilation, emergency equipment, or other required safety systems are not functioning properly.

6.5.1 AFTER-HOURS CONTACT INFORMATION FOR CRITICAL EQUIPMENT AND EXPERIMENTS

Laboratories with critical equipment, such as -80°C freezers, refrigerators, incubators, or ongoing experiments that may be affected by utility failures should provide current after-hours contact information to the NDSU Communications Call Center. This allows the Communications Call Center staff to contact responsible personnel after hours when a utility failure or related emergency may affect laboratory equipment, research materials, or ongoing experiments.

Principal Investigators and laboratory supervisors are responsible for ensuring that after-hours contact information is kept current. Utility failures and planned outages occurring during regular business hours will generally be communicated through normal university communication channels.

6.6 EXPOSURE AND INCIDENT REPORTING

All incidents involving hazardous chemicals must be reported promptly (within 24 hours) to the Safety Office and the Principal Investigator or laboratory supervisor.

Incidents requiring reporting may include:

- Chemical spills whether an injury occurred or not
- Exposure through inhalation, ingestion, skin contact, or injection
- Laboratory injuries
- Potential or suspected exposure
- Property damage

Reporting incidents allows the university to ensure appropriate medical evaluation, conduct investigations when necessary, and implement corrective actions to prevent similar incidents from occurring in the future.

Incident reports submitted to the Safety Office are reviewed to determine:

- The cause of the incident.
- Whether existing safety procedures were followed.
- Whether additional controls or training are necessary.

Based on this review, corrective actions may include:

- Modifications to laboratory procedures or Standard Operating Procedures.
- Additional training for laboratory personnel.
- Improvements to engineering controls or safety equipment.
- Updates to the Chemical Hygiene Plan.

Sharing lessons learned from incidents helps prevent similar events from occurring in other laboratories.

6.7 NEAR MISS AND HAZARD REPORTING

Laboratory personnel should report hazardous situations using the university's near miss reporting system. Reporting near misses allows hazards to be identified and corrected before an incident occurs. In accordance with guidance provided in NDSU Baseline Safety Training, a near miss report shall be filed when an employee becomes aware of a situation or environment that did not result in personal injury or property damage, but has the potential to do so and could happen under the existing conditions. An Incident/Near Miss Report shall be filed when circumstances arise that constitute a hazardous situation. This is the mechanism whereby corrections can be made prior to an accident, spill, etc.

Examples of near miss situations may include:

- Equipment failures that could have caused injury.
- Unsafe laboratory conditions that could lead to accidents.

Prompt reporting helps improve laboratory safety and supports continuous improvement of safety practices.

6.8 FIRST AID FOR CHEMICAL EXPOSURE

Anyone exposed or potentially exposed to a hazardous chemical through inhalation, ingestion, skin or eye contact, or injection must immediately stop work and take appropriate first-aid measures. Depending on the exposure, these measures may include using an eyewash or safety shower, rinsing affected skin or wounds with water, and removing contaminated clothing.

Call 9-1-1 for life-threatening conditions or when emergency medical care is needed. Employees requiring nonemergency medical evaluation must use an NDSU-designated medical provider unless circumstances require emergency department care. Students who are not university employees, visitors, and other nonemployees may seek care from a medical provider of their choice.

When reasonably available, provide the medical provider with:

- The Safety Data Sheet for each chemical involved;
- A description of the exposure and circumstances; and
- Any available information concerning the duration, concentration, or route of exposure.

All chemical exposures and suspected exposures must be reported promptly in accordance with Section 6.6. Individuals receiving medical care must follow documented work restrictions until the medical provider releases them from care.

6.9 POST-INCIDENT RESPONSE AND RECOVERY

Following a laboratory emergency, the affected area must be evaluated to determine whether additional protective measures are necessary before work resumes.

Post-incident actions may include:

- Monitoring the affected area for contamination.
- Decontamination of equipment or work surfaces.
- Evaluation of laboratory procedures and safety controls.

- Preparation of incident reports describing the event and corrective actions taken.

The Safety Office may assist in evaluating the incident and determining appropriate corrective measures to prevent recurrence.

Laboratory personnel must not return to normal operations until it has been determined that the laboratory environment is safe and any hazards have been properly controlled.

