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Langley Research Center

POTENTIALLY HAZARDOUS MATERIALS-HAZARD COMMUNICATION STANDARD (revised 9/24/07))

National Aeronautics and Space Administration

PREFACE

P.1 PURPOSE

a. The purpose of this Langley Procedural Requirement (LPR) is to define organizational requirements, procedures for the safe use of potentially hazardous materials, and to facilitate compliance with regulations promulgated by the Occupational Safety and Health Administration (OSHA) and other consensus standards that may be appropriate at LaRC.

b. These procedural requirements implement the requirements of OSHA 29 CFR 1910.1200, "Hazard Communication" and 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories." It outlines the procedures to be followed to obtain and maintain information on potentially hazardous materials and the requirements for training employees on the use of this information.

c. Organizational responsibilities and administrative procedures for the acquisition and use of potentially hazardous materials are stated within this LPR, including the requirement that a permit system shall be used for dangerous potentially hazardous materials including carcinogens and highly toxic gases.

d. General and specific health and safety information for various classes of potentially hazardous materials is included in these procedural requirements, which is intended to be used as a general reference and is not intended to necessarily furnish all information required to plan and execute the safe operation for a given material. A list of sources of additional information is maintained by the Safety and Facility Assurance Branch (SFAB), Safety and Mission Assurance Office (SMAO).

e. The intent of this procedural requirement is not to address all procedures and laws pertaining to potentially hazardous materials, such as the Department of Transportation shipping regulations for potentially hazardous materials sent off LaRC. For technical assistance in this area, employees shall contact the LaRC Transportation Officer, Logistics Management Team (LMT), Center Operations Directorate (COD). Environmental laws and requirements concerning the manufacture, emission, and disposal of hazardous materials are not detailed in this LPR, but are presented in LPR 8800.1, "Environmental Program Manual." For technical assistance on environmental requirements contact the Environmental Management Team (EMT), COD.

P.2 APPLICABILITY

a. The provisions of this procedural requirement are applicable within the LaRC organizational elements to both NASA contractors, to the extent required by their contracts, and resident organizations directly concerned with the procurement, handling, use, storage, disposal, and inspection of potentially hazardous materials. The training of employees to meet the basic hazard communication and laboratory standard requirements shall be the responsibility of NASA for civil servant employees and the

contracting company for contractor employees. As a minimum, contractor requirements shall be in accordance with the LaRC requirements as described in these procedural requirements.

P.3 AUTHORITY

a. ANSI Z400.1, "Hazardous Industrial Chemicals - Material Safety Data Sheets - Preparation."
b. ANSI Standard Z87.1, "Practice for Occupational and Educational Eye and Face Protection."
c. Air Force Inter-service Manual 24-204, TM-38-250, NAVSUP PUB 505, MCO P4030.19H, DLA 414.3, Transportation, "Preparing Hazardous Materials for Military Air Shipments."
d. Code of Federal Regulations (CFR), Title 49, Subtitle B, Chapter 1, "Research and Special Programs Administration."
e. 49 CFR, Subtitle B, Chapter 1, Subchapter C, "Hazardous Materials Regulations," Parts 171-177.
f. 46 CFR, "Shipping."
g. Federal Supply Class (FSC), FED-STD-313C, "Material Safety Data Sheets."
h. National Fire Protection Association (NFPA) 30, "Flammable and Combustible Liquids Code."
i. NFPA 704, "Standard System for the Identification of Hazardous Materials for Emergency Response."
j. NFPA 77, "Recommended Practice on Static Electricity."
k. OSHA 29 CFR, Subpart I, 1910.132, "General Requirements."
l. OSHA 29 CFR 1910.1200, "Hazard Communication."
m. OSHA 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories," including Appendix B, "References (Non-Mandatory)."

P.4 REFERENCES

a. International Agency for Research on Cancer
b. Matheson Gas Data Book," "Handbook of Compressed Gas," "Encyclopedia of Chemical Technology."
c. National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards.
d. National Toxicology Program.
e. OSHA Form 174, "Material Safety Data Sheet."
f. LAPD 1150.2, "Councils, Boards, Panels, Committees, Teams, and Groups."
g. LAPD 1700.1, "Safety Program."
h. LAPD 1700.2, "Safety Assignments."
i. LPR 1710.4, "Personnel Protection - Clothing and Equipment."
j. LPR 1710.5, "Ionizing Radiation."
k. LPR 1710.7, "Use and Handling of Explosives and Pyrotechnics."
l. LPR 1740.6, "Personnel Safety Certification."
m. LPR 8800.1, "Environmental Program Manual."

n. Langley Management System (LMS) CP-4505, "Purchase Requisition (PR) Initiation/Modification/Cancellation and Supporting Documentation."
o. LMS-CP-4540, "Purchase Card."
p. LMS-CP-4703, "Review of Purchase Requisitions by the Safety and Mission Assurance Office (SMAO)."
q. LMS-CP-4759, "Acquisition of Hazardous Materials."
r. LMS-CP-4760, "Reporting Injuries, Illnesses, Compensation Claims and Unsafe Working Conditions."
s. National Science Foundation, Article 49, "Government Performance and Results Act."
t. NASA Langley Form 44, "Hazardous Material--Procurement, Inventory, and Storage Record."
u. NASA Langley Form 52, "Shipping/Transfer Document."
v. NASA Langley Form 62, “Chemical Worker's Certification Card."
w. NASA Langley Form 66, “Worker Appointment and Certification Form."
x. NASA Langley Form 118, "Safety Permit Request - Hazardous Material."
y. NASA Langley Form 163, "Waste Material Data Sheet."
z. NASA Langley Form 131, "Receipt and Inspection Report (Non-stocked Items)."
aa. NASA Langley Form 175, "Material Safety Data Sheet Review Request."
bb. NASA Langley Form 498, "Safety Permit."

P.5 CANCELLATION

LPR 1710.12 dated October 3, 2004.

Original signed on file

Lesa B. Roe
Director

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Chapter 1

INTRODUCTION

a. Potentially hazardous materials (PHM) are defined as any substance having intrinsic properties, which can pose a risk of injury or illness to personnel or of destruction to property. That is, any material which is a health or physical hazard. Specifically, provisions of these procedural requirements are applicable to materials having toxic, flammable, corrosive, cryogenic, or asphyxiation properties. Radioactive and explosive materials are not included as they are covered in LPR 1710.5, "Ionizing Radiation," and LPR 1710.7, "Use and Handling of Explosives and Pyrotechnics," respectively.

b. PHM includes those substances defined by the Occupational Safety and Health Administration (OSHA) as hazardous chemicals. The OSHA definition includes as hazardous chemicals those for which there is statistically significant evidence, based on at least one study, conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. OSHA includes in its definition hazardous chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. (Reference 29 CFR 1910.1450, Appendix B.)

1.1 DEFINITIONS AND TERMINOLOGY

Appendix E contains definitions and terminology used in these procedural requirements.

1.2 RECORDS

The following forms are completed when implementing requirements:

a. NASA Langley Form 44, "Hazardous Material--Procurement, Inventory, and Storage Record."
b. NASA Langley Form 52, "Shipping/Transfer Document."
c. NASA Langley Form 62, “Chemical Worker's Certification Card."
d. NASA Langley Form 66, “Worker Appointment and Certification Form."
e. NASA Langley Form 118, "Safety Permit Request - Hazardous Material."
f. NASA Langley Form 131, "Receipt and Inspection Report (Non-stocked Items)."
g. NASA Langley Form 163, "Waste Material Data Sheet."
h. NASA Langley Form 175, "Material Safety Data Sheet Review Request."
i. NASA Langley Form 498, "Safety Permit."

Chapter 2

RESPONSIBILITIES

2.1 POTENTIALLY HAZARDOUS MATERIALS COMMITTEE

a. The Potentially Hazardous Materials Committee (PHMC) is established under the authority of LAPD 1700.1, “Safety Program,” and LAPD 1150.2, "Councils, Boards, Panels, Committees, Teams, and Groups." Any member of this committee is authorized to investigate any questionable use of a PHM, act in the name of the Center Director to stop work or to prevent use of the material, which is considered unsafe, and initiate action to eliminate the unsafe condition. Such action shall be documented within 24 hours by formal letter to the Chairperson, PHMC. However, if line management is not in agreement with the corrective action recommended by the official who stopped the work, these reasons shall be submitted to the Chairperson, Executive Safety Council (ESC), who shall make an appropriate review. In these cases, work shall not resume without the approval of the Chairperson, ESC.

b. Due to the need for the PHMC to maintain an overview of operations at LaRC involving PHM’s, a review system has been established. This review system includes NASA Langley Form 498, "Safety Permit" which is described in Chapter 5 of this procedural requirement. NASA Langley Form 498s are required before operations commence.

c. The PHMC shall also overview the activities of the Explosives Support Engineer for control of pyrotechnic materials.

2.1.1 Structure and Organization

a. The PHMC functions as a committee of the ESC. Its position in the organization for control of PHM’s is shown in Figure 2.1. Committee members, including the Chairperson, shall be appointed by the ESC, by virtue of their technical and/or educational expertise in such areas as chemistry, hazardous gases, and compatibility of materials. Members are appointed to serve for a three-year term. During the first meeting of a new calendar year, the committee shall elect a committee secretary from its full membership. The committee secretary's responsibilities include preparing and distributing committee minutes in addition to all other functional responsibilities. Representatives of the SFAB, SMAO shall serve as members of the committee. Typically, this representation shall consist of the SFAB Industrial Hygiene (IH) staff and the LaRC Safety Manager or his/her designated representative.

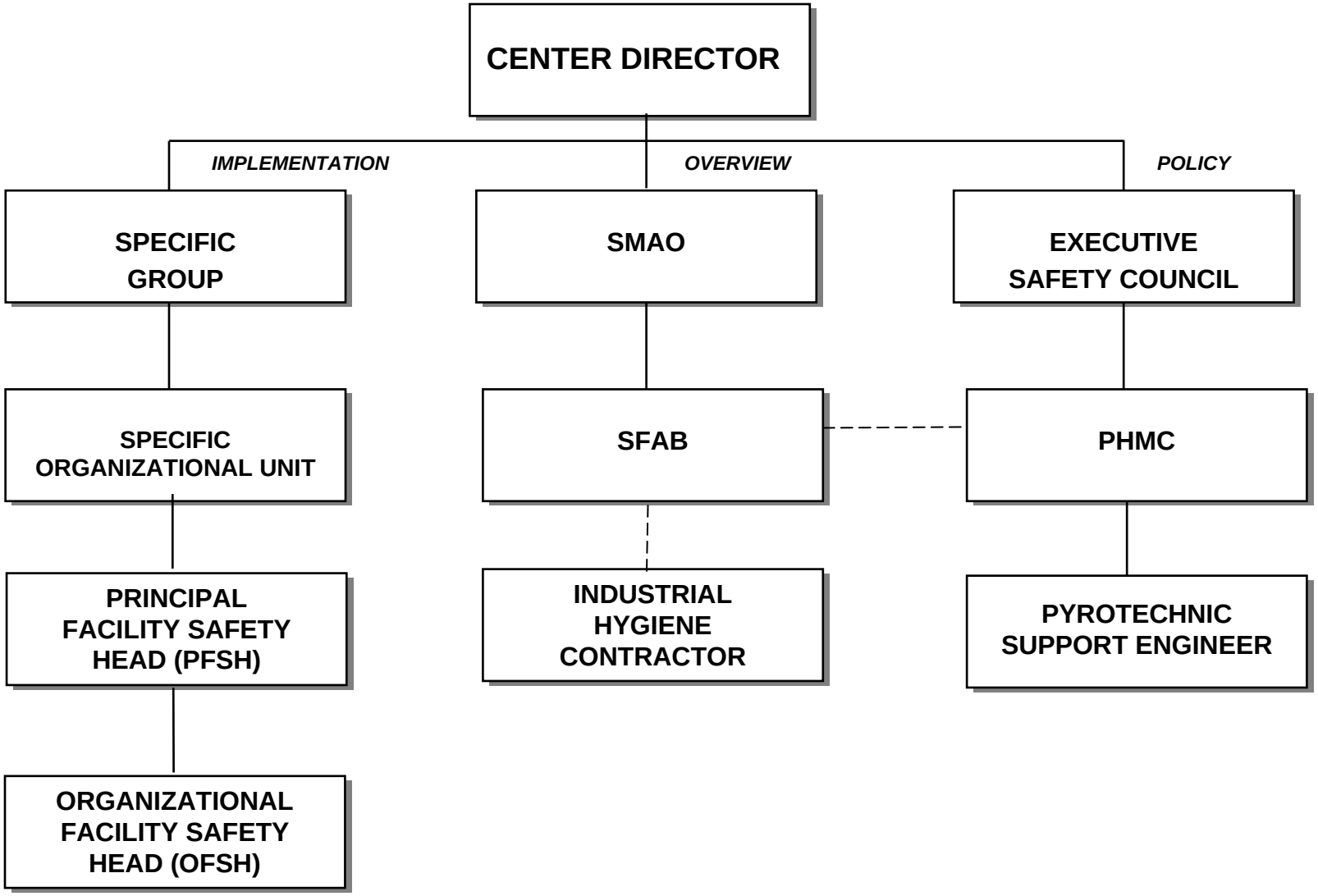


Figure 2.1, LaRC Organization for Control of Potentially Hazardous Materials.

