



Dryden Flight Research Center
Edwards, California 93523

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Dryden Centerwide Procedure

Code S

Laboratory Safety

Electronically approved by
Assistant Director for Management Systems

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1.0 PURPOSE OF DOCUMENT

This document describes procedures, delegates authority, and assigns responsibility for managing the Dryden Flight Research Center (DFRC) laboratory safety program.

2.0 PROCEDURE SCOPE & APPLICABILITY

Scope: This procedure applies to laboratories where relatively small quantities of hazardous chemicals (including toxic, nano-materials, and carcinogens) are handled, stored, and used in a nonroutine and nonproduction manner using protective laboratory practices and equipment.

Applicability: This procedure applies to all NASA employees at DFRC and visitors who use multiple chemical products, or work with hazardous chemicals in laboratories.

Applicability Exceptions: Excludes battery, loads, and simulation labs.

3.0 PROCEDURE OBJECTIVES, TARGETS, METRICS, & TREND ANALYSIS

Objective: Identify, eliminate, or control chemical incidents

Target: Zero mishaps during laboratory operations

Metric: Number of chemical incidents during laboratory operations

Trend analysis: Metrics will be analyzed to determine whether procedural objectives have been met.

4.0 WAIVER AUTHORITY

Requests for waivers and variances to DFRC specific safety documents will be made to the Chief, Safety, Health, and Environmental Office (Code SH). Requests for waivers and variances to NASA safety instructions will be made to NASA HQ in accordance with instructions provided by NPR 8715.3, NASA Safety Manual, Par. 1-19, Safety Variance Process, and Table 1-1: NASA Safety Risk and Approval Process Matrix.

5.0 RESPONSIBILITY

5.1 Directorates & Single Letter Organizations

Approve projects, ensure resources, and provide training necessary to safely conduct chemical laboratory activities.

5.2 Safety, Health, & Environmental Office

The Chief of Safety, Health, and Environmental Office has oversight responsibilities for laboratory safety at DFRC and incurs the following responsibilities:

- A. Advise management on matters concerning chemical laboratory safety.
- B. Ensure adequate local safety policies are written for the control of hazardous chemicals in laboratories.
- C. Appoint a Chemical Hygiene Officer (CHO).
- D. Investigate chemical laboratory mishaps and incidents and report findings to management and required agencies. Follow instructions in NPD 8621.1G. NASA Mishap Reporting and Investigation Policy when appropriate.
- E. Review this chapter annually for necessary revisions.

5.3 Chemical Hygiene Officer (CHO)

The CHO will be qualified by training or experience to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Program. Primary duties of the CHO are:

- A. Oversee the implementation of the DFRC Chemical Hygiene Program. Approve hazard analysis and laboratory safety plan.
- B. Provide advice, oversight, and consultation to DFRC management, supervisors, and workers to ensure compliance with relevant regulations and policies for procurement, use, and disposal of hazardous chemicals in laboratories.
- C. Review laboratory procedures for the use of Particularly Hazardous Substances, as defined.
- D. Conduct exposure assessments of laboratories and provide findings to directorates, single letter offices, laboratory supervisors, and workers. Make over-exposure assessment results available to the Health Unit in order that they may be incorporated into personnel health records. Maintain a file of each laboratory's assessments in order to track discrepancies.

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- E. Survey operational fume hoods at least annually.
- F. Immediately follow up on any complaints involving hazards from laboratory employees. Inform directorates, single letter offices, supervisors, and employees of findings and corrective actions taken. Notify the Health Unit when findings indicate a health hazard.
- G. Include any chemical laboratory safety discrepancies in the Hazardous Material Management System (HMMS).

5.4 Laboratory Supervisors

Laboratory supervisors are directly responsible for laboratory safety and for ensuring compliance with relevant regulations, policies, and procedures.