6.10 IMPORTANT CONTACT INFORMATION

EMERGENCY

Fire and Life-Threatening Emergency

Phone: 9-1-1

Chemical Spills or Hazardous Materials Incidents

Phone: 701-231-7759

NDSU SAFETY OFFICE / CHEMICAL HYGIENE OFFICER

Phone: 701-231-7759

Email: ndsu.police.safety@ndsu.edu

NDSU COMMUNICATIONS CALL CENTER

Phone: 701-231-8998

Email: ndsu.police.safety@ndsu.edu

FACILITIES MANAGEMENT

Phone: 701-231-7911

Email: ndsu.facilitiesmgmt@ndsu.edu

MEDICAL SERVICES

Occupational Health - Sanford

Phone: 701-234-4700

Hours: 8:00-4:30 Monday - Friday

Address: 3838 12th Ave N, Fargo

Occupational Health – Essentia – NO walk-ins

Phone: 701-364-5757

Hours: 8:00-4:30 Monday - Friday

Address: 1100 19th Ave N, Fargo

Visit the Safety Office website for a list of Designated Medical Providers.

7. PROGRAM EVALUATION AND CONTINUOUS IMPROVEMENT

The Chemical Hygiene Plan is intended to be a living document that evolves as laboratory activities, regulatory requirements, and safety practices change. Regular evaluation of the Chemical Hygiene Program helps ensure that laboratory safety practices remain effective and that emerging hazards are appropriately addressed.

North Dakota State University is committed to maintaining and improving laboratory safety through periodic review of this plan, routine inspections of laboratory facilities, and the evaluation of incidents or hazardous situations that may occur during laboratory operations.

7.1 LABORATORY SAFETY INSPECTIONS

Routine laboratory safety inspections are conducted to verify compliance with the requirements of the Chemical Hygiene Plan and to identify potential hazards before they result in accidents or exposures.

Laboratory inspections may be conducted by:

- Safety Office personnel
- Department safety representatives
- Principal Investigators or laboratory supervisors

These inspections evaluate laboratory conditions including:

- Chemical storage practices
- Use of personal protective equipment
- Hazard communication and signage
- Housekeeping and laboratory practices
- Hazardous waste management

When deficiencies are identified, the responsible department or laboratory supervisor will be notified and provided with a timeframe for corrective action. Follow-up inspections may be conducted to ensure that corrective actions have been implemented.

If deficiencies remain unresolved, the issue may be elevated through departmental leadership and university administration until appropriate corrective actions are taken.

7.2 CHEMICAL HYGIENE PLAN REVIEW AND UPDATES

As part of the annual Chemical Hygiene Plan review, the Laboratory and Chemical Safety Committee and Safety Office will consider changes in regulatory requirements, new or changing research activities, findings from laboratory inspections and incident investigations, and advances in laboratory safety practices.

The most recent version of the Chemical Hygiene Plan is available on the Safety Office website.

Departments and laboratories are responsible for ensuring that personnel are familiar with the current version of the Chemical Hygiene Plan and that laboratory practices remain consistent with its requirements.

7.3 PROMOTING A CULTURE OF LABORATORY SAFETY

Maintaining a safe laboratory environment requires active participation from all members of the university community. Faculty, staff, and students must report unsafe conditions, suggest improvements to laboratory safety practices, and participate in safety training and programs.

Through collaboration between laboratory personnel, departments, and the Safety Office, North Dakota State University seeks to continually improve laboratory safety practices and maintain a working environment that protects the health and safety of employees, students, and the public.

APPENDIX A – DEFINITIONS

The following definitions are based primarily on information contained in the OSHA Laboratory Standard, 29 CFR 1910.1450, and the OSHA Hazard Communication Standard, 29 CFR 1910.1200. Terms such as administrative controls, engineering controls, PPE, and Threshold Limit Value are included for implementation purposes but are not separately defined in 29 CFR 1910.1450(b).

Acute Toxicity: The potential for a chemical to cause serious harm after a single or short exposure through inhalation, skin contact, ingestion, or injection. Information from the Hazard Communication Standard assigns acute toxicity Categories 1 through 4 for each applicable

exposure route; Category 1 is the most severe. Consult the chemical's safety data sheet (SDS) for its classification when conducting a risk assessment for selecting controls and planning the work.

Administrative Controls: Policies, procedures, training, scheduling, access restrictions, supervision, and other management practices used to reduce the likelihood, frequency, or duration of exposure to a hazard.

Carcinogen: The Hazard Communication Standard broadly classifies carcinogens according to the strength and weight of evidence that a substance induces cancer or increases its incidence. Also see **Select Carcinogen**.

Chemical Fume Hood (Laboratory-Type Hood): A fire- and chemical-resistant local exhaust ventilation device enclosed on five sides with a movable sash, designed to draw air from the laboratory, capture and contain airborne contaminants, and exhaust them safely to the exterior of the building.