2.1.2 Duties and Responsibilities

a. The duties and responsibilities of the committee are set forth in LAPD 1150.2. The committee functions as a review and guidance body providing recommendations in applicable areas as required. The committee shall:

(1) Prepare and distribute minutes of committee meetings, which shall contain, as a minimum, a record of persons present and a description of matters discussed and conclusions reached including the opinions of dissenting members, and copies of all reports issued or approved by the committee. Committee minutes shall be distributed to all members, the affected operations personnel, the Chairperson, ESC, and the Director, SMAO.
(2) Carry on official correspondence for the committee as needed.

b. Membership duties are:

(1) Be cognizant of matters pertaining to use of PHM's at LaRC. This is chiefly, but not entirely, achieved by attending the committee meetings and participating in the decisions made by the committee.
(2) Serve on ad hoc committees, which are appointed by the Chairperson as needed.

2.2 SAFETY AND HEALTH FUNCTIONS

a. The primary responsibility for the safe use of PHM's lies with the individual user. Although this responsibility cannot be delegated, various LaRC functions provide planning, management, and assistance.

2.2.1 Facility Safety Head (FSH)/Chemical Hygiene Officer (CHO)

a. The prime responsibilities of the Facility Safety Head (FSH) are the safe operation of the research apparatus and maintenance of a safe working environment. The scope of this responsibility encompasses such elements as the establishment and use of normal and emergency operating procedures, configuration control, safety training, preventative maintenance, and the other traditional institutional types of safety considerations.

b. The FSH may appoint an Organizational Facility Safety Head (OFSH) for each operation that is functionally distinct. Procedures for appointments are provided in LAPD 1700.2, "Safety Assignments." The FSH or OFSH shall, in each case, be a representative of line management who is thoroughly familiar with the operation.

c. FSH's and/or OFSH's shall be familiar with any NASA Langley Form 498s issued for their facilities. For laboratories operating under a Chemical Hygiene Plan (CHP), the FSH shall be the Chemical Hygiene Officer (CHO). The CHO is an employee who is

qualified by training or experience to provide technical guidance in the development and implementation of the provisions of the CHP and applicable NASA Langley Form 498s.

2.2.1.1 Interfaces

a. The FSH or OFSH of the facility where the PHM is to be used shall be the first point of contact for the individual who has the need for the procurement, use, storage, or disposal of a PHM. The first point of contact for the FSH or OFSH for assistance with use of PHM's shall be the SFAB Industrial Hygiene (IH) staff.

2.2.1.2 Responsibilities

a. The basic responsibilities of the FSH or OFSH are described in LAPD 1700.2. The FSH or OFSH shall implement these requirements for the safe use of PHM's:

(1) Establish and review normal and emergency operating procedures. These procedures shall include cleanup of Class I ("Integrated Spill Contingency Plan") spills by facility personnel (normally, the using agency). Class II ("Integrated Spill Contingency Plan") spill assistance shall be sought from the LaRC Safety Manager (Chapter 2.2.4). All spills shall be reported to the LaRC Safety Manager.

(2) Supervise and coordinate the procurement, use, storage, and disposal of PHM's. Requirements for the initial identification and procurement of hazardous materials as contained in this chapter of this procedural requirement. Disposal is covered in detail in LPR 8800.1 and is mentioned in Chapter 6 of these procedural requirements.

(3) Maintain an inventory of hazardous materials using the Center's web-based Chemical Material Tracking System (CMTS). Specific requirements are covered in LPR 8800.1, Chapter 19.

(4) Maintain a file of Material Safety Data Sheets (MSDS's), (see Chapter 4) of all PHM's used in the facility. This MSDS file shall be one central file, (several small files in separate work areas in a large facility is permitted). The FSH shall determine the appropriate file location(s). Requirements for these files are as follows:

(a). These files shall include all appropriate MSDS's. For example, several containers of 100 percent acetone (even if from multiple vendors) need only one MSDS since acetones chemical makeup does not vary. However, files for the generic class "cleaning solvent" or class "black enamel paint, spray, 16 ounce," may contain several MSDS's for each of these items because several vendors may have supplied similar materials. The MSDS may vary from vendor to vendor since the chemicals, and hazards, will differ. **A MSDS IS REQUIRED FOR EACH POTENTIALLY HAZARDOUS CHEMICAL PRESENT.** This MSDS requirement includes "free" vendor samples as well as LaRC research and development test chemicals in use outside of their manufacturing location (e.g., laboratory hood, batch processor).

(b). The MSDS file(s) shall be accessible to all employees working in the facility and its location(s) shall be made known.
(c). Exceptions exist for the maintenance of MSDS files under the chemical laboratory standard. Laboratories operating under a NASA Langley Form 498 shall maintain documentation on basic hazardous materials produced. The chemical laboratory safety program relies on process control through procedures, rather than identification of all hazardous components.
(d). Hazardous materials including research and development chemicals produced for processing or evaluation in facilities other than the point of manufacture shall have a MSDS completed, with one copy being forwarded for hazard review to the SFAB IH staff for PHMC and SFAB, SMAO review (See Chapter 4).

(5) Ensure that all employees who routinely work in the facility are aware of the physical or chemical hazards of the materials they routinely work with, and other hazardous materials in the facility that they may encounter in any foreseeable emergency. For facilities with highly toxic substances in use or in storage, visitors shall be apprised of special facility emergency procedures in the event of leaks or spills. For example, if warning lights are used to indicate hazardous conditions, visitors (including other on-site LaRC personnel who may periodically enter the facility) shall be informed of the meaning of the warning light and appropriate actions. Warning lights, bells, and so forth, shall include signs indicating the purpose of the alarm (e.g., "Fluorine Gas Alarm").
(6) Provide or acquire periodic refresher training for workers whenever significant changes occur for chemicals in use in the facility.
(7) Maintain a current list of employees in the organization who are trained and certified to use materials under NASA Langley Form 498 (Chapter 5).
(8) Ensure capabilities and procedures exist in the facility for cleanup of Class I spills of hazardous materials. Seek the assistance of the EMT and the LaRC Safety Manager's staff for containment and cleanup assistance of Class II spills involving hazardous materials.
(9) Accompany SFAB, SMAO, personnel and representatives during all surveys and audits of the organization.

2.2.2 Facility Coordinator (FC)

a. In the absence of the FSH, the Facility Coordinator (FC) shall accompany SFAB, SMAO personnel during surveys and audits of the organization.

2.2.3 SFAB Industrial Hygiene Staff

a. The SFAB IH staff has specific interfaces and responsibilities with regard to PHM’s. The SFAB IH staff shall be comprised of individuals who are Certified Industrial Hygienists by the American Board of Industrial Hygiene.

2.2.3.1 Interfaces

a. The SFAB IH staff reports directly to the LaRC Safety Manager and serves on the PHMC. The SFAB IH staff shall be the primary committee contact for on-site users of PHM's.

2.2.3.2 Responsibilities

a. The SFAB IH staff responsibilities are to:

(1) Provide technical and administrative guidance to LaRC personnel for the safe use of PHM's where such material may pose a health hazard. Assist personnel in the interpretation of MSDS technical data.
(2) Provide monitoring services to document personnel exposures. Results of these surveys shall be provided to the individual (or to the facility for posting) within 15 business days of receipt of results of laboratory analysis.
(3) Perform pre-operational surveys to identify potential health hazards and recommend control procedures. This shall include assisting in the determination of industrial ventilation to control health hazards.
(4) Perform periodic inspections to assure the effectiveness of control procedures and identify the need for a NASA Langley Form 498. Ventilation systems (fume hoods and paint booths) used to control health hazards shall be surveyed annually. Audit all NASA Langley Form 498s at least annually for compliance and report results to the PHMC.
(5) Provide training and indoctrination of personnel in health hazard control measures such as personal protective equipment (e.g., respirators, gloves).
(6) Review PHM purchase requests for compatibility with approved policies and procedures and to help identify changes in use, which may require new or additional health hazard control measures.
(7) Advise the LaRC Safety Manager of non-health related hazards associated with the use of PHM's.
(8) Advise the PHMC, the Occupational Health Services (OHS), and SFAB, SMAO of developments in statutory requirements and standards of good practice for the control of PHM's where such materials may pose health hazards.
(9) Supply MSDS's, to NASA Langley Form 44 Coordinator, from MSDS databases or assist in the acquisition and technical interpretation of proprietary or trade secret MSDS information.

2.2.4 LaRC Safety Manager (Head, SFAB, SMAO)

a. The LaRC Safety Manager has specific interfaces and responsibilities with regard to PHM's.

2.2.4.1 Interfaces

a. The LaRC Safety Manager shall:

(1) Report directly to the Director, SMAO
(2) Serve on the PHMC as a member (or assign a designee)

(3) Be the principal LaRC contact with federal safety and health regulatory agencies.

2.2.4.2 Responsibilities

a. The responsibilities of the LaRC Safety Manager are described in LAPD 1700.2, Safety Assignments." The LaRC Safety Manager's responsibilities for the safe use of PHM's are to:

(1) Provide technical and administrative guidance for the safe storage and use of PHM's where such material poses hazards not primarily health related.
(2) Ensure the SFAB IH staff conducts pre-operational reviews of new PHM activities to identify hazards and their control procedures.
(3) Use annual facility safety and health audits to assure the effectiveness of the NASA Langley Form 498 control measures.
(4) Review training data and/or provide training and indoctrination of personnel through the SFAB IH staff, as needed, to assure understanding of the LaRC hazard communication requirements.
(5) Serve as the final reviewing and/or certifying authority for the following:
  (a). NASA Langley Form 66, "Worker Appointment and Certification Form" (Chapter 5).
  (b). NASA Langley Form 44, "Hazardous Material--Procurement, Inventory, and Storage Record" (Chapter 3).
  (c). NASA Langley Form 498, "Safety Permit".
(6) Provide assistance to facility personnel in Class II spills control (Class II spills are environmentally reportable) through the use of supplies and manpower available on-site or through prior planning and arrangements by SFAB, SMAO with off-site response teams. These activities are outlined in "Integrated Spill Contingency Plan," and LPR 8800.1, "Environmental Program Manual."

2.2.5 LaRC Safety Manager Designated Representative, SFAB, SMAO

a. In the absence of the LaRC Safety Manager in matters regarding PHM's, full signature authority shall be granted to the LaRC Safety Manager's designated representative.

2.2.6 Occupational Health Services

a. The Office of Human Capital Management (OHCM) through the Occupational Health Officer (OHO) and the Occupational Health Services (OHS) contractor shall be the primary contact for LaRC employees for matters relating to occupational health. Responsibilities are described in LAPD 1700.2. The Director, OHCM shall implement these responsibilities for the safe use of PHM's:

(1) Recommend and implement medical surveillance of users of PHM's.
(2) Maintain appropriate records of such surveillance.
(3) Serve as a qualifying official on NASA Langley Form 66.

(4) Stay alert for adverse health incidents, such as possible chemical related contact dermatitis, involving PHM's.

2.2.7 Logistics Management Team, Capital Assets Management

a. The Capital Assets Management (CAM) shall ensure Logistics Management Team (LMT):

(1) Maintain a file of MSDS's for all materials available through the stores stock, and provide a copy of the MSDS to users upon chemical issue.
(2) Transmit to users a copy of the MSDS provided by suppliers for materials obtained by Purchase Request.
(3) Attach NFPA 704A labels to items issued from supply.
(4) Only issue store stock items that have an approved Langley Form 44.

2.2.8 Employee Responsibilities

a. Employees shall:

(1) Participate in training. The OHCM shall incorporate basic hazard communication training information into its NASA LaRC employee indoctrination program.
(2) Review MSDS's prior to using PHM's. New MSDS's on existing materials from vendors shall be changed when the ingredients are changed or technical information is changed. New MSDS's shall be reviewed when received.
(3) Not cover or mark any warning labels used on containers or products received or in use. For transfers to other containers, place labels or legibly mark the containers with the LaRC warning label and the name of the PHM. (NOTE: This marking is not required if the transfer container is used immediately [usually within a few minutes] in the process.)