- A. Review and approve each laboratory procedure to include the hazards of the chemical/s involved, safety measures to be used, and personal protective equipment needed.
- B. Develop a general laboratory safety plan for standard operations. In addition to the standard plan a hazard analysis will be developed for each project that uses Particularly Hazardous Substances, as defined. See Section 7.0, Hazard Analysis and Safety Plan, and Appendix B.
- C. Ensure that employees working within the laboratory have the training on the lab safety plan, hazard analysis, laboratory standard operating procedures, and knowledge to complete projects safely.
- D. Maintain an up-to-date chemical, carcinogens, and toxic material inventory.
- E. Ensure that resources necessary to safely complete a project are available.
- F. Ensure that, MSDS, operating procedures, and other appropriate documents are made available to laboratory employees.
- G. Conduct informal safety and housekeeping inspection daily when the laboratory is in operation.
- H. Post danger and warning signs, such as National Fire Protection Association (NFPA) chemical warning signs, where required.

5.5 Laboratory Workers

- A. Have proper training and knowledge to perform assigned tasks and follow established laboratory standard operating procedures, and safety plan.
- B. Understand and follow safety procedures required by each project. If a worker has questions regarding safety procedures he/she will request clarification from the laboratory supervisor before continuing.

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- C. Immediately report any concerns of unsafe or unhealthy working practices or conditions.
- D. Immediately report any ill effects experienced to the laboratory supervisor and seek medical consultation at the DFRC Health Unit.

5.6 Off-Site Contractors & Visiting Experimenters

- A. Follow this procedure or a Chemical Hygiene Plan approved by the CHO and adhere to relevant safety regulations that pertain to the project being conducted.
- B. Provide the CHO with a summary of the projects to be accomplished including the hazardous chemicals to be used, precautions to be taken, and Personal Protective Equipment (PPE) required.

5.7 Contracting Officer Technical Representative (COTR)

- A. Monitor compliance with this or contractor's Chemical Hygiene Plan and relevant safety regulations governing the contractor's chemical laboratory operations.
- B. Notify the Dryden CHO or Safety, Health, and Environmental Office of any deviations from the Chemical Hygiene Plan or related safety requirements.

6.0 CONTROL MEASURES

The large number and variety of hazardous materials and their many uses does not allow a review of each possible situation that may be encountered in a laboratory setting. To help solve this problem general control measures have been developed to provide a framework for minimizing risks in chemical laboratories.

6.1 Types of Controls

- A. Elimination - Remove requirement for use of hazardous chemical in procedure. Some circumstances chemical or formulation of chemicals can be purchased ready for use, eliminating formulation exposure and decreasing constituent exposures.
- B. Chemical Substitution – In many cases, a highly toxic chemical may be substituted for one that is less toxic. An evaluation to determine the least toxic materials that satisfy requirements of a project will be made by the laboratory supervisor.
- C. Engineering Controls – Good engineering controls are essential to safe laboratory operations. Consideration for containment, enclosures, process change, ventilation, adequate workspace, and general facility design will make a laboratory a safer place to work.

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- D. Administrative Controls – Administrative controls include written safety procedures, training requirements, access control, medical surveillance requirements, record keeping, and documentation.
- E. Personal Protective Equipment (PPE) – Training in the use of PPE is mandatory for persons working in a chemical laboratory. Chemical laboratory PPE may include items such as, respirators, face shields, gloves, and protective clothing.
- F. Work Practices – Work practices are possibly the most important safety aspect of chemical laboratory. Work practices include both personal hygiene habits and laboratory techniques. Employees will use Appendix A, Chemical Laboratory Safety Guidelines, for a summary of laboratory safety practices.

7.0 HAZARD ANALYSIS & LABORATORY SAFETY PLAN

Prior to conducting a project the laboratory supervisor will ensure that a hazard analysis is conducted whenever Particularly Hazardous Substances, as defined, are used. The hazard analysis will be reviewed and approved by the CHO. The hazard analysis will include:

- A. Inherent toxic and physical properties of the materials and their intended use.
- B. Possibility of unplanned outcomes, spills, or accidents.
- C. Workplace factors such as existing ventilation, protective systems, and the need for PPE.
- D. Possible exposure routes (inhalation, skin or eye contact, or ingestion).
- E. Skills, training, and prior experience of the individual performing the project.
- F. Laboratory Safety Plan – Prior to conducting a project, the laboratory supervisor will ensure that a Laboratory Safety Plan (See Appendix B for guidance.) that conforms to CFR 1910.1450 is developed. This safety plan will be reviewed and approved by the CHO.