Chemical Hygiene Officer (CHO): An employee designated by the employer who is qualified by training or experience to provide technical guidance in the development and implementation of the Chemical Hygiene Plan. The designation does not restrict the position description or job classification the individual may hold within the employer's organization.

Chemical Hygiene Plan (CHP): A written program developed and implemented by the employer that establishes procedures, equipment, personal protective equipment, and work practices capable of protecting employees from the health hazards presented by hazardous chemicals used in the workplace.

Chemical Inventory: A current record of hazardous chemicals present in a laboratory or other covered work area.

Compressed Gas: Any material or mixture contained under pressure exceeding 276 kPa (40 psi) at 21 °C (70 °F), or 717 kPa (104 psi) at 54 °C (130 °F), or a flammable liquid with vapor pressure exceeding 276 kPa at 38 °C (100 °F).

Corrosive Chemical: A substance that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact, or possesses a pH of 2.0 or less, or 12.5 or greater under EPA/OSHA criteria.

Cryogenic Materials: Extremely low-temperature liquefied gases (such as liquid nitrogen, liquid helium, or dry ice) that cause severe tissue freeze burns upon contact and rapidly expand into gas capable of displacing oxygen and causing asphyxiation.

Designated Area: An area that may be used for work with select carcinogens, reproductive toxins, or substances having a high degree of acute toxicity. A designated area may be an entire laboratory, a portion of a laboratory, or a containment device such as a laboratory hood.

Emergency: Any occurrence, including equipment failure, container rupture, or failure of control equipment, that results in an uncontrolled release of a hazardous chemical into the workplace.

Employee: An individual employed in a laboratory workplace who may be exposed to hazardous chemicals during the course of assigned duties. .

Engineering Controls: Equipment or facility features that eliminate a hazard or isolate personnel from it. Engineering controls include chemical fume hoods, local exhaust ventilation, glove boxes, enclosed processes, ventilated gas cabinets, safety shields, and other containment systems.

Exposure Monitoring: The measurement of an individual's exposure to a hazardous chemical or the concentration of a hazardous chemical in the workplace using air sampling, direct-reading instruments, biological monitoring, or other appropriate methods.

Exposure Routes (Routes of Exposure): The pathways by which hazardous chemicals enter the body: inhalation (breathing vapors/gases), dermal contact (skin/eye absorption), ingestion (swallowing), and accidental injection (punctures).

Flammable: A chemical classified as a flammable gas, aerosol, liquid, or solid under the physical-hazard criteria of the Hazard Communication Standard. Relevant definitions include:

- A flammable gas is a gas having a flammable range with air at 20°C (68°F) and a standard pressure of 101.3 kPa.
- A flammable liquid is a liquid having a flash point of not more than 93°C (199.4°F).
- A flammable solid is a readily combustible solid or a solid that may cause or contribute to fire through friction.
- A flammable aerosol is an aerosol classified as flammable based on its components, heat of combustion, ignition distance, enclosed-space ignition, or other applicable testing criteria.

Hazard: A chemical, biological, physical, or other source or condition with the potential to cause injury, illness, property damage, or environmental harm.

Hazard Assessment: A documented evaluation used to identify hazards associated with a laboratory activity and determine the controls, personal protective equipment, procedures, training, and emergency measures needed to perform the work safely.

Hazardous Chemical: Any chemical classified as a health hazard or simple asphyxiant in accordance with the information contained in OSHA Hazard Communication Standard.

Hazardous Waste: A discarded material that is regulated as hazardous waste because it is specifically listed or exhibits a hazardous characteristic under applicable federal or state hazardous-waste regulations.

Health Hazard: A chemical classified as posing one or more of the following hazardous effects: acute toxicity by any route of exposure; skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ-cell mutagenicity; carcinogenicity; reproductive toxicity; specific target-organ toxicity following single or repeated exposure; or aspiration hazard. The applicable classification criteria are derived from information contained in Appendix A to 29 CFR 1910.1200.

HEPA Filter (High-Efficiency Particulate Air): A filter capable of trapping at least 99.97% of airborne particles 0.3 micrometers (μm) or larger, essential for containing engineered nanoparticles and fine particulate hazards.

Hierarchy of Controls: A systematic method for selecting measures to eliminate or reduce hazards, prioritized from most to least effective: elimination, substitution, engineering controls, administrative and work-practice controls, and personal protective equipment.

Incompatible Materials: Chemicals that can react violently, generate significant heat/pressure, or release toxic or flammable gases upon direct contact.