2.3 OFF STANDARD HOURS LABORATORY WORK

a. Standard-shift working hours for laboratory areas are permitted between 6:00 am and 6:00 pm, Monday through Friday, excluding holidays. During standard hours, employees shall not be alone when conducting their work; laboratory procedures performed outside of the standard shift are affected by the following requirements:

(1) Routine laboratory operations are permitted during off standard working hours if the "buddy system" is used. The "buddy system" requires having a designated, qualified LaRC employee or "buddy" present in the area that will remain in the same laboratory/room as the employee performing the laboratory operation. The FSH or Branch Head shall maintain a list of qualified persons who may act as a "buddy." Examples of routine laboratory operations include wet chemistry, film casting, composite preparations, hydraulic systems, any machinery or shop equipment, and permitted operations. Questions concerning whether an operation requires use of the "buddy system" shall be referred to the FSH.

(2) Non-hazardous laboratory operations not requiring the “buddy system” during off standard hours shall be limited to non-invasive type tasks such as making visual checks of experimental apparatus, turning instruments or controls on or off, and data recording. Characterization experiments also shall be performed if the procedure does not involve the handling of hazardous materials (e.g., liquid nitrogen).

(3) All office work is permitted during off standard hours and shall not require using the “buddy system.” Employees performing office work during off standard working hours are reminded to adhere to the Center’s security and safety procedures.

(4) Non-emergency assistance during off standard working hours shall be obtained by calling the Duty Officer at 864-4927. Medical and fire emergency assistance may be obtained by calling 911 from any Center phone or 864-2222 from a cellular phone.

Chapter 3

ACQUISITION, RECEIPT, HANDLING, STORAGE, MARKING, PRESERVATION AND DELIVERY OF POTENTIALLY HAZARDOUS MATERIAL

a. This chapter describes the procedural requirements for the procurement, acquisition, and on site transfer of PHM's and MSDS's. PHM may be brought on site and stored or used in facilities after approval of the Langley Form 44. Procedures for the shipment of PHM's off-site are briefly outlined in Chapter 6 of this procedural requirement. Requirements for the storage of PHM's at LaRC are also briefly outlined in Chapter 6.

3.1 ACQUISITION AND TRANSFER OF POTENTIALLY HAZARDOUS MATERIAL

a. Refer to Langley Management System (LMS) Center Procedures (CP) 4505, "Purchase Requisition (PR) Initiation/Modification/Cancellation and Supporting Documentation," LMS-CP-4540, "Purchase Card," LMS-CP-4703, "Review of Purchase Requisitions by the Safety and Mission Assurance Office (SMAO)," and LMS-CP-4759, "Acquisition of Hazardous Materials." These CP's shall be followed for all PHM's brought on-site including purchasing from commercial sources, through contractor sources, research and development engineering samples, and commercial product samples. All PHM's brought on-site shall have an MSDS.

b. The use of facility maintenance PHM's (e.g., solvent, paints, hydraulic fluids) and cleaning supplies are normally done by on-site contractors. Electronic NASA Langley Form 44s and MSDS's shall not be required for the transfer of maintenance or custodial PHM's between the operating site MSDS file and files at individual job sites. These support contractors shall provide appropriate PHM MSDS's for material in use or stored in the facility to FSH's or their representatives.

3.2 IDENTIFICATION OF HAZARDOUS ITEMS BY FEDERAL SUPPLY CLASS

a. Federal Supply Class (FSC), FED-STD-313C, "Material Safety Data Sheets," contains lists identifying hazardous items. Any FSC item could contain a PHM. The listings in Tables I and II of FED-STD-313C are not intended to be inclusive listings of all hazardous items, but to identify the major classes, which contain PHM's and provide examples of hazardous items in other classes. Contact the SFAH IH staff to obtain the most recent version of these Tables.

b. MSDS's shall be submitted for all items in the FSC-STD-313C, Table I. MSDS's shall be submitted for the PHM's in FSC-STD-313C not listed in Table I. Some examples of PHM's in other FSC are listed in Table II of FSC-STD-313C.

3.3 PROCEDURE FOR ACQUISITION, RECEIPT, STORAGE, ISSUE AND DISPOSAL OF HAZARDOUS MATERIALS

3.3.1 Acquisition

a. The following procedures shall be used for the acquisition of PHM's. The process for purchasing hazardous material is described within this chapter.

3.3.1.1 NASA Purchase Requisition and SAP

a. Reference LMS-CP-4505, "Purchase Requisition (PR) Initiation/Modification/Cancellation and Supporting Documentation."

3.3.1.2 Material Handling

a. Reference LMS-CP-4759, "Acquisition of Hazardous Materials."

3.3.1.3 NASA Procurement Card Order

a. Reference LMS-CP-4540, "Purchase Card."

3.3.1.4 Contractor Purchase

a. Contractor order, procurement, handling, and disposal of PHM's shall be done in accordance with the Statement of Work (SOW) and the terms/conditions of the contract. Requirements in this section shall still be adhered to.

3.3.1.5 Free Engineering Samples

a. Many companies will send free samples of materials they normally only sell in bulk quantities. Use this method if the user needs only a small amount of material to test for an application and the supplier is willing to send a free sample. NASA Langley Form 44 and a MSDS shall be used for this transaction. Be sure to indicate in the obtained by box of the NASA Langley Form 44 that the material is a free sample. Provide the vendor with an accurate delivery location within your facility, which shall not include office areas. Receipt of free engineering samples shall be conducted by Receiving or by the individual, depending on where the item was sent. Notify the FSH (or designated Hazardous Material Inventory Manager) when the item is received so it can be added to the facility chemical inventory. For more information contact the SFAB IH staff.

3.3.2 Transfer of Hazardous Materials Between NASA Langley Research Center Facilities

a. Reference LMS-CP-4759, "Acquisition of Hazardous Materials."

3.3.2.1 Shipping Hazardous Materials to an Off-Site Location

a. When a hazardous material must be shipped to an off-site location, use NASA Langley Form 52, "Shipping/Transfer Document", a NASA Langley Form 44, and a MSDS. If the item is research material, a MSDS shall be prepared prior to delivery of the material to the Shipping Office (Chapter 4). For more information contact the Shipping Office or the CMTS Administrator.

3.3.2.2 Transfer of Hazardous Materials to and From an Off-site Location

a. Personally transporting PHM’s to an outside source shall not be permitted. If at all possible these products shall be shipped off-site. Personally transporting PHM’s from an outside source shall also not be permitted. If at all possible, these products shall be shipped.

Chapter 4

MATERIAL SAFETY DATA SHEETS

a. This chapter contains information for technical assistance in the preparation of MSDS's. The format presented meets basic OSHA requirements and is in accordance with ANSI Z400.1, "Hazardous Industrial Chemicals - Material Safety Data Sheets - Preparation" requirements. Different countries may have additional technical or procedural requirements for this type of information. All LaRC created MSDS's shall be entered in the CMTS. LaRC created MSDS's should be sent to CMTS administrator at cmts@larc.nasa.gov.

b. MSDS's are required for all PHM's. A copy of the MSDS for each PHM used in facility research or maintenance operations shall be readily accessible to employees in that facility. The location and set up of MSDS files shall be the responsibility of FSH's. PHM's include metals, solvents, paints and fiberglass. Review Paragraph 4.3 of this section of "Material Safety Data Sheets," for additional information on which materials require MSDS's.

c. MSDS recordkeeping of facility cleaning and maintenance PHM (including solvents, paints, and hydraulic fluids) is normally done by on-site contractors. These contractor operations can maintain either a central operating site MSDS file or files at individual job sites. These support contractors shall provide appropriate PHM MSDS's for materials in use or stored in the facility to FSH's or their representative, if requested.

d. For PHM requested by the facility from LaRC supply stock, MSDS information shall be maintained and forwarded by supply personnel when requested by the facility. NASA Langley Form 44, "Hazardous Material--Procurement, Inventory, and Storage Record." shall be noted in the supply catalog when required.

e. Trade secret and proprietary MSDS's exist and their access and distribution is limited (under OSHA regulations) to medical and other selected personnel. In these situations, the SFAB IH staff shall be contacted to acquire the necessary information to assist in working with authorized personnel to determine safe use of the materials planned for use. MSDS's so acquired shall be maintained by the SFAB IH staff.

4.1 PREPARATION OF MSDS FOR CENTER-DEVELOPED MATERIALS

a. MSDS's shall be prepared to provide basic hazard warning information for PHM's being transferred between facilities or as operations are scaled up for testing in facilities. MSDS's shall be required by off-site facilities using the material in other applications. These MSDS's shall be shipped with the material.

b. All MSDS's prepared shall be reviewed by the SFAB IH staff, LaRC Safety Manager, and the PHMC. MSDS's shall be forwarded to the LaRC Safety Manager to start this process.

c. Copies of the reviewed MSDS's shall be maintained by the LaRC Safety Manager's staff. The 24 hour emergency point of contact required by OSHA shall be the Emergency Dispatch Officer at the Fire Department. The Fire Department provides a telephone service only and shall forward emergency calls to the technical researcher/expert on the item.

4.2 NASA LaRC MSDS LIBRARY

a. The EMT shall maintain an electronic library of MSDS's for all known PHM's at the Center through the CMTS. Information from MSDS's along with inventory information collected in the CMTS shall be used to perform calculations for regulatory reports. These reports shall be submitted to federal, state, and local agencies to keep the Center in compliance with environmental as well as health and safety regulations and permits. The procedures for accessing, searching, and adding MSDS's to the MSDS Library are described herein.

4.2.1 Accessing and Searching the Library

a. The Library can be accessed by anyone at the Center on-line at the following address:

http://osemant1.larc.nasa.gov/cmts/

Instructions on how to use the Library are on-line or you may contact the CMTS Administrator at the following e-mail address:

cmts@larc.nasa.gov

The Library is not meant to be a replacement for the Center's MSDS's book, but rather a supplement.

4.2.2 Adding MSDS's to the Library

a. LaRC continues to purchase new items to accomplish its research mission. In order to keep the Center's MSDS Library up-to-date, Center personnel shall ensure that MSDS's for new materials are submitted to EMT for entry.

b. A MSDS shall be submitted for entry to the MSDS Library one of the following ways:

(1) Mail a copy of the MSDS to the CMTS Administrator at MS 320.
(2) E-mail an electronic copy of the MSDS to the CMTS Administrator at:

cmts@larc.nasa.gov.

4.3 SCOPE AND APPLICATION

a. 29 CFR 1910.1200, "Hazard Communication Standard" defines the requirements by which MSDS's shall be prepared for chemicals or mixtures of chemicals that are hazardous. The procedural requirement at NASA LaRC is to prepare MSDS's for all hazardous materials and chemicals, resins, adhesives, powders, fibers, prepreg, towpreg, abrasive materials, ceramic powders, metal alloys, foams, colloids, solutions, oils and lubricants, and gases produced by NASA or on-site contract employees. MSDS's shall be required to transfer materials from the area of origin, or to be shipped off-site.

b. Preparation of a MSDS shall require specific information on the ingredients of a newly developed material. If the researcher or engineer has new, useful or unusual intellectual property, and is uncomfortable about disclosure of such information, they shall seek patent protection for their product. Because review of a MSDS will take approximately 30 days, it is necessary for researchers and engineers to anticipate the need for MSDS's prior to shipment of their product off-site. MSDS's shall be prepared in advance for materials that may be needed for technology transfer operations.

c. This chapter shall be used by persons responsible for developing MSDS's for chemicals produced at NASA-LaRC. This step-by-step procedural requirement shall aid in the preparation of MSDS's for materials that are invented on-site. Because the information included in a MSDS is from many diverse areas, a team approach shall be used to produce the MSDS, with researchers and engineers collaborating with IH's, occupational physicians, environmental and fire safety engineers, and the shipping officials who have regulatory knowledge in their appropriate fields. The originator (or responsible researcher) of the material shall have primary responsibility for the production and review of the MSDS with contributions made from a number of different individuals. When the final document is completed, a NASA Langley Form 175, "Material Safety Data Sheet Review Request" shall be attached to the document and sent for approval to the Chairperson of the PHMC.

d. A MSDS template has been developed to standardize the MSDS's being produced at LaRC. The specific sections of the MSDS are detailed below. Unknown or unavailable information or data shall be indicated as such. Information in this document has been taken from ANSI Z400.1 and many of the terms and acronyms used here are found in the glossary of that document. The full document contains many useful examples of phrases that may be used in the sections below.