8.0 MEDICAL

The DFRC Health Unit provides emergency medical care for all persons at DFRC. Employees will be referred to the Health Unit:

- A. For baseline examination when working with substances that require medical surveillance.
- B. If they experience headaches, dizziness, nausea, rashes, mental confusion, or loss of motor control that could be related to the handling of a chemical.

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- C. When air monitoring indicates toxic chemical air levels have exceeded PEL or TLV limits.
- D. When an event such as a spill, leak, or explosion results in an exposure.

Use the emergency 911 telephone system to notify the Health Unit and Safety, Health, and Environmental Office of a reportable acute exposure.

8.1 Employee Exposure

If an employee is exposed to a hazardous chemical and requires medical attention, medical personnel will be informed of:

- A. Any signs or symptoms described by the employee and symptoms other employees may have seen in the employee or experienced themselves.
- B. The name and nature of the chemical, including an MSDS, and how the chemical was being used.
- C. The results of any monitoring or testing that were done to determine the level of exposure.
- D. Follow-up care, within the capacity of the Health Unit, will be provided to DFRC civil servants. Non-civil service personnel will be referred to their company's physician or private practitioner for further treatment and follow-up evaluation.

If the Health Unit is unable to provide the required level of care needed, the patient will be referred to a facility that has the capability.

8.2 Pregnant Workers

The laboratory supervisor will inform each female worker under his/her supervision who is of childbearing age to immediately declare her pregnancy in writing should it occur. Once declared, the pregnant worker will be monitored for exposure to certain materials that could affect the fetus. Chemicals that must be carefully handled or avoided by the pregnant worker are those listed as embryotoxins, mutagens, or teratogens.

9.0 TRAINING

Occupational Safety and Health Administration (OSHA) requires that chemical laboratory employees be provided with specific information about the chemical hazards in their work area and be trained on how to safely work with such chemicals.

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9.1 Required Information

Each employee who works in a chemical laboratory where hazardous chemicals are used, stored, or transferred will be given the following information:

- A. The location of hazardous chemicals in the work area at the time of initial assignment and before each new assignment that involves chemicals to which the employees may be exposed.
- B. PELs or TLVs for OSHA regulated substances used in the employee's job assignment. For a list of the most current PELs and TLVs contact the Safety, Health, and Environmental Office.
- C. Hazcom information on the effects, signs, and symptoms of exposure to hazardous substance being used.
- D. Location and availability of standard reference materials on the hazards found in the individual laboratories, including safe handling, storage, and disposal procedures for hazardous chemicals.
- E. Location of Chemical Hygiene Plan, laboratory standard operating procedures, lab safety plan, MSDSs, OSHA standards, emergency telephone numbers, and other documentation of importance to the safe accomplishment of a specific project.

9.2 Training

Laboratory employee training is similar to hazard communication training required by 29 CFR 1910.1200 and will consist of:

- A. Methods and observations used to determine the presence or release of a hazardous chemical such as monitoring devices, visual appearance, and odor of chemicals.
- B. Methods employees may take to protect themselves from hazards. These include appropriate engineering and administrative controls, PPE, work practices, and emergency procedures.
- C. Review of the physical and health hazards that can occur in the work place, including flammable and reactive materials, irritants and corrosives, acute poisons, chronic organic toxins, allergens, and genetic toxins.
- D. How to extract needed information from a Material Safety Data Sheet (MSDS).
- E. The proper labeling, storage, and waste disposal procedures for all levels of chemicals.
- F. Review of the requirements in the local Chemical Hygiene Plan.

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9.3 Refresher Training

Refresher training for chemical laboratory operations is not defined in current standards, however, laboratory supervisors are encouraged to evaluate the need for refresher training for employees and provide refresher on a reoccurring basis and when procedures, chemicals, or equipment change.

10.0 MANAGEMENT RECORDS & RECORD RETENTION

10.1 Laboratory Supervisor

After completion of the project, a disposition for the records, including training records will be made using NPD 1441.1, Records Retention Schedules, and DFRC records management procedures

A. Laboratory Records – The laboratory supervisor will:

- 1) Keep a record of any measurements taken of employee exposures and any medical consultation and examinations including tests or written opinions required by 29 CFR 1910.1450.
- 2) Assure such reports are maintained, in accordance with NASA, federal, and state requirements.
- 3) Keep records such as receipts, inventories, transfers, hazardous materials disposal records, etc., in a separate working file for each project.