Laboratory: A facility where laboratory use of hazardous chemicals occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory Personnel: Employees, students, visiting researchers, volunteers, and other authorized individuals who perform or support activities in a laboratory or other area covered by this Chemical Hygiene Plan.

Laboratory Supervisor: A principal investigator, instructor, manager, or other individual designated to oversee laboratory activities and personnel.

Maximum Allowable Quantity (MAQ): The maximum volume or weight of hazardous materials (such as flammable liquids or compressed gases) permitted to be stored or used within a specific laboratory control area under International Fire Code standards.

Nanomaterials: Engineered or natural materials with at least one dimension in the size range of 1 to 100 nanometers (nm), exhibiting unique physical, chemical, or biological properties.

Occupational Exposure Limit (OEL): A regulatory or recommended limit on the concentration of a hazardous chemical in workplace air, generally expressed as a time-weighted average, short-term exposure limit, or ceiling value. OELs include Permissible Exposure Limits and recognized exposure guidelines established by other authoritative organizations.

Oxidizer or Oxidizing Chemical: A chemical that is not necessarily combustible but may, generally by yielding oxygen, cause or contribute to the combustion of other material. Oxidizers include oxidizing gases, liquids, and solids classified under Appendix B to the Hazard Communication Standard.

Particularly Hazardous Substances (PHS): For purposes of this Chemical Hygiene Plan, chemicals or materials that present elevated health or physical hazards and therefore require additional planning, controls, training, or oversight before use. PHS include the substances and materials identified in Section 3.4 and may include significant health, toxicity, fire, explosion, reactivity, or other hazards.

Permissible Exposure Limit (PEL): The limit on employee exposure to a regulated airborne contaminant. A PEL may be expressed as an eight-hour time-weighted average, a short-term exposure limit, or a ceiling concentration.

Peroxide-Forming Chemicals: Reagents and organic solvents (e.g., ethers, THF, dioxane) that react with ambient oxygen or light over time to form shock- and heat-sensitive explosive peroxide crystals.

Personal Protective Equipment (PPE): Equipment worn to minimize exposure to hazards that may cause workplace injury or illness. PPE may include protective clothing, gloves, safety glasses, chemical splash goggles, face shields, and respiratory protection.

Physical Hazard: A chemical classified as posing one or more of the following hazardous effects: explosive; flammable gas, aerosol, liquid, or solid; oxidizing liquid, solid, or gas; self-reactive; pyrophoric gas, liquid, or solid; self-heating; organic peroxide; corrosive to metal; gas under pressure; chemical that emits flammable gas when in contact with water; or combustible dust. Classification criteria are derived from the information contained in Appendix B to 29 CFR 1910.1200.

Principal Investigator (PI): A faculty member or other individual authorized by NDSU to direct research, instructional, or other laboratory activities and oversee the personnel conducting those activities.

Pyrophoric Chemical: A pyrophoric gas, liquid, or solid capable of igniting spontaneously under specified conditions:

- A pyrophoric gas is a chemical in a gaseous state that will ignite spontaneously in air at a temperature of 54°C (130°F) or below.
- A pyrophoric liquid is a liquid that, even in small quantities, is liable to ignite within five minutes after coming into contact with air.
- A pyrophoric solid is a solid that, even in small quantities, is liable to ignite within five minutes after coming into contact with air.

RAMP Framework: A systematic approach to laboratory safety developed by the American Chemical Society that consists of four principles: **Recognize hazards, Assess risks, Minimize risks, and Prepare for emergencies**.

Reactive Chemical: A substance capable of reacting violently, decomposing, polymerizing, or exploding under shock, friction, heat, or contact with incompatible materials.

Reproductive Toxin: A chemical that adversely affects sexual function or fertility in adults or produces adverse effects on the development of offspring. Reproductive toxicity includes adverse effects on sexual function and fertility, adverse effects on development of offspring, and effects on or through lactation.

Risk Assessment: A systematic evaluation of the hazards associated with a laboratory activity, the likelihood and potential severity of harm, and the measures needed to reduce the risk to an acceptable level.

Safety Data Sheet (SDS): Written or printed information concerning a hazardous chemical prepared in accordance with 29 CFR 1910.1200(g). An SDS follows a standardized 16-section format addressing identification; hazard identification; composition; first aid; firefighting; accidental release; handling and storage; exposure controls and PPE; physical and chemical properties; stability and reactivity; toxicology; ecological information; disposal; transportation; regulatory information; and other information.

Satellite Accumulation Area (SAA): A designated lab location at or near the point of waste generation under operator control where hazardous waste is temporarily accumulated.