4.4 DETAILED TEMPLATE DESCRIPTIONS

a. Detailed descriptions of each section of the LaRC MSDS template are:

4.4.1 CENTER IDENTIFICATION

a. This information shall be provided by the originator or responsible researcher or engineer who developed the material. This section identifies the specific source of the material at LaRC, identifies a 24-hour contact for emergency information and identifies a technical information contact. If the MSDS is intended for foreign distribution, an indication that the telephone numbers are United States telephone numbers shall be included.

b. The format used on the LaRC MSDS template is as follows:

NASA Langley Research Center
_____ Branch or Organizational Unit
Mail Stop _____, _____
Hampton, VA 23681-2199
Emergency Telephone: (___) ___-____ (24-hr contact)
Information Telephone: Area code and telephone number of the responsible researcher of the material (Monday-Friday, 9:00 AM to 3:99 PM EST)

4.4.2 SECTION 1: MATERIAL IDENTIFICATION

a. This information shall be provided by the responsible researcher of the material. This section links the MSDS's to the specific material by listing the trade name, as it appears on the label and a specific product code reference, for example a notebook number, work order number, batch or run number which can be used to provide more specific information on the materials. Synonyms or alternate names shall also be included here, although the trade name shall always be the name listed on the product label.

b. The format used on the LaRC MSDS template is as follows:

Trade Name:
Product Code:

4.4.3 SECTION 2: COMPOSITION

a. The information on components, Chemical Abstract Service (CAS) Number, and weight percent shall be provided by the responsible researcher of the material. Exposure limit information shall be provided by the SFAB IH staff. This section lists the OSHA hazardous components (as defined in OSHA 29 CFR 1910.1200(g) Appendix A). All ingredients that contribute to the hazards of the material or which otherwise meet the OSHA 29 CFR 1910.1200 criteria shall be identified. If this compound is formed from the chemical reaction of more than one chemical, these ingredients only need to be listed if they are present in the final product in quantities greater than 1percent (0.1 percent for carcinogens).

b. The format used on the NASA LaRC MSDS template is as follows:

			EXPOSURE LIMITS		
COMPONENT	CAS #	WT %	OSHA PEL	ACGIH TLV	OTHER LIMITS

4.4.4 SECTION 3: HAZARDS IDENTIFICATION/POTENTIAL HEALTH EFFECTS

a. This section provides information from the SFAB IH staff and the responsible researcher on the potential adverse human health effects and symptoms that might result from reasonably foreseeable use or misuse. The format used on the LaRC MSDS template is as follows:

Emergency Overview:	List the most significant concerns for emergency response personnel. It is listed first in this section, so that it will be easy to find.
Route(s) of Entry:	List the probable routes of entry. Include as applicable: inhalation, absorption through the skin and eyes, and accidental ingestion.
Signs And Symptoms of Overexposure:	List any known signs or symptoms of overexposure to materials or components.
Immediate or Acute Effects:	List effects that will appear a short time after a single exposure.
Long Term or Chronic Effects:	List effects of product or of any hazardous components that may occur over persistent, prolonged or repeated exposure. Target organ information may also be included here.
Carcinogenicity:	Products or components of products, which are listed as carcinogens or potential carcinogens by OSHA, IARC, NTP or NIOSH, shall be specified here. This information is required for components in quantities $\geq$ 0.1percent. Specify the source of information and class of carcinogen if available.
Reproductive Hazards:	Products or components of products, which are, listed as reproductive hazards or potential reproductive hazards by REPROTEXT, TERIS, REPROTOX or Shepard's Catalog of Teratogenic Effects shall be specified here. Specify source of information and what type of hazard is shown.

4.4.5 SECTION 4: FIRST AID MEASURES

a. This information is provided by the OHCM OHS contractor physician. It shall provide instructions to be taken if accidental exposure requires immediate treatment. It may also include special instructions to medical personnel. This section shall provide information for each applicable route of entry, in lay language, when the results of

exposure require immediate treatment (first aid) and when simple measures may be taken before professional medical assistance is available. Include simple remedial measures such as washing exposed area, removing clothing, or removing exposed individuals from the area of exposure if it will lessen the exposure. Also include information on first aid for a specific method of handling as opposed to the toxicity of the material, for example, frostbite from cryogenic liquids. Include any known antidotes that may be administered by a layperson. Indicate whether immediate medical attention is required and if delayed effects can be expected after exposure.

b. The format used on the LaRC MSDS template is as follows:

Eyes:
Skin:
Inhalation:
Ingestion:
Medical Conditions Aggravated by Exposure:

4.4.6 SECTION 5: FIRE FIGHTING MEASURES

a. This section shall provide basic fire-fighting requirements, including appropriate extinguishing media. It also describes other fire and explosive properties useful for fighting fires involving the material, such as flash point and explosive limits. This information shall be provided by the SFAB, SMAO Fire Protection Engineer. The responsible researcher shall provide known or anticipated hazardous products of combustion. The format used on the LaRC MSDS template is as follows:

Flashpoint, º F:	List the flashpoint of the material as tested by open or closed cup methods. If the product as a whole has not been tested, state this and list the component with the lowest flash point in the material.
Method Used:	List the flashpoint test used.
Auto ignition Temperature, º F:	List the temperature at which a flammable gas or vapor/air mixture will ignite without necessity of a spark or flame.
Flammable or Combustible Classification (NFPA 30):	Calculate the class of flammable or combustible liquid using the flashpoint and boiling point of the material. These classifications may be found in NFPA 30, "Flammable and Combustible Liquids Code" and 29 CFR 1910.1200. If the item is a flammable solid or gas, state this here.
Explosive Limits Upper/Lower (UEL/LEL):	List UEL's and Ells for the product if available, or for its components.
Extinguishing Media:	List extinguishing media here. The logic shall be similar to that found in the latest edition of the NFPA 704, "Stand System for the Identification of Hazardous Materials for Emergency Response."

Known or Anticipated Hazardous Products of Combustion:	The responsible researcher shall provide this information.
Fire Fighting Instructions:	Instructions shall be directed at protecting lives of those in the fire area (including firefighters), and noting unusual impact on the environment and minimizing property loss. Special environmental warnings, such as toxicity of firewater runoff, shall be made.
Unusual Fire And Explosion Hazards:	List known or anticipated hazards of flammable and nonflammable materials that initiate or uniquely contribute to the intensity of a fire, such as strong oxidizers (providing fuel), any pyrophoric materials or reaction products, or materials that may form organic peroxides that may be shock or temperature sensitive. Also list the potential for dust explosions, any reactions (with metals for example) which produce flammable gases or vapors, and reactions or conditions with a potential for release of flammable vapors that could cause flash back. Reactivity hazards that enhance the fire and explosion potential shall be listed in this section. Dangerous or explosive reactions with specific chemicals shall be covered in Section 10: Stability and Reactivity.

4.4.6 SECTION 6: ACCIDENTAL RELEASE MEASURES

a. This section describes actions to be taken to minimize the adverse effects of an accidental spill, leak or release of the material. This information shall be provided by the EMT Environmental Engineer. The responsible researcher shall suggest a neutralizing agent, if known, based on the chemical properties of the material. The format used on the LaRC MSDS template is as follows:

If Material Spills or Leaks:	Include information on containment techniques, cleanup procedures, equipment and other emergency advice relating to spills and releases. There may be specific reporting requirements to reference information in this section or in Section 15: Regulatory Information.
Neutralizing Agent:	This shall be provided by the responsible researcher based on the chemical properties of the material. The EMT Environmental Engineer shall assure that the neutralizing agent will not create a greater hazard than the material.

4.4.7 SECTION 7: STORAGE AND HANDLING

a. This information shall be provided by the responsible researcher of the material. It provides information on appropriate practices for safe handling and storage. This

section shall be reviewed by the SFAB IH staff. The format used on the LaRC MSDS template is as follows:

Storage Precautions:	Emphasize precautions relating to the unique properties of the material. List storage practices that minimize risks from fire for flammable and combustible materials or dangerous reactions with incompatible materials and that minimize the release to the environment. Note or reference specific federal regulatory requirements on the safe storage requirements for the material. Storage temperatures and light conditions shall be listed to extend the life of the material. List hazards of materials that form reactive organic peroxides with time and exposure to air. Hygroscopic materials and specified shelf life shall also be indicated here.
Handling Precautions:	List handling practices that minimize contact between the worker and the material, minimize risks from fire for flammable and combustibles or dangerous reactions with incompatible materials that could cause harm to the worker. Include handling practices such as how to prevent vapor release, the need for a totally enclosed system and safe practices for unloading and moving the material. Include statements about the use of non-sparking tools, explosion proof equipment and grounding when handling flammable materials. List practices that shall be followed to prevent dangerous reactions, such as inert blanketing, avoiding oil in equipment used with strong oxidizers, or careful opening of containers that may be under pressure. Include precautions for handling cryogenic or hot materials.
Repair and Maintenance Precautions:	This section shall be used to anticipate the material's use in structural systems, such as using composite materials to fabricate aircraft. Anticipated hazards from dust generated by grinding and drilling, welding fumes generated, or exposure to maintenance personnel shall be listed.

4.4.8 SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

a. This information shall be provided by the SFAB IH staff. It provides information on practices and/or equipment to minimize worker exposure. It also provides guidance on selection of personal protective equipment. The format used on the LaRC MSDS template is as follows:

Eye Protection:	Recommend eye and face protection based on the properties of the materials. For example, corrosive materials shall require protective goggles and a face shield.
Skin Protection:	Recommend protective clothing and gloves of the best barrier material to prevent skin absorption of the material.

Respiratory Protection:	Identify different types of respiratory protection anticipated for different conditions and exposure ranges. If air-purifying respirators are used, the proper cartridge or canister shall be specified. If an air-purifying respirator is not adequate protection, a pressure-demand, air-supplied respirator shall be specified.
Engineering Controls:	This section discusses engineering controls required to help minimize chemical or physical hazards and to control exposures during it's anticipated use.
Other Protective Measures:	As stated.

4.4.9 SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

a. This information shall be provided by the responsible researcher. This section provides additional data that can be used to help characterize the material and design safe work practices. Any other properties of the material that have been measured shall also be included here. The following characteristics shall appear in this section. Clearly identify if specific characteristics do not apply (NA) or for which data are not available. The format used on the NASA LaRC MSDS template is as follows:

Appearance:
Odor:
Physical State:
pH:
Vapor Pressure, mmHg:
Vapor Density, air = 1:
Boiling Point, º F:
Freezing/Melting Point (specify which), º F:
Specific Gravity:
Solubility in Water:

Other characteristics, which may apply only to certain materials, shall be included if known:

Specific heat:
Particle size, microns:
Softening point, º F:
Evaporation rate, g/min:
Viscosity, dL/g or poise:
Bulk density, g/cm^3:
Octanol/water partition coefficient:
Saturated vapor concentration:
Molecular weight, g/mol:
Molecular formula:
Fiber area weight, g/m^2:
Tg, º C:

Corrosion rate:
Decomposition temperature:
Volatile organic content (VOC), g/L (TEST METHOD):

4.4.10 SECTION 10: STABILITY AND REACTIVITY

a. This information shall be provided by the responsible researcher based on the material's chemical properties. This section describes the conditions to be avoided or other materials that may cause a reaction, which would change the intrinsic stability of the material. The format used on the LaRC MSDS template is as follows:

Stability:	Indicate if the material is stable or dangerously unstable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Hazardous Polymerization:	State if the material will polymerize releasing excess pressure, heat, or creating other hazardous conditions. State under what conditions the hazardous polymerization could occur.
Conditions To Avoid:	List conditions such as heat, pressure, shock, exposure to light or air or other physical stresses that might result in a hazardous situation.
Incompatibility:	Address chemicals and other materials that the substance could react with to produce a hazardous situation, for example explosion, release of toxic or flammable materials, liberation of excessive heat or sudden change of physical state. In determining incompatibility, consider the materials, containers, and contaminants the substance might be exposed to during transportation, storage and use.
Hazardous Decomposition Products:	List known or anticipated hazardous materials produced as a result of oxidation (except burning), heating, or reaction with another material, including the production of flammable and toxic materials.