A record of all hazardous materials used as listed in 29 CFR 1910.1000 Subpart Z, must be included.

B. Training Records

Training records will be maintained by the trainer with a copy provided to the laboratory supervisor and be available to the employee and for inspection by authorized persons. On site contractors are responsible for maintaining their employees training records.

Training records will be maintained in accordance with NPD 1441.1D, Record Retention Schedules.

C. Chemical Hygiene Office (CHO)

The CHO is responsible for maintaining a copy of records and receipts such as approval requests and authorizations, procurement, inventories, surveys, calibrations, bioassay results, exposures, waste

disposal, and any other records that pertain to the use of hazardous materials as listed in 29 CFR 1910.1000, Subpart Z.

11.0 RELEVANT DOCUMENTS

11.1 Authority Documents

NPD 8700.1	NASA Policy for Safety and Mission Success
29 CFR 1910.1450	Occupational Exposure to Hazardous Chemicals In Laboratories
NPR 8715.3	NASA Safety Manual
American Conference of Governmental Industrial Hygienists (ACGIH)	Industrial Ventilation
National Fire Protection Association (NFPA) 45	Standard on Fire Protection for Laboratories Using Chemicals

11.2 Reference Documents

NPD 1820.1	NASA Environmental Health Program
National Research Council (NRC)	Prudent Practices for Handling Hazardous Chemicals in Laboratories

12.0 ACRONYMS & DEFINITIONS

12.1 Acronyms

ACGIH	American Conference of Government Industrial Hygienists
CHO	Chemical Hygiene Officer
COTR	Contracting Officer Technical Representative
HEPA	High Efficiency Particulate Air filter system
HMMS	Hazardous Materials Management System
MSDS	Material Safety Data Sheet

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NFPA	National Fire Protection Association
NRC	National Research Council
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limits
PPE	Personal Protective Equipment
TLVs	Threshold Limit Values

12.2 Definitions

Action Level	The level of concentration of an airborne substance calculated on an 8 hr time weighted average and that initiate certain activities such as monitoring or medical surveillance.
Acute Toxicity	The toxic effect of a substance that has a rapid onset, sharp or severe effects, and pronounced symptoms but is not chronic.
Chemical Hygiene Plan	A written plan developed and implemented by the employer that establishes the procedures, equipment, personal protective equipment, and work practices to protect employees from health hazards caused by chemicals used in laboratory settings. The plan must meet the requirements of 29 CFR 1910.1450 guidelines.
Chronic Toxicity	Harmful health effects that develop over time and last for a long time. Effects may have a delayed onset.
Designated Area	An area that may be used to work with select carcinogens, reproductive toxins, or substances, which have a high degree of acute toxicity. An area may be the entire laboratory, a specific area of a laboratory, or a device such as a fume hood.
Embryotoxins	A group of toxins that have the ability to damage an embryo.
Carcinogen	A substance or material that has caused cancer in tests with laboratory animals or is know or believed to be capable of causing cancers in humans.
Designated Carcinogen	A carcinogen that meets the criteria for OSHA select carcinogen or falls into Category 1 or 2 of the ACGIH's list of carcinogens.
Flammable Chemical	An aerosol, gas, liquid, or solid chemical that meets the OSHA definition of flammable.
Hazardous	A chemical for which there is statistically significant