Secondary Containment: A liquid-tight barrier, tray, or tub designed to capture leaks or spills from primary chemical or waste storage containers.

Select Carcinogen: A substance meeting one or more of the following criteria:

- It is regulated by OSHA as a carcinogen.

- It is listed as "known to be carcinogens" in the latest edition of the National Toxicology Program's Report on Carcinogens.
- It is listed in Group 1, "carcinogenic to humans," in the latest editions of the International Agency for Research on Cancer Monographs.

It is listed in IARC Group 2A or 2B or as "reasonably anticipated to be carcinogens" by the NTP and causes a statistically significant incidence of tumors in experimental animals under any of the following conditions:

- Inhalation exposure of six to seven hours per day, five days per week, for a significant portion of a lifetime, at dosages of less than 10 milligrams per cubic meter;
- Repeated skin application of less than 300 milligrams per kilogram of body weight per week;
- Oral administration of less than 50 milligrams per kilogram of body weight per day.

Sharps: Any laboratory object capable of cutting or puncturing skin, including needles, razor blades, scalpels, syringes, and broken glass.

Standard Operating Procedure (SOP): A written procedure that identifies the hazards associated with a laboratory activity and specifies the steps, controls, personal protective equipment, emergency measures, and other precautions necessary to perform the work safely.

Universal Waste: A category of widely generated hazardous wastes subject to streamlined regulations, including batteries, fluorescent lamps, mercury devices, used oil, and aerosol cans.

Water-Reactive Chemical or Chemical That Emits Flammable Gas When in Contact With Water: A solid or liquid chemical that, through interaction with water, is liable to become spontaneously flammable or release flammable gas in dangerous quantities. Under the Hazard Communication Standard:

- **Category 1:** The chemical reacts vigorously with water at ambient temperature and generally demonstrates a tendency for the gas produced to ignite spontaneously, or it reacts readily with water so that the rate of evolution of flammable gas is at least 10 liters per kilogram of chemical over any one-minute period.
- **Category 2:** The chemical reacts readily with water so that the maximum rate of evolution of flammable gas is at least 20 liters per kilogram of chemical per hour and it does not meet Category 1 criteria.

- **Category 3:** The chemical reacts slowly with water so that the maximum rate of evolution of flammable gas is at least 1 liter per kilogram of chemical per hour and it does not meet Category 1 or Category 2 criteria.

APPENDIX B – HAZARDOUS WASTE MANAGEMENT

B.1 PURPOSE

This appendix establishes North Dakota State University's policies and procedures for the safe management of hazardous waste at NDSU.

All personnel who generate or handle hazardous waste are responsible for complying with the procedures described in this appendix.

B.2 REGULATORY FRAMEWORK

Hazardous waste management at NDSU is governed by the following regulations and authorities:

Resource Conservation and Recovery Act (RCRA)

Federal legislation that regulates hazardous waste from generation to final disposal ("cradle-to-grave").

North Dakota Department of Environmental Quality (NDDEQ)

The authorized state agency responsible for implementing and enforcing hazardous waste regulations in North Dakota.

There may be other agencies and regulations that NDSU must comply with as applicable not listed in this appendix.

NDSU must comply with these regulations as a large quantity hazardous waste generator.

B.3 DEFINITION AND CLASSIFICATION OF HAZARDOUS WASTE

Hazardous waste is used or unwanted material that can cause harm to human health or the environment when handled improperly.

Examples of hazardous waste generated at NDSU include:

- Unused, expired, or unwanted chemicals
- Chemical reaction byproducts, solvents, acids, bases, and heavy metal-containing wastes
- Contaminated wipes, gloves, absorbents, sharps, glassware, or spill cleanup debris
- Paints, stains, varnishes, inks, adhesives, and other art-related chemical wastes
- Cleaning chemicals, degreasers, oils, filters, and other shop or facilities maintenance wastes

- Aerosol cans, batteries, lamps, mercury-containing devices, and other universal wastes

Hazardous waste must never be disposed of in regular trash or poured down drains.

For waste management purposes, hazardous waste is classified by hazard class. Hazard class means the primary type of hazard a chemical or waste presents, based on its physical, chemical, health, or environmental properties. Hazard class is used to help determine how waste must be labeled, stored, segregated, transported, and disposed of.