4.4.11 SECTION 11: TOXICOLOGICAL INFORMATION

a. This section gives a background of toxicological data on the material or its compounds. If data is not available on the material or its components, it shall be stated. This information, if available for components of the system, or the substance as a whole, shall be provided by the SFAB IH staff. If special toxicological tests have been conducted on the material or it's components that are not currently listed on the available national databases this information shall be given to the SFAB IH staff.

b. The format used on the LaRC MSDS template is as follows:

COMPONENT	ORAL	DERMAL	INHALATION	OTHER

4.4.12 SECTION 12: ECOLOGICAL INFORMATION

a. This information, if available for components of the system, or the material as a whole, shall be provided by the EMT Environmental Engineer. This section provides information on the effects the material may have on plants, animals, and its environmental fate. Provide information if the material or its components have the potential to be toxic in land, water or air. Indicate the potential adverse effect and the species. Indicate if the material or its components have the potential to persist or bio-concentrate, reaching levels that may have an adverse environmental impact. State if the material or its components have the unique potential to be harmful to wastewater treatment facilities. If data is not available on the material or its components, it shall be so stated.

4.4.13 SECTION 13: DISPOSAL CONSIDERATIONS

a. This section includes information that is relevant to and will assist in determining the proper and permissible waste management options of disposal, recycling or reclamation. The information shall be provided by the EMT Environmental Team.

b. The following information shall be included:

- Classification under RCRA and 40 CFR 261,
- US EPA Waste Identification Number and descriptions,
- Physical/chemical properties related to disposal option, for example heat value particle size, VOC content,
- Special instructions or specific limitations,
- Advice that 40 CRF 261may also apply to empty containers,
- Advice that laws may change,
- Advice that state and local regulations are complex and may be different from federal regulations, and
- Advice that the owner of the waste has the responsibility for proper disposal.

c. A disclaimer closure statement may be included as follows:

Chemical additions, processing, or otherwise altering this material may make the waste management information herein incomplete, inaccurate, or otherwise inappropriate. Additionally, state and local requirements for waste disposal may be more restrictive or otherwise different from federal laws and regulations. Consult state and local regulations regarding disposal of this material.

4.4.14 SECTION 14: TRANSPORT INFORMATION

a. This section provides basic shipping classification information. This information shall be provided by the Shipping Official or EMT Environmental Engineer. The format used on the LaRC MSDS template is as follows:

US DOT SHIPPING INFORMATION:
PROPER SHIPPING NAME: UN _____ HAZARD CLASS: PG:

REPORTABLE QUANTITY:
POSTAL SERVICE:
IATA SHIPPING INFORMATION:
PROPER SHIPPING NAME: UN_____ PG:

b. OTHER CLASSIFICATIONS: May include classifications/descriptions under International Transportation Regulations, including International Maritime Organization (IMO), International Civil Aviation Organization (ICAO), Transport Canada, Environmental Protection Agency (EPA), and Rapid Inventory Development (RID).

4.4.15 SECTION 15: REGULATORY INFORMATION

a. As regulatory databases are cited in the above sections, they shall be included here in a list as they apply to the material. This section shall also be used to provide additional information on regulations affecting materials that are not listed in the previous sections.

US Federal Regulations, Statutes, and Agencies:	The following shall be searched for information regarding the material and its components: OSHA, Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), Toxic Substances Control Act (TSCA), Comprehensive Environmental Response Compensation (CERCLA), EPA Superfund Amendments and Reauthorization Act (SARA) Title III, EPA Clean Air Amendment (CAA), EPA Clean Water Act (CWA), EPA Safe Drinking Water Act (SDWA), Consumer Specialty Products Association (CSPA), Drug Enforcement Agency (DEA), and Food and Drug Administration (FDA//United States Department of Agriculture (USDA).
US State Regulations:	Most states have adopted the OSHA 29 CFR 1910.1200, but may have additional information requirements. Massachusetts, Pennsylvania (PA), Rhode Island and California (CA) require inclusion of state listed substances on the MSDS. PA requires disclosure of non-hazardous ingredients. CA requires listing of volatile organic compounds (VOC) and Vermont requires listing of environmental effects.
International Regulations:	The following regulations can be searched for the material and its components: Workplace Hazardous Materials Information System (WHMIS), Canadian Environmental Protection Agency (CEPA), European Inventory of Existing Commercial Chemicals (EINECS), Ministry of International Trade and Industry (MITI).

4.4.16 SECTION 16: SUPPLEMENTAL INFORMATION

a. This section is used to list any other information known about the material. Additional information shall also be included in the previous sections where appropriate. The SFAB IH staff shall be responsible for assigning this code after the information in the previous sections is completed. The hazard rating system shall be included in this section using the following format:

NFPA HAZARD RATING SYSTEM:
HEALTH =
FIRE =
REACTIVITY = (scale of 0-4, 4 being most severe)

b. The responsible researcher shall list his/her name as the preparer. Other contributors shall also be listed. The date that the MSDS was prepared or revised shall also be included.

Prepared by: Responsible researcher's name
Date prepared: Date originally prepared
Revision date: Latest date MSDS was changed (Revisions shall be italicized in the body of the document to make changes easy to find.)

4.4.17 SECTION 17: DISCLAIMER

a. This information shall be provided by the NASA LaRC Office of Chief Counsel and shall end each MSDS produced at LaRC. The disclaimer statement shall be as follows:

The information and recommendations contained herein are based upon data believed to be correct. However, since much of the information has been received from sources outside NASA Langley Research Center, we cannot guarantee its accuracy or completeness. Health and safety precautions contained within this data sheet may not be adequate for all individuals and/or situations. It is the user's obligation to evaluate and use this data in order to comply with all applicable laws and regulations. Additionally, no guarantee or warranty of any kind, expressed or implied, is made with respect to the information contained herein.

Chapter 5

POTENTIALLY HAZARDOUS MATERIAL PERMIT PROCESS

a. NASA Langley Form 498s issued for PHM's shall be one of the administrative controls available to identify the employees and procedures in use for higher risk PHM operation. The need for and use of NASA Langley Form 498 shall be determined by the FSH and/or the LaRC Safety Manager.

b. All materials for which OSHA has promulgated a standard based on carcinogenic potential of the material shall be considered for NASA Langley Form 498. Conditions of use, storage and quantity of material used shall be considered when determining the need for a PHM permit. Other potential high risk PHM where a NASA Langley Form 498 shall be needed are those materials for which data is not fully available. These include research and development research material where toxicity data is limited (including prepreg material still under research and development and laser dyes). Further information on high hazard material is presented in Chapters 6 and Appendices A and B of this procedural requirement.

c. CHP's shall be used in all laboratories that routinely synthesize chemicals. The CHP is an OSHA process for the control of hazards used in chemical laboratories. Process controls and procedures, rather than PHM specific MSDS's, shall be used to manage the risks from the PHM and their chemical intermediaries.

d. The PHMC or the LaRC Safety Manager shall also require submission of NASA Langley Form 118, "Safety Permit Request - Hazardous Material," and issuance of a NASA Langley Form 498 to use any material it deems significantly hazardous.

e. NASA Langley Form 498s shall be used to standardize procedures and identify training and personnel involved with high-risk operations associated with PHM. Other options permitted for determining the same risk reduction controls shall be to use other committees of functional risk management organizations available at LaRC. These include the Systems Operation Committee (SOC) and/or the Configuration Management Program (CMP), however the use of SOC and CMP to determine risk reduction controls does not alleviate the requirement for a NASA Langley Form 498. The FSH and/or the LaRC Safety Manager shall determine which of these techniques or combination of programs are best for the situation under consideration. These individuals shall disapprove operations or procedures where they consider the risks to be unacceptable and not issue a NASA Langley Form 498.

f. The FSH or designated representative, such as the OFSH, shall complete NASA Langley Form 118 and a NASA Langley Form 66, shall be submitted to the Safety Office for each person actively involved in the operation. After completion of any special training or medical requirements, these workers shall be certified as "Chemical Workers" under NASA Langley Form 498.

g. After review and approval, a NASA Langley Form 498 shall be issued to the facility. A NASA Langley Form 62, “Chemical Worker's Certification Card" shall be issued to each qualified employee. The worker shall have the card on-hand or readily accessible, as proof of his/her certification, while conducting applicable tasks. The cards shall be revalidated annually by the SFAB IH staff, immediate supervisor and the LaRC Safety Manager.

h. NASA Langley Form 118 shall be prepared by the FSH, the lead test engineer and/or the researcher performing the work. All NASA Langley Form 118s shall be reviewed and resubmitted by the PFSH who has overall responsibility for the entire facility safety program.

5.1 SUMMARY OF TOPICS INCLUDED IN NASA LANGLEY FORM 498 ISSUED FOR POTENTIALLY HAZARDOUS MATERIALS

a. A summary of topics to consider during the preparation of NASA Langley Form 118 are as follows:

(1) Brief description of activity objectives,
(2) Brief description of the PHM or process to be controlled,
(3) Type and amounts of material present (maximum at site), and
(4) Amount of material in use during the process (including hazardous material quantity, application rate, flow),
(5) List of all operators in the controlled area during use of PHM and their operator responsibilities,
(6) Additional training planned for use of PHM named in NASA Langley Form 498. The minimum training in accordance with NASA Langley Form 498 procedures shall be required for each individual named. For example, if LaRC safety videos (such as Gloves for Composite Materials) shall be required, describe the additional training to be required, and
(7) Regulatory requirements: A NASA Langley Form 66 for each civil servant shall be forwarded with NASA Langley Form 118. These forms document training and alert the OHCM OHS contractor to possible new medical exam requirements. For each person added after the issuance of a NASA Langley Form 498, forward an additional NASA Langley Form 66. Non-NASA personnel wishing to operate under the NASA Langley Form 498 shall forward equivalent requests through the FSH to the SFAB, SMAO. Personnel shall not operate under the NASA Langley Form 498 until training, medical exams, and LaRC Safety Manager approvals have been obtained.

b. The Safety Operating Plan is the main narrative on how the hazards of the PHM are to be controlled through operational procedures and hazard awareness by workers. The goal of the plan is to describe controls to reduce personnel and facility risks. Narratives submitted with NASA Langley Form 118 shall address the following topics as applicable:

(1) How the PHM is to be used and controlled. (Note: Use PHM with lower fire or health hazards where possible.)
(2) Planned schedule of operations and estimated frequency of operations. Include comments on weekend operations, and overnight or continuous process schedules, if applicable. These affect risk control procedures. Standard operations shall involve operators always present during normal day shift unless otherwise noted.
(3) Ventilation system use (including, but not limited to, laboratory hoods exhausting to outside with flow monitoring devices, dedicated exhaust systems, low flow alarms, as needed). Ventilation alarm device descriptions shall state whether they alarm locally only or to other Center control points (Duty Officer or Fire Department). Responsibilities for calibration of monitoring devices shall be specified.
(4) Procedural controls planned (e.g., Will hazardous gas piping systems be tested with inert gases for leaks prior to using toxic or flammable gases? Are gas systems to be vented and shut off after each use or remain pressurized? Where will low use PHM's, such as calibration gases or materials be stored [outside for hazardous gases] during prolonged non-use periods?).
(5) Personal protective equipment planned for routine operations. (Note: LaRC procedures require that the Fire Department perform all rescue operations in the event of an accident involving personnel.)
(6) Warning alarms and monitoring devices planned for use in control of leak detection procedures (e.g., hydrogen gas alarm, HF gas alarm for fluorine gas). Plans shall include how these alarms shall be used to alert operators, other facility personnel, and/or the Fire Department. System shutdown or facility evacuation procedures shall be addressed in conjunction with these alarm set points.
(7) PHM spill or leak procedures shall be addressed. Minor spills are usually handled by the operators. Specialized training (OSHA requires a HAZWOPER 8 hour or longer course) shall be required for chemical spills. LPR 8800.1 Chapter 14, "Oil and Hazardous Material Spill Control," contains spill cleanup information.
(8) Sketches of the operational area, the experimental layout, or piping and valve controls, as applicable.

5.2 NASA LANGLEY FORM 498 APPROVALS, DURATION, AND RENEWALS

a. The PHMC shall determine the approval duration of NASA Langley Form 498. Normally, FSH's or OFSH's shall request approvals for the duration of the research and development activity, if known. Initial approvals shall be for a maximum of one year, and the FSH/OFSH/Project engineer shall reapply for NASA Langley Form 498. Reapplications to continue work shall be submitted to a PHMC representative (normally, the SFAB IH staff) at least 30 days before expiration. Maximum renewal periods for existing NASA Langley Form 498's shall be determined by the PHMC and shall be up to four years.

b. Modification to existing NASA Langley Form 498's can be submitted at any time during the issuance. When reviewed and approved, the PHMC shall issue a modified form and a PHMC representative from SFAB, SMAO or the SFAB IH staff, shall do initial reviews of new and renewal NASA Langley Form 498's. Final approval of NASA Langley Form 498 shall be conducted by the PHMC and the LaRC Safety Manger.

5.3 WORKER TRAINING AND CERTIFICATION

a. The NASA Langley Form 498 process shall include a determination of and requirements for PHM employee training and certification including hazard communication, CHP, periodic refresher, and medical surveillance. Employee training and certification shall be conducted in accordance with LPR 1740.6, "Personnel Safety Certification."