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Chemical	evidence, based on at least one study conducted in accordance with established scientific principles that may cause acute or chronic health effects following exposure.
Health Hazard	Includes chemicals that are carcinogens, toxic or highly toxic, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic systems, or agents that damage the lungs, skin, eyes, or mucous membranes.
Hematopoietic	Pertaining to the blood producing organs of the body.
Hepatotoxins	A group of toxins that have the ability to damage the liver.
Laboratory	A facility where the laboratory scale use of hazardous chemicals occurs or a workplace where relatively small quantities of hazardous chemicals are used on a nonproduction basis.
Laboratory Scale	Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. Workplaces that produce commercial quantities of materials are excluded.
Mutagens	A substance or material that has the ability to damage DNA with the results of mutating a fetus.
Teratogens	See Mutagens above.
Nephrotoxins	Toxins that have the ability to damage the kidneys.
Neurotoxins	Toxins that have the ability to damage the nervous system.
Particularly Hazardous Substances	Select carcinogens, reproductive toxins, compounds with a high degree of acute toxicity, and highly flammable or explosive substances. Chemicals and substances that require special handling.
Protective Laboratory Practices and Equipment	Laboratory procedures, practices, and equipment accepted by laboratory health and safety professionals as effective, or those that the employer can show to be effective in minimizing employee exposure to hazardous chemicals.
Regulated Area	A work area with limited access where substances are regulated by specific OSHA standard.
Reproductive Toxins	Toxins that interfere with the reproductive processes.
Sensitizers	Substances or materials that cause reactions within the

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body, an example: allergens.

For additional definitions see 29 CFR 1910.1450 (b), definitions, and Chapter 9, Hazard Communications, Appendix A: DFRC Data Sheet Instruction Guide and Dictionary.

APPENDIX A – CHEMICAL LABORATORY SAFETY

GENERAL SAFETY PROCEDURES

The following safety procedures have, for the most part, been taken from 29 CFR 1910.1450, Appendix A. These safety practices represent good judgment that must be used when hazardous chemicals are used. An excellent source of laboratory safety procedures is the National Academy of Science publication: Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, 2101 Constitution Ave., NW, Washington, D.C. Laboratory supervisors may obtain a copy of this publication from the DFRC Safety, Health, and Environmental Office.

- 1) Do not smell, taste, or use mouth suction for pipetting or starting a siphon.
- 2) Vent apparatus (e.g., vacuum pumps and distillation columns) that may discharge toxic chemicals into local exhaust systems. Do not release toxic substances into cold or warm rooms as these rooms may have contained recirculated atmospheres.
- 3) Handle and store laboratory glassware carefully to avoid damage; do not use damaged glassware. Use extra care with Dewar flasks and other evacuated glass apparatus; if necessary, shield or wrap them to contain chemicals and protect garments in case an implosion occurs. Use equipment only for its designed purpose.
- 4) Carry hazardous chemicals in a secondary container. In many cases a bucket type container serves this purpose.
- 5) Wash exposed areas of skin well before leaving laboratory.
- 6) Avoid practical jokes or other behavior that might confuse, startle, or distract another worker.
- 7) Confine long hair and loose clothing. Wear shoes. Sandals and perforated shoes are not permitted in the laboratory.
- 8) Keep work areas clean and uncluttered. Clean up after completing an operation and at the end of each shift. Ensure that chemicals and equipment are properly labeled and stored.
- 9) When possible, do not wear contact lenses in the laboratory. If contact lenses must be worn, inform supervisor so that special precautions may be taken.
- 10) Remove laboratory coats and other clothing immediately if contaminated. Bag all contaminated clothing.
- 11) Keep materials stored in hoods to a minimum: do not allow materials to block vents or the airflow. Use only the quality and quantity of chemicals that the ventilation system can handle.
- 12) Leave the fume hood on when not in use, especially if it contains toxic substances or if it is uncertain whether adequate general laboratory ventilation is provided when the hood is off.

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- 13) If chemical gets into the eyes, flush for 15 minutes and obtain medical help. For skin contact, flush with water and if symptoms persist seek medical assistance.
- 14) If a chemical is ingested immediately contact the Health Unit using the emergency 911 telephone system. Encourage the victim to drink large amounts of water ONLY if approved for the specific chemical, has been approved by a medical doctor, the Poison Control Center, or MSDS.
- 15) MSDSs must be available to employees at all times.
- 16) Avoid eating, drinking, smoking, chewing gum, and applying cosmetics.
- 17) Do not conduct a hazardous procedure when you are the only person in the laboratory.
- 18) Know and follow proper waste disposal procedures.
- 19) Use approved procedures for using allergens and embryotoxins. Women of childbearing age must take special care, such as using PPE, especially gloves, to avoid contact when working with embryotoxins.
- 20) Review the use of allergens and embryotoxins with laboratory supervisor. Notify supervisor of any releases, spills, exposures, etc., and contact the Health Unit.