Hazard classes used at NDSU include:

- **Flammable:** Flammables will readily burn under certain conditions.
- **Oxidizer:** A material that is not necessarily combustible itself but may intensify the combustion of other material.
- **Acidic:** Corrosive chemicals with a pH less than ~4. Cause destruction of skin tissue at the site of contact or are highly corrosive to steel.
- **Caustic (base):** Corrosive chemicals with a pH greater than ~10. Cause destruction of skin tissue at the site of contact or are highly corrosive to steel.
- **Halogenated:** Volatile organic chemicals consisting of a hydrocarbon chain with one or more chlorine, bromine or other halogen atoms. (e.g., carbon tetrachloride, dichloromethane, chloroform, etc.)
- **Toxic:** Chemicals that cause health or environmental damage upon exposure.
- **Water reactive:** Chemicals that react vigorously with water or liberate toxic gas when in contact with water or moisture in the air.

A waste may possess more than one hazard class. Laboratory personnel must use Safety Data Sheets (SDS) and generator knowledge to determine the appropriate hazard classification.

B.4 ROLES AND RESPONSIBILITIES

B.4.1 SAFETY OFFICE

The NDSU Safety Office administers the university hazardous waste management program and is responsible for:

- Providing hazardous waste containers, tags, and tickets.
- Collecting hazardous waste from laboratories.
- Managing hazardous waste storage and disposal.
- Overseeing regulatory compliance.
- Providing hazardous waste training.

- Conducting inspections and program oversight.
- Maintaining a 24-hour emergency response capability.

B.4.2 PRINCIPAL INVESTIGATORS AND SUPERVISORS

Principal investigators and laboratory supervisors are responsible for:

- Ensuring laboratory personnel receive all applicable training.
- Maintaining compliance with labeling and storage requirements.
- Ensuring waste containers are properly managed.
- Ensuring unknown chemicals are not left in laboratories.
- Ensuring waste is submitted for disposal within required time limits.

B.4.3 LABORATORY PERSONNEL

Laboratory personnel who generate hazardous waste must:

- Correctly identify and label waste.
- Store waste in approved containers.
- Maintain containers in a closed condition.
- Submit waste for pickup promptly.
- Report spills, unsafe conditions, or incidents to the Safety Office.

B.5 SATELLITE ACCUMULATION AREA REQUIREMENTS

Satellite Accumulation Area (SAA) is a temporary designated location where a hazardous waste generator may accumulate limited amounts of hazardous waste. The definition relies on being at or near the point of generation, under operator control, and adhering to volume limits.

The following requirements apply to all SAAs.

B.5.1 COMPATIBLE CONTAINERS

Hazardous waste must be collected only in containers provided by the Safety Office. These include liquid waste jugs and solid waste buckets.

Containers must:

- Be chemically compatible with the waste
- Be structurally sound and leak-free

Incompatible waste materials must never be mixed in the same container.

B.5.2 CLOSED CONTAINERS

Hazardous waste containers must remain closed at all times, except when actively adding waste. Improper container closure is a common regulatory violation. Examples of improper closure include: funnels left in containers, open waste containers, and loosely fitted caps

Containers should be filled no more than approximately 90% full to allow the lid to be properly secured.

B.5.3 HAZARDOUS WASTE LABELING

All hazardous waste containers must be labeled immediately when waste is first added to the container.

Hazardous waste tags must include:

- Primary hazard class
- Complete list of chemical contents
- Accumulation start date

When the container is ready for disposal, the generator must also add:

- End date

Unknown chemicals will not be accepted for disposal and must be identified by the generator.

Chemical abbreviations should not be used when labeling waste containers.

B.5.4 STORAGE CONDITIONS

Hazardous waste must be stored in a designated area of the laboratory.

Waste containers must: remain upright, be free of external contamination, be stored in compatible secondary containment when feasible, be inspected regularly for leaks or damage.

Leaking containers must be replaced or over-packed immediately.

B.5.5 MAXIMUM STORAGE TIME

Hazardous waste containers must be removed within the following time limits. The applicable storage time limit begins when hazardous waste is first accumulated in a satellite accumulation area.

Satellite accumulation areas may accumulate up to 55 gallons of non-acute hazardous waste or 1 quart (or 1 kilogram) of acute hazardous waste. Once these limits are reached, the excess waste must be removed from the satellite accumulation area within 3 calendar days.

- Research laboratories
  Waste must be removed within 9 months of the accumulation start date.

- Educational laboratories
  Waste must be removed at the end of each semester.

B.6 HAZARDOUS WASTE PICKUP PROCEDURES

B.6.1 HAZARDOUS WASTE TICKETS

Before requesting pickup, each waste container must have a completed Hazardous Waste Ticket. Tickets must be legible and completed using a pen. The Hazardous Waste Ticket contains two copies of the ticket, the NDSU Safety Office collects both copies.

The ticket must include: building and room number, contact information, Principal Investigator information, hazard class, chemical contents and approximate quantities, total mass or volume, pH, start and end dates.

B.6.2 REQUESTING PICKUP

Hazardous waste pickup requests may be submitted through the online hazardous waste request form, or by calling the Safety Office.

Waste containers must be submitted for pickup immediately after the container is full or when an end date is added. Once an end date is recorded on a hazardous waste container, the laboratory must request pickup within 24 hours.

B.6.3 SAFETY OFFICE COLLECTION

The Safety Office will:

- Collect hazardous waste containers.
- Provide replacement containers, tags, and tickets.
- Transport waste to the central accumulation area.
- Coordinate off-site disposal with licensed vendors.

B.7 SPECIAL WASTE STREAMS

B.7.1 SHARPS

Sharps include: needles, razor blades, scalpels, syringes, or any other object that may puncture the skin.

Sharps must be collected in approved sharps containers and disposed of as regulated waste. Sharps that are not chemically or biologically contaminated still need to be collected by the NDSU Safety Office. Sharps cannot be disposed of in the regular trash.

Biohazard-contaminated sharps must be placed in red biohazard sharps containers. Chemically contaminated sharps must be placed in a hazardous waste bucket and clearly labeled "SHARPS," with chemical contaminants identified. Uncontaminated sharps must be collected in a Safety Office provided sharps container or other approved container.

The NDSU Safety Office will provide sharps containers and collect all sharps waste.

B.7.2 UNIVERSAL WASTE

Universal waste includes commonly generated items containing hazardous components such as: batteries, fluorescent lamps, aerosol cans, used oil, and mercury containing devices.

Universal waste containers must be:

- Closed
- Properly labeled (USED LAMPS, USED BATTERIES, USED AEROSOL CANS, USED OIL, USED MERCURY CONTAINING DEVICES)
- Marked with an accumulation start date

Universal waste must be disposed of within 9 months.

B.7.3 CHEMICALLY CONTAMINATED GLASS

Empty chemical containers may be disposed in the trash after:

- Triple rinsing with an appropriate solvent.
- Collecting the rinsate as hazardous waste.
- Defacing the original chemical label.
- Labeling the container "3× rinsed".

If triple rinsing is not safe, practical, or appropriate because it would generate unnecessary hazardous waste, the contaminated glass must be collected and disposed of through the hazardous waste program.

B.7.4 MIXED WASTE

Mixed waste is waste that contains more than one regulated waste type, such as chemical, biological, or radioactive hazards. Mixed waste can be difficult and costly to manage and must be avoided whenever

possible. Do not combine chemical hazardous waste with biological waste, chemical hazardous waste with radioactive waste, or biological waste with radioactive waste. Each waste type must be collected in clearly labeled, separate containers unless the Safety Office has reviewed and approved the process in advance. Always contact the Safety Office before generating mixed waste.

B.7.5 CHEMICAL CLEANOUTS

Unwanted or expired chemicals must be disposed of through the Safety Office.

Chemicals left behind by departing researchers become the responsibility of the PI, laboratory supervisor, or department responsible for the space. Additional requirements are outlined in Section 5.9: Laboratory Closeout and Researcher Departure.

The Safety Office will assist with laboratory chemical cleanouts.

B.8 EMERGENCY PROCEDURES

If a hazardous waste spill or exposure occurs:

- Life-threatening emergency:
  Call 9-1-1

- Chemical spills or hazardous materials incidents:
  Contact the Safety Office (701-231-7759)

Do not attempt to clean up large chemical spills unless properly trained.

The Safety Office maintains a 24-hour spill response team.

APPENDIX C – NANOMATERIAL SAFETY

C.1 PURPOSE

This appendix provides guidance for the safe handling, storage, and disposal of nanomaterials used in research and educational activities at North Dakota State University.

Due to their small size and unique physical and chemical properties, nanomaterials may present health and safety risks that differ from those of bulk materials. This appendix outlines best practices for minimizing exposure and managing risks associated with nanomaterials.

C.2 DEFINITION OF NANOMATERIALS

Nanomaterials are materials with at least one dimension in the size range of approximately 1 to 100 nanometers (nm).

Examples of nanomaterials include:

- Carbon nanotubes
- Nanoparticles (e.g., metal, metal oxide, quantum dots)
- Nanofibers
- Nanoscale coatings or powders

C.3 HAZARDS OF NANOMATERIALS

The health effects of many nanomaterials may not be fully understood. Potential hazards may include:

- Increased toxicity compared to bulk materials.
- Ability to penetrate skin or biological membranes.
- Respiratory hazards due to inhalation of fine particles.
- Increased surface reactivity or catalytic activity.

Nanomaterials in dry powder form present the greatest potential for exposure, particularly through inhalation.

C.4 EXPOSURE ROUTES

Potential routes of exposure to nanomaterials include:

- **Inhalation** of airborne nanoparticles or aerosols.
- **Skin contact** with suspensions or powders.
- **Ingestion** through contaminated hands or surfaces.
- **Injection** or puncture through sharps or contaminated materials.

Laboratory personnel must assume that nanomaterials may be hazardous and take appropriate precautions to minimize exposure.

C.5 RISK ASSESSMENT

Prior to working with nanomaterials, laboratory personnel must:

- Evaluate the hazards of the specific nanomaterial.
- Review available Safety Data Sheets (SDS) and literature.
- Consider the physical form (powder, suspension, embedded material).
- Assess potential exposure routes.
- Determine appropriate control measures.

Principal Investigators are responsible for ensuring that nanomaterial hazards are evaluated and that appropriate controls are implemented.

C.6 ENGINEERING CONTROLS

Engineering controls are the primary method for minimizing exposure to nanomaterials.

The following controls should be used whenever feasible:

- Laboratory fume hoods
- Local exhaust ventilation
- Enclosed systems or glove boxes for high-risk materials
- HEPA-filtered containment systems

Dry nanomaterials should be handled in a manner that minimizes dust generation and airborne release.

C.7 ADMINISTRATIVE CONTROLS

Administrative controls include:

- Developing Standard Operating Procedures (SOPs) for nanomaterial use.
- Limiting access to areas where nanomaterials are handled.
- Providing training specific to nanomaterial hazards.
- Using signage to identify areas where nanomaterials are present.
- Minimizing quantities used and stored in laboratories.

To minimize exposure:

- Avoid handling nanomaterials in dry powder form when possible.
- Use wet methods or suspensions to reduce airborne particles.
- Avoid generating dust or aerosols.
- Keep containers closed when not in use.
- Work over trays or containment surfaces.
- Clean surfaces using wet wiping methods or HEPA-filtered vacuum systems.

Do not use compressed air or dry sweeping methods to clean nanomaterials.

C.8 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Appropriate PPE must be used when handling nanomaterials, including:

- Laboratory coat or protective clothing.
- Disposable nitrile or chemically resistant gloves.
- Safety glasses or goggles.
- Additional respiratory protection if required by the NDSU Respiratory Protection Program.

Contaminated PPE must be handled as potentially hazardous and disposed of appropriately.

C.9 STORAGE AND LABELING

Nanomaterials must be:

- Stored in clearly labeled containers.
- Kept in closed, sealed containers when not in use.
- Labeled to indicate the presence of nanomaterials and associated hazards.

Secondary containment is recommended to prevent accidental release.

C.10 WASTE MANAGEMENT

Nanomaterial waste must be managed as hazardous waste unless otherwise determined by the Safety Office.

This includes:

- Unused nanomaterials.
- Contaminated PPE.
- Wipes, absorbents, or cleanup materials.
- Contaminated equipment or containers.

Nanomaterial waste must:

- Be collected in compatible, closed containers.
- Be properly labeled.
- Be disposed of through the NDSU hazardous waste program.

Nanomaterials must not be disposed of in sinks, drains, or regular trash.

C.11 SPILL AND EMERGENCY RESPONSE

Small spills of nanomaterials may be managed by trained laboratory personnel using appropriate spill response procedures.

For spills:

- Avoid creating airborne dust.
- Use wet wiping methods or HEPA-filtered vacuum systems.
- Wear appropriate PPE.

For large spills or unknown hazards:

- Evacuate the area.
- Restrict access.
- Contact the Safety Office.

C.12 TRAINING REQUIREMENTS

Personnel working with nanomaterials must receive:

- General laboratory safety training.
- Hazard-specific training related to nanomaterials. Nanomaterial Safety Training has been developed by the Safety Office and is available online.
- Lab specific training on proper handling, storage, and disposal procedures.

Principal Investigators are responsible for ensuring that personnel are adequately trained.

C.13 MEDICAL AND EXPOSURE CONCERNS

Due to limited data on long-term health effects, exposure to nanomaterials should be minimized to the greatest extent possible.

Any suspected exposure, including inhalation or skin contact, must be reported in accordance with NDSU incident reporting procedures.