5.3.1 Hazard Communication Standard Training

a. The following information shall be provided or made available to each employee where a PHM is stored or used. This information is considered part of the basic hazard communication program and shall be required for all new employees. NASA personnel shall receive basic hazard communication training within 90 days of being hired and, if needed, through courses provided by SFAB, SMAO. Contractors shall provide an equivalent program for on-site operations.

b. Employees shall receive this training on LaRC procedures for:

(1) Means of identification of PHM's (i.e., labeling and posting, Chapter 6),
(2) Health hazard data,
(3) Fire, explosion, and reactivity data,
(4) Precautions for safe use, handling, storage, and disposal,
(5) Required protective clothing and equipment, and
(6) Emergency and first aid procedures.

c. The MSDS's shall be used as a primary source for this information. Personnel shall be cognizant of this information prior to actually handling the material.

5.3.2 Chemical Hygiene Plan Training

a. Training for laboratory workers operating under a CHP is in addition to the preceding. All workers involved in processes conducted under the CHP shall be familiar with the basic NASA Langley Form 498 procedures for their operation and/or facility. This training shall be the responsibility of the designated CHO. Support shall be provided by the SFAB IH staff as appropriate.

5.3.3 Periodic Refresher Training

a. Periodic refresher training shall be required if the hazardous materials change or the processes generating hazardous materials change. This training shall be the responsibility of the FSH and/or the CHO, with SFAB, SMAO assistance as needed.

5.4 MEDICAL SURVEILLANCE

a. Medical monitoring of civil service personnel at risk from exposure to PHM's shall be done by the OHCM OHS contractor located at 10 West Taylor Street, Building 1149. The requirements for medical surveillance are identified by Occupational Medical Examination Protocols (OMEP's) determined by the OHCM OHS contractor physician and assessments of risk by the LaRC Safety Manager and his/her staff through periodic audits or special surveys of workplaces when requested by FSH's. Other site or OSHA requirements, such as those determined in past labor management agreements or specific OSHA standards, shall also be used in determining the need for, and procedures in, examinations. Medical surveillance requirements for contract employees shall be the responsibility of the contracting company. The SFAB IH staff shall perform all assessments of site PHM health risks and report these to FSH's and the LaRC Safety Manager.

b. FSH's and their designated representatives shall establish procedures for periodic reviews of their at-risk employee population for the use of PHM's. At-risk workers shall be identified to the OHCM OHS contractor at the time of initial assignment to work with PHM's through the use of NASA Langley Form 66. Pre-certification and annual examinations, as well as examinations required due to exposure shall be scheduled and conducted by the OHCM OHS contractor in accordance with the applicable OMEP. The completed NASA Langley Form 66's shall be maintained in individual medical records at the OHCM OHS contractor location.

c. The determination of the need for periodic medical surveillance of workers shall depend on several factors, including the PHM in use, toxicity, manner and duration of use, and potential routes of entry into employees. Depending on the nature of the hazards, medical surveillance shall be recommended. FSH's shall request assistance from the SFAB IH staff in the risk assessments. Occasionally, such as in the use of research and development mutagenic material, additional input from the OHCM OHS contractor physician may be needed to determine OMEP needs.

d. FSH's shall identify temporary or transient personnel (civil servant and contractor) who periodically come into their facility to work with PHM's. For example, an engineer may come into their laboratory for 5 days per month over a 6-month period to perform "hands-on" work in PHM research and development of a new process. If the risks warrant clinical monitoring, these temporary or transient personnel shall be identified to the OHCM OHS contractor using NASA Langley Form 66 or equivalent contractor forms. As a general rule, if other workers receive clinical examinations for

exposure for their daily work with low to moderately toxic material, these temporary personnel shall also be referred to the OHCM OHS contractor for monitoring if they receive more than one month's (20 working days) exposure in a year.

e. All workers named on NASA Langley Form 498 shall be considered Chemical Workers. Specific clinical examinations for Chemical Workers shall be determined by the OHCM OHS contractor physician. Procedures for the use of NASA Langley Form 498, NASA Langley Form 62, and clinical examinations are presented in LPR 1740.6. Chemical Workers shall be the individuals who physically use the material or are, or could be, involved in the permitted operations. Administration and management personnel shall not be considered unless they actually work with the material named.

f. Reviews or updates to identify personnel needing, or no longer needing, PHM-related clinical examinations shall be conducted by FSH's after consultation with facility personnel, as circumstances warrant. These clinical examination-listing updates shall be conducted during periodic industrial hygiene audits, conducted by the SFAB IH staff, of facility operations.

g. The OHCM OHS contractor shall, as circumstances warrant, notify the LaRC Safety Manager and FSH's on trends seen in the worker population monitored through its OMEP program.

h. Clinical examinations required because of workplace exposures to PHM's can be either recommended or mandatory by law. If medical surveillance is recommended and the employee declines to participate, the OHCM OHS contractor shall obtain a statement, which shall be included in the employee's medical records. The statement shall indicate that the employee understands the risk involved by declining to participate in the surveillance program. The LaRC Safety Manager and FSH's shall be notified concerning trends or an individuals declining to participate.

i. If the medical examination is mandatory by law, appropriate personnel (including supervisors and FSH's) shall be notified if the individual fails to complete medical monitoring examinations for the workplace PHM exposure.

Chapter 6

USE AND HANDLING OF POTENTIALLY HAZARDOUS MATERIALS

a. Prior to initial acquisition or transfer of PHM's, FSH's shall make the initial decision on the use of a particular PHM or PHM process in their facility, the amount to be stored in the facility, and the initial assessments for further safety and process control measures. In cases where PHM's pose a significant hazard because of their toxicity, flammability, or other potentially hazardous properties, control procedures and other operational details shall be documented and approved through the NASA Langley Form 498 process. The NASA Langley Form 498 process is discussed in Chapter 5 of this procedural requirement.

b. Additionally, assistance can also be provided by the LaRC Safety Manager, his/her staff, the PHMC, other LaRC committees, and other technical area experts.

6.1 LABORATORY OPERATIONS AND PRODUCTION OF POTENTIALLY HAZARDOUS MATERIALS

a. Laboratory operations and the production of PHM's includes chemical synthesis in laboratories and the transfer of test chemicals.

6.1.1 Chemical Synthesis in Laboratories

a. Production or synthesis of chemicals and their intermediaries are usually involved processes. Laboratories performing these processes shall have a CHP. The NASA Langley Form 498 process shall be used for each laboratory CHP. Laboratories operating under a CHP shall not be required to have MSDS's for each chemical intermediary involved in the chemical process. Federal law requires annual review of the CHP.

6.1.2 Transfer of Test Chemicals

a. On-site operations that produce test specimens of PHM's for use in other facilities and/or special projects shall provide MSDS's for use by other personnel working with the material. The LaRC MSDS template is discussed in Chapter 4 of this procedural requirement. MSDS's produced shall be forwarded to the SFAB IH staff for review and submittal to the PHMC and LaRC Safety Manager.

6.2 WARNING LABELS AND HAZARD INFORMATION

6.2.1 Original Manufacturers' Containers (Primary Containers)

a. The material or its container shall be clearly labeled to identify the material (chemical or trade name) and to provide precautionary statements required by regulatory agencies or LaRC. OSHA 29 CFR 1910.1200 requires manufacturers, importers or distributors to label

each container of hazardous chemicals. Therefore, each container of PHM's received on the Center shall have existing labels that comply with the OSHA requirements.

b. All PHM used and stored at the Center shall have a CMTS label with its inventory record number. Detailed information on CMTS labels is available on-line at:

http://osemant1.larc.nasa.gov/cmts/instruct/

6.2.1.1 Secondary Containers

a. If PHM's are transferred into unmarked containers, these containers shall bear the name of the chemical, along with the diamond symbol of the NFPA in accordance with NFPA 704 (Figure 6.1). This symbol indicates the severity of the hazard on a numerical scale of 0 to 4, and the type of hazard (health, flammability or reactivity) according to a color code. The ranking of severity of the health hazard is based upon acute exposures, and therefore, may not adequately reflect the actual hazard associated with chronic exposures to relatively small quantities of the material. LaRC shall use the NFPA diamond as a warning symbol to increase worker awareness of hazardous materials. For example, a laboratory squeeze bottle used to hold the cleaning solvent methyl ethyl ketone will have an NFPA diamond label with numbering for HEALTH = 1, FLAMMABILITY = 3, and REACTIVITY = 0, along with the name "methyl ethyl ketone", or "MEK".

b. Any material subject to a specific OSHA labeling standard shall be labeled in accordance with those requirements in addition to those given above.

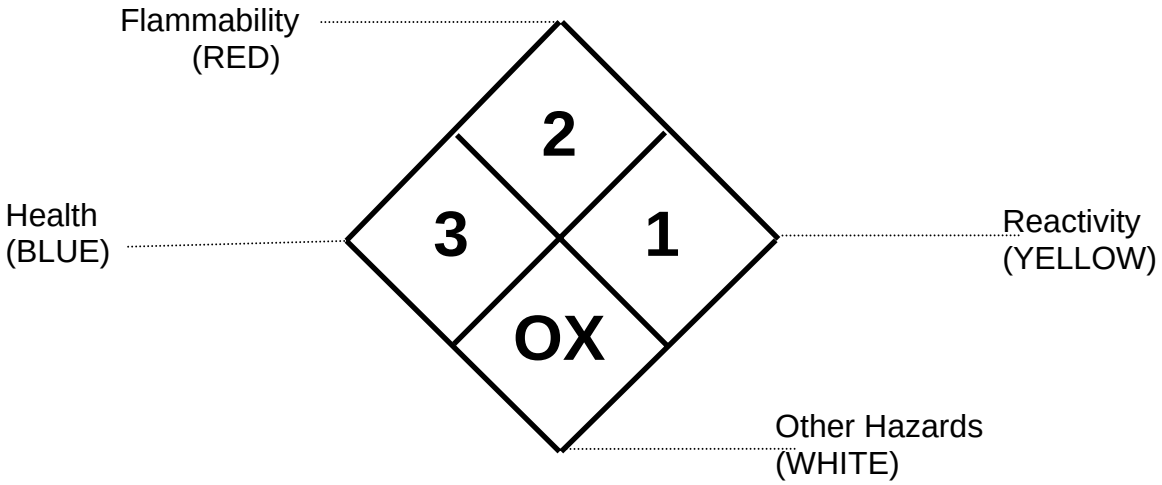
c. Figure 6.1 shows the diamond label and the rationale for assigning codes. Codes for several chemicals are found in NFPA 704. Assistance in assigning these codes shall be obtained from the SFAB IH staff. The diamond code information shall be entered on NASA Langley Form 44, when the request for PHM's is submitted.

d. Labeling of all containers of experimental chemical materials shall be in compliance with OSHA 1910.1450. For items that are to be stored and retained within a laboratory where the properties of materials are likely to be well understood, only the sample identification and/or name shall be needed. Samples that will be transferred outside the laboratory, or that may be handled by individuals not generally familiar with the type of material involved, shall be labeled as completely as possible, including the name, address, and telephone number of the sender and recipient for samples in transit.

6.2.2 Hazard Survey Information

a. The NFPA diamond symbol is intended to increase worker awareness of the presence of PHM's. The actual hazard from a material depends on how it is used. Periodic audits and surveys shall be conducted by the SFAB IH staff to determine actual health hazards from hazardous material operations. The results of these audits shall be

reported back to the facilities. Workers can request information on past surveys by contacting their supervisors, LaRC Safety Manager or the SFAB IH staff.



Identification of Health Hazards Color Code: BLUE		Identification of Flammability Color Code: RED		Identification of Reactivity Color Code: YELLOW	
Signal	Type of Possible Injury	Signal	Susceptibility of Materials to Burning	Signal	Susceptibility to Release of Energy
4	Materials, which on very short exposure could cause death or major residual injury even though prompt medical treatment, is given.	**4**	Materials, which will rapidly or completely, vaporized at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn read	**4**	Materials, which in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.
3	Materials, which on short exposure could cause serious temporary or residual injury even though prompt medical treatment, is given.	**3**	Liquids and solids that can be ignited under almost all ambient temperature conditions.	**3**	Materials which in themselves are capable of detonation or explosive reaction, but require a strong initiating source or which must be heated under confinement before initiating, or which react explosively with water.
2	Materials, which on intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment, is given.	**2**	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.	**2**	Materials, which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. Also materials, which may react violently with, water or which may form potentially explosive mixtures with water.
1	Materials, which on exposure could cause irritation but only minor residual injury, even if no treatment is given.	**1**	Materials that must be preheated before ignition can occur.	**1**	Materials, which in themselves are normally stable, but which can become unstable at elevated temperatures and pressures, or which may react with water with some, release of energy, but not violently.
0	Materials, which on exposure under fire conditions, would offer no hazard beyond that of ordinary combustible materials.	**0**	Materials that will not burn.	**0**	Materials, which in themselves are normally, stable, even under fire exposure conditions, and which are not reactive with water.

Other Hazards - Color Code: WHITE
Ox - Oxidizer
~~W~~ - Use no water

Figure 6.1, National Fire Protection Association Symbols.

6.3 STORAGE AND POSTING AREAS WITH POTENTIALLY HAZARDOUS MATERIAL

a. PHM, particularly compressed gases and flammables or combustibles, shall be stored in accordance with Figure 6.2, "Suggested Shelf Storage Pattern," Figure 6.3, "Partial List of Incompatible Compounds (Toxic Hazards)," and Figure 6.4, "List of Incompatible Chemicals" of this procedural requirement. Before using and planning of new operations involving PHM's, the individuals shall incorporate all statutory requirements as promulgated by OSHA and any other national consensus standards. These include recommendations of the NFPA, Compressed Gas Association (CPA), and American National Standards Institute (ANSI).

b. Requirements for the storage of flammable materials are addressed in this chapter. Contact the LaRC Safety Manager or the LaRC Fire Chief if assistance is needed in determining flammable storage needs and requirements.

6.3.1 Storage of Potentially Hazardous Materials

a. The requirements for the storage of PHM's in a facility, or adjacent to a facility, are to minimize risks in the event of a fire or an accident. Technical guidance for gases are detailed in Appendix B of this procedural requirement. Material quality storage requirements, such as the use of refrigerated storage to prolong the quality of the substance, are not considered or detailed in this chapter. For storage of environmentally regulated hazardous wastes, consult LPR 8800.1

b. Fire codes for the storage of flammable materials in facilities have been incorporated into OSHA standards. These mandatory OSHA requirements are included in this chapter. For assistance in interpreting these laws, contact the LaRC Safety Manger or LaRC Fire Chief.

6.3.2 Flammable and Combustible Liquids Storage

a. This section applies to the storage of flammable or combustible liquids in drums or other containers not exceeding 60 gallons of individual capacity and portable tanks not exceeding 660 gallons of individual capacity. For further interpretation, contact the SFAB, SMAO.

6.3.2.1 Design and Capacity of Containers

a. Only approved containers and portable tanks shall be used. Metal containers and portable tanks meeting the requirements of and containing products authorized by Department of Transportation (DOT) 49 CFR, "Transportation," Subtitle B, Chapter 1, "Research and Special Programs Administration, Department of Transportation", shall be deemed to be acceptable. The LaRC Fire Chief shall be available to provide guidance in these areas.

6.3.3 Suggested PHM Shelf Storage Pattern

a. Figures 6.2 and 6.3, contain information obtained from a NASA Course on Laboratory Safety and Health. No current regulatory requirements exist for storage lockers; however, the data presented is suggested for use to help avoid storing incompatible materials on the same or adjacent shelves.

INORGANIC	ORGANIC
INORGANIC # 10 SULFUR, PHOSPHORUS, ARSENIC, PHOSPHORUS PENTOXIDE	ORGANIC # 2 ALCOHOLS, GLYCOLS (Store flammables in dedicated cabinet)
INORGANIC # 2 HALIDES, SULFATES, SULFITES, THIOSULFATES, PHOSPHATES	ORGANIC # 3 HYDROCARBONS, ESTERS (Store flammables in a dedicated cabinet)
INORGANIC # 3 AMIDES, NITRATES. (Not AMMONIUM NITRATE). Nitrates	ORGANIC # 4 ETHERS, KETONES (Store flammables in a dedicated cabinet)
INORGANIC # 1 METALS AND HYDRIDES (Store away from water)	ORGANIC # 5 EPOXY COMPOUNDS, ISOCYANATES
INORGANIC # 4 HYDROXIDES, OXIDES, SILICATES	ORGANIC # 7 SULFIDES, POLYSULFIDES
INORGANIC # 7 ARSENATES, CYANIDES (Store above acids)	ORGANIC # 8 PHENOL, CRESOLS
INORGANIC # 5 SULFIDES, SELENIDES, PHOSPHIDES, CARBIDES, NITRIDES	ORGANIC # 6 PEROXIDES, AZIDES
INORGANIC # 8 BORATES, CHROMATES, MANGANATES, PERMANGANATES	ORGANIC # 1 ACIDS, ANHYDRIDES, PERACIDS
INORGANIC # 6 CHLORATES, PERCHLORATES, CHLORITES, PERCHLORIC ACID, PEROXIDE	MISCELLANEOUS
INORGANIC # 9 ACIDS, except NITRIC (Acids are best stored in dedicated cabinets)	MISCELLANEOUS (Nitric Acid)

Figure 6.2, Suggested Shelf Storage Pattern

Arsenical Materials	Any Reducing Agent	Arsine
Azides	Acids	Hydrogen Azide
Cyanides	Acids	Hydrogen Cyanide
Hypochlorites		Chlorine or Hypochlorous Acid
Nitrates	Sulfuric Acid	Nitrogen Dioxide
Nitric Acid	Copper, Brass, Heavy Metals	Nitrogen Dioxide
Nitrites	Acids	Nitrous Fumes
Phosphorus	Caustic Alkalis/Reducers	Phosphine
Selenides	Reducers	Hydrogen Selenide
Sulfides	Acids	Hydrogen Sulfide
Tellurides	Reducers	Hydrogen Telluride

Figure 6.3, Partial List of Incompatible Chemicals (Toxic Hazards)

b. Substances in the left hand column shall be stored and handled so that they cannot under any circumstances accidentally contact corresponding substances in the center column, as toxic materials (right hand column) would be produced.

Chemical	Potentially Incompatible Chemicals/Materials/Conditions
Acetic acid	Chromic acid, nitric acid, perchloric acid, hydroxyl-containing compounds, ethylene glycol, peroxides, and permanganates
Acetone	Concentrated nitric, sulfuric, perchloric, and chromic acid mixtures, and certain plastic materials
Acetylene	Chlorine, bromine, copper, silver, brass (red), fluorine, mercury, and oxygen
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrates, sulfur, finely divided organics, or combustibles
Ammonium hydroxide	Acids
Ammonium iodine	Acids and oxidizing agents
Ammonium sulfide	Acids
Arsenical materials	Any reducing agent
Bromine	Ammonia, acetylene, butadiene, butane, and other petroleum gases; hydrogen; sodium carbide; turpentine; benzene; and finely divided metals
Carbon, activated	Calcium hypochlorite and ruthenium tetroxide
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organics, or combustibles
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, and turpentine
Chromic acid	Acetic acid, acetone, naphthalene, camphor, glycerin, turpentine, alcohol, and most flammable organic compounds
Copper	Acetylene of hydrogen peroxide
Cyanides	Acids
Diethyl ether	Nitric acid (concentrated and fuming) and other strong oxidizing agents (dichromate, permanganate), heat, or aluminum
Flammable liquids	Ammonium nitrate, chromatic acid, hydrogen peroxide, nitric acid, sodium peroxide, and halogens

Figure 6.4, List of Incompatible Chemicals (page 1 of 2)

Chemical	Potentially Incompatible Chemicals/Materials/Conditions
Hydrochloric acid	Bases or manganese dioxide
Hydrocyanic acid	Nitric acid or alkalis
Hydrogen peroxide	Copper, chromium iron, most metals or their salts, and flammable liquid, combustible materials, aniline, and nitromethane
Hydrofluoric acid (anhydrous)	Ammonia, aqueous, or anhydrous
Hydrogen sulfide	Fuming nitric acid, oxidizing gases, heat, and most common metals
Hydrocarbons (benzene, butane, propane, gasoline, turpentine)	Fluorine, chlorine, bromine, chromic acid, and sodium peroxide
Mercury	Acetylene, fulminic acid, ammonia, and concentrated nitric acid
Methyl isobutyl ketone	Nitric acid (concentrated and fuming), dichromate, and (hexane) permanganate
Nitric acid (conc.)	Acetic acid, aniline, chromic acid, Hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, nitratable substances such as organic compounds, including diethyl ether and methyl ketone (hexane), and bases
Oxygen	Oils, grease, hydrogen, flammable liquids, solids, or gases
Oxalic acid	Silver and mercury
Perchloric acid	Acetic anhydride, acetone, alcohol, bismuth and its alloys, charcoal, paper, wood, bases, or organic compounds
Potassium chlorate	Acids and organic compounds
Potassium perchlorate	Acids and organic compounds
Potassium permanganate	Glycerine, ethylene glycol, benzaldehyde, and sulfuric acid
Sodium carbide, acetylene	Water (also see acetylene, which is liberated from sodium carbide on exposure to moisture)
Sodium hydroxide	Acids, organic materials, most common metals, and water
Sodium nitrate	Ammonium nitrate and other ammonium salts
Sodium peroxide	Any oxidizable substance, such as ethanol, methanol, glacial acetic acid, acetic anhydride, benzaidehyde, carbon disulfide, glycerine, ethylene glycol, ethyl acetate, methyl acetate, and furfural
Sulfuric acid	Chlorates, perchlorates, permanganates, water, and bases
Strong bases	Strong acids, organic materials, water and most common metals

Figure 6.4, List of Incompatible Chemicals (page 2 of 2)

6.3.4 Storage Time Limits of Peroxidizable Compounds

a. Some chemicals form peroxides upon prolonged storage and/or contact with air. Peroxides are compounds, which are sensitive to shock, heat, friction, or accidental ignition (sparks). Peroxidizable compounds slowly deteriorate into peroxides when exposed to air. A list of some of these chemicals is provided in Figure 6.5, "Storage Time Limits of Peroxidizable Compounds." To ensure that the storage time limit of the peroxide-forming compound is not exceeded, the date the container is opened shall be prominently displayed on the container. Expired chemicals shall be disposed of immediately. When possible, order peroxidizable compounds containing an inhibitor to slow the formation of peroxides. If research requires the use of an unstabilized solvent the FSH shall be notified prior to ordering. Distillation or purification of a peroxidizable compound, either stabilized or unstabilized, shall also require the permission of the FSH. Only distill or purify the amount of solvent that will be immediately used, DO NOT STORE distilled or purified peroxidizable solvents. If crystals are noticed on a container of peroxidizable compounds exercise extreme caution and notify the FSH and LaRC Safety Manager for assistance as soon as possible. On site treatment of a peroxidizable compound is strictly prohibited.

6.4 TRANSPORTATION OF POTENTIALLY HAZARDOUS MATERIAL

Specific requirements for off- and on-site transport of PHM's are detailed in this section.

6.4.1 PHM Transportation Off-Site

a. PHM's shall not be introduced into interstate commerce unless in full compliance with applicable regulations of 49 CFR, Subtitle B, Chapter 1, parts 171-177, "Hazardous Materials Regulations." For example, materials containing cyanides shall not be transported in vehicles containing acids.

b. Contact the LMT for assistance on shipment and for restrictions on the movement of PHM's off-site. LMT personnel can assist in authorized type of shipments (e.g. pounds of PHM's that are air transportable, performance oriented packaging requirements, PHM transportation packaging, and vehicle placarding).

c. PHM's transported off-site shall be accompanied by a NASA Langley Form 44 and the appropriate MSDS. The NASA Langley Form 44 shall be used to track LaRC PHM's.

d. Shipments of minor (less than 10 gram) quantities of PHM laboratory samples for off-site testing shall not require a NASA Langley Form 44. The package label for these items shall clearly identify the name, address, and telephone number of the individual knowledgeable about the test specimen, a brief description of the samples, and the date shipped, in order to meet federal requirements for shipment of laboratory samples as defined in DOT 49 CFR 173, "SHIPPERS—General Requirements for Shipments and Packagings." Check for other PHM limits on quantity, transportation methods, and packaging that apply to the shipment.

e. Any person transporting PHM's off-site shall be subject to the motor vehicle laws of the federal government and the Commonwealth of Virginia. Current laws require certain classes of motor vehicle operators to have Commercial Driver's Licenses with a Hazardous Materials endorsement for transport of PHM's.

RED LABEL - PEROXIDE HAZARD ON STORAGE
DISCARD AFTER THREE MONTHS

isopropyl ether
divinyl acetylene
vinylidene chloride
potassium metal
sodium amide

YELLOW LABEL - PEROXIDE HAZARD ON CONCENTRATION
DISCARD AFTER ONE YEAR

diethyl ether	dicyclopentadicene
tetrahydrofuran	diacetylene
dioxane	methyl acetylene
acetal	cumene
methyl isobutyl ketone	tetrahydronaphthalene (TetraUn)
ethylene glycol dimethyl ether (glyme)	cyclohexene
vinyl ethers	methylcyclopentane

YELLOW LABEL - HAZARDOUS DUE TO PEROXIDE INITIATION OF POLYMERIZATION*
DISCARD AFTER ONE YEAR

methyl methacrytate	chlorotrifluoroethylene
styrene	vinyl acetylene
acrylic acid	vinyl acetate
acrylonitrile	vinyl chloride
butadiene-	vinyl pyridine
tetrafluoroethylene	chloroprene

*Under conditions of storage in the liquid state, the peroxide-forming potential increases and certain of these monomers (especially butadiene, chloroprene, and tetrafluorethylene) should then be considered as A-list compounds.

From H. L. Jackson, W. B. McCormack, C. S. Rondestvedt, K. C. Smeltz, and I. E. Viele: "Safety in the Chemical Laboratory. LXI: Control of Peroxidizable Compounds." *J Chem. Educ.* 47(3): A176 (March, 1970).

Figure 6.5, Storage Time Limits of Peroxidizable Compounds

6.4.2 PHM Transportation On-Site

a. The on-site transportation of PHM's shall be conducted by personnel trained in hazardous material transportation. Contact the LMT for assistance in hazardous material transfer. NASA personnel without a Commercial Drivers License may use NASA vehicles for the limited on-site transfer of PHM's. An example would be an emergency transfer of hydraulic fluid from stock or another on-site facility to support pump repair work for a wind tunnel.

6.5 EXCESS PHM, ACCIDENTS INVOLVING PHM, AND DISPOSAL OF WASTE PHM

a. Information on various other topics associated with the storage, excess turn in, spills, documenting information of new materials (i.e. MSDS), OSHA carcinogens, and hazardous gases is outlined in more detail in other chapters of this procedural requirement, in other safety-related documents or in LPR 8800.1. Additional general procedures are included herein.

b. Users shall consider the use of alternative material, ventilation, and personal protective equipment in all processes. Whenever possible, less hazardous material shall be substituted first in processes. If substitution is not possible, process ventilation shall be used to minimize hazards. Ventilation design guidelines, as found in the American Conference of Governmental Industrial Hygienists Ventilation Manual, shall be used. As a last resort, personal protective equipment shall be relied on to minimize risks from PHM. Procedures for obtaining individual personal protective equipment (e.g. gloves, eye wear, respirators) are presented in LPR 1710.4, "Personnel Protection - Clothing and Equipment." FSH's shall contact the SFAB IH staff for recommendations.

6.5.1 Accidents, Spills, and First Aid Involving PHM

a. All accidents involving PHM, no matter how small, shall be reported to the CAM and the FSH. Personnel using the material shall be responsible for the clean up of minor spills in their work area. Minor accidents, when reported, can lead to a recognition of potential trends and the identification of needs for better equipment or procedures. For example, a minor break and splash of a PHM from a beaker in a laboratory hood could lead to the identification of a need for laboratory chemical splash barriers.

b. Establishing accident and first aid procedures is an integral part of planning for the use of PHM's. It shall be the responsibility of the user to effectively contain PHM's in the event of a minor spill and to perform clean-up operations. Consultation with EMT in developing emergency procedures shall be required. All spills of PHM shall be reported by calling 911 from any Center phone or 864-2222 from an off Center (cell phone) line. PHM's shall be deleted from inventory via the CMTS.

c. Professional first aid services are available from the OHCM OHS contractor located at 10 West Taylor Street (Building 1149), 7:00 a.m. – ~~3:30~~3:00 p.m., Monday through Friday. On-site ambulance service can be obtained at anytime by calling 911 from any Center telephone or by calling 864-5600 from a cellular telephone.

d. Preplanning for accidents involving PHM's shall always be required. Specialized training (OSHA HAZWOPER 8 hour or longer course) shall be required for chemical leaks of PHM, depending upon the situation involved. Spill clean up information and procedures to request assistance for spills beyond facility capabilities shall be in accordance with LPR 8800.1, Chapter 14, "Hazardous Material Spill Control and Contingency Plan," and on-line at:

http://osemant1.larc.nasa.gov/

6.5.2 Waste PHM

a. Waste PHM disposal shall be in accordance with federal, state, and local regulations, and LaRC procedural requirements presented in LPR 8800.1. Contact the EMT for more information or the EMT web page listed above.

6.6 OSHA/IARC/NTP SELECT CARCINOGENS

a. Carcinogenic materials shall be used only under an approved NASA Langley Form 498. Carcinogenic materials include any material for which OSHA has promulgated an emergency temporary or permanent standard that reflects its carcinogenic potential. A list of materials having this status is provided in 29 CFR 1910.1450, Appendix B, and thereby are regulated chemicals. Additions to this list may occur. The PHMC shall include any other materials it deems appropriate.

b. OSHA has worked with other agencies on a list of "select carcinogens." These materials are suspect as possible human carcinogens. These suspect carcinogens are defined in 29 CFR 1910.1450(b) and published by the International Agency for Research on Cancer (IARC) and the National Toxicology Program (NTP). Additions to the list may occur. It shall be noted that materials appearing in OSHA carcinogen standards, on NTP lists, and on IARC lists are on the select list presented. Under the OSHA 29 CFR 1910.1200, materials having OSHA carcinogen standards, or appearing on the NTP Carcinogen Report, or being listed in IARC Group 1 or 2A, shall have references to their carcinogenic effects in both MSDS's and on material labels.

c. At LaRC, these "select carcinogens" shall be considered for use under a NASA Langley Form 498, issued to define the procedures for use.

6.7 BIOLOGICAL AGENTS

6.7.1 Scope and Application

a. All operations requiring the use of biological agents at LaRC shall be permitted through the PHMC. This committee reviews the Standard Operating Procedures (SOP) drafted by the researcher for the control and use of biological agents. This SOP shall identify hazards, specify standard and specific micro bacterial laboratory techniques, create regulated areas, provide for employee training and medical monitoring, detail the requirements for exposure monitoring, list the required personal protective equipment, specify the proper procedures for the disposal of wastes, and anticipate spills and emergency response actions that may be required. Each different etiological species or new activity shall require an individual NASA Langley Form 180, "Biological Agent Approval Form."

b. At present, biological agent use is restricted to biosafety level (BSL) 1 operations; however, facility requirements shall be built and maintained at BSL-2. No research involving human body fluids or blood, human or primate cells, animals, whole plants or toxic gene products shall be permitted. Work with ionizing or non-ionizing radiation materials shall require clearance through the Ionizing or Non-ionizing Radiation Committee in addition to the PHMC.

6.7.2 Principles of Biosafety

a. Levels of protection based on the relative ability of the organism to cause disease in normal healthy adult humans and the potential for transmission during laboratory manipulation are assigned to all biological agents. Based on the biosafety levels, laboratory employees shall be protected from hazards by employing specific and special microbiological laboratory practices, using containment and barriers and assuring personal safety through training, medical surveillance and immunization when applicable. The following procedures have been adapted from “Biosafety in Microbiological and Biomedical Laboratories”, fourth edition, Centers for Disease Control (CDC) and Prevention and National Institutes of Health (NIH), and “NIH Guidelines for Research Involving Recombinant DNA Molecules." Some practices are stricter than in the CDC or NIH recommendations because their application seems appropriate for all microbiological laboratories.

b. In addition to the risk level of the organism, it is also important to evaluate the operation to determine additional hazards. The biosafety level of the entire operation shall be raised if aerosols or splashes could be released, large amounts of materials are used, or hazardous gene products are produced during an operation.

c. Biosafety Level 1 is suitable for work involving well-characterized agents not known to cause disease in healthy adult humans. These agents are of minimal potential hazard to laboratory personnel and the environment. These agents are not known to cause disease in healthy adults.

d. Biosafety Level 2 is suitable for work involving agents of moderate potential hazard to personnel and the environment. These agents are associated with human disease and hazards exist from percutaneous injury, ingestion, and mucous membrane exposure to the agent. It differs from BSL-1 in that (1) laboratory personnel have specific training in handling pathogenic agents and are directed by a competent scientist; (2) access to the laboratory is limited when work is being conducted; (3) extreme precautions are taken with contaminated sharp items; (4) certain procedures where infectious aerosols or splashes may be created are conducted in biological safety cabinets or other physical containment equipment.

6.7.3 Biosafety Level Operational Conditions and Procedures

Standard operation procedures for BSL-1 and 2 are outlined below:

BIOSAFETY LEVEL 1

Practices

Standard Microbiological Practices

1. Access to the laboratory is limited or restricted at the discretion of the principal investigator when experiments or work with cultures and specimens are in progress.

2. Hand washing shall be required after handling viable materials, after removing gloves and prior to leaving the laboratory.

3. Eating, drinking, smoking, handling contact lenses, applying cosmetics and storing food for human use shall be prohibited in the laboratory. Contact lenses shall not permitted to be worn in the laboratory.

4. Mechanical pipetting devices shall be used, mouth pipetting shall be prohibited.

5. An effective “sharps” handling program shall be used.

6. All procedures, which could produce splashes, spills or aerosol formation, shall be documented and procedures shall be followed to eliminate or minimize the hazards of these operations.

7. Prior to the start of project, decontamination methods shall determined and these procedures shall be used to decontaminate all cultures, stocks and other regulated wastes prior to proper disposal. Materials to be decontaminated shall be placed in a durable, leak proof container and closed when not in use.

8. Work surfaces shall be decontaminated upon completion of work, at the end of the day and after a spill of any viable organism. The workstation shall be left decontaminated at the end of the work shift and all viable organisms stored in proper storage areas.

9. A biohazard sign shall be posted on the entrance to the laboratory whenever biological agents are being used. In addition, a biohazard sign shall also be posted on all areas where biological agents are stored. The name of the principal investigator, telephone number, classification and names of agents shall be listed on all signs

10. An insect and rodent control program shall be in effect.

Safety Equipment (primary barriers)

1. Special containment devices or equipment such as biological safety cabinets are generally not required for manipulations of BSL-1 agents.

2. Lab coats and gloves shall be recommended to prevent contamination of street clothes and skin. These items shall be left in the laboratory and not worn into other work areas to prevent cross contamination. All protective clothing shall be either disposed of in the laboratory, or placed in special bins to be laundered by the employer. It shall never be taken home.

3. Protective eyewear shall be worn in the laboratory at all times.

Facility Requirements (secondary barriers)

1. Laboratories shall have doors that allow access control.

2. An open bench top sink for hand washing shall be required.

3. The materials of the laboratory shall be designed to be easily cleaned and decontaminated. Bench tops, walls and floors shall be impervious to water and resistant to moderate heat and the organic solvents, acids, alkalis and chemicals used to decontaminate the work surfaces and equipment. Chairs and other furniture used in the laboratory shall be covered with a non-fabric material that can be easily decontaminated. Carpets and rugs are not appropriate.

4. Laboratory furniture shall be capable of supporting anticipated loading and uses. Spaces between benches, cabinets, and equipment shall be accessible for cleaning.

5. An eyewash station shall be readily available and inspection conducted and documented ~~monthly~~weekly.

6. If the laboratory has windows that are open to the exterior, they shall be fitted with fly screens.

7. Mechanical ventilation systems shall be balanced to provide an inward flow of air without recirculation to spaces outside the laboratory.

8. Illumination shall be adequate for all activities, avoiding reflections and glare that could impede vision.

BIOSAFETY LEVEL 2

Practices

Standard Microbiological Practices listed under BSL-1 in addition to

1. If materials are required to be transported outside the laboratory for decontamination or disposal, they shall be packaged in accordance with applicable local, state and federal regulations prior to moving from the laboratory.

2. The principal investigator shall establish policies and procedures, which insure that only persons who have been advised of the potential hazards and meet specific entry requirements (i.e. immunizations) may enter the laboratory.

3. In addition to the information listed in BSL-1, any required immunizations, personal protective equipment, and special procedures needed to exit the laboratory shall be listed on all biohazard signs.

4. Laboratory personnel shall receive all appropriate immunizations or tests for the agents handled or potentially present in the laboratory. When appropriate, baseline serum samples for laboratory and other at risk personnel shall be collected and stored. Additional periodic sampling shall be required.

5. The principal investigator shall insure that laboratory and support personnel receive and document appropriate training on the potential hazards associated with the work involved, the necessary precautions to prevent exposures and the exposure evaluation procedures. Annual refresher training shall be required.

6. Needles and other sharp