WORKING WITH CHEMICALS OF MODERATE CHRONIC OR HIGH ACUTE TOXICITY

- 1) Minimize exposure to these toxic substances by any route using all reasonable precautions.
- 2) Store in a restricted area with required warning signs.
- 3) Use with an approved hood or other containment devices for procedures that could generate aerosols or vapors. If possible, trap released vapors to prevent discharge.
- 4) Avoid contact by using proper PPE and always wash hands and arms immediately after working with these materials.
- 5) Take precautions to prevent spills. Use secondary containers if primary container is breakable. Always ensure two people are in the laboratory when these chemicals are in use.
- 6) Handle waste materials appropriately.

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WORKING WITH CHEMICALS OF HIGH CHRONIC TOXICITY

- 1) Conduct all transfers and work with these substances in a controlled area such as a hood glove box, or a designated area within the laboratory. Ensure each substance is clearly labeled, and that the designated area is properly marked. Ensure all persons working in the laboratory are aware of the substances being used, the restrictions, and the precautions required.
- 2) Protect equipment from being contaminated and always decontaminate the controlled area before it is used for other projects.
- 3) Remove protective apparel, wash hands, arms, face, and neck. Place apparel in appropriately labeled containers to be disposed of as hazardous waste or decontaminated and cleaned for further use depending on the exposure and substance used.
- 4) Do not sweep powdered toxic materials; use wet mop or a vacuum cleaner with HEPA filter.
- 5) Have an emergency plan to protect persons, equipment, and materials in case of an accident.
- 6) Store properly labeled substances in a clearly marked, limited access, substantial and ventilated cabinet. Substances will be contained in non-breakable or secondary containers. When storing toxic substances, take into consideration that DFRC is located in a seismic active area.
- 7) Keep records on substances used and inventories on hand.

ANIMAL EXPERIMENTS WITH CHEMICALS OF HIGH CHRONIC TOXICITY

- 1) Administer substance by injection or gavage instead of diet when possible. If substance is given by diet, a caging system with negative pressure under laminar airflow directed toward HEPA filters will be required.
- 2) Minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces. Use HEPA filtered vacuum equipment for cleaning. Dampen contaminated bedding before removal from cage and mix diets in closed containers in a hood.
- 3) Wear plastic or rubber gloves and fully buttoned laboratory coats or jumpsuits when working in the animal room.
- 4) Specially designed facilities with restricted access are preferred for long time or large-scale animal studies.

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APPENDIX B – LABORATORY SAFETY PLAN CHECKLIST

Laboratory supervisors are responsible for ensuring that a safety plan is developed before toxic chemicals or substances are used in a laboratory. The following checklist may be used to assist in developing a laboratory safety plan.

Name of responsible

- Code _____
- Directorate or Single Letter Office _____
- Project Supervisor _____
- Laboratory Supervisor _____
- Laboratory Employees _____, _____, _____,
_____, _____, _____, _____

Location of Laboratory _____

Permits needed such as for controlled drugs, radioisotopes, laser, confined space, etc.

_____, _____, _____,
_____, _____, _____

Hazard Analysis completed date ____/____/____
(See Section 7.0, Hazard Analyses & Laboratory Safety Plan, for requirements)

Name of substances to be used _____, _____
_____, _____, _____

General description of procedures and processes to be used, (Add an attachment if process so indicates.) _____

Written procedures for particular hazardous substances. (Add attachment if needed.) _____

Equipment needed (ventilation, ovens, refrigerators, flame generators, etc.)

Access control (warning signs, access badges, door locks, etc.)

Laboratory personnel training requirements

Emergency procedures for spills, releases, fire, emergency shutdown, etc. (Add an attachment if needed).

Inspection schedules

In-house _____
Safety Office _____
External agencies _____

Chemical inventory schedule _____

Document location:

Training records _____
Inspection records _____
Chemical inventories _____
Others (list) _____

Personal Protection Equipment needed

Waste disposal procedures (May require a separate document if process so indicates).

Waste permits required _____
Waste procedures to be used _____

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This page is for informational purposes and does not have to be retained with the document.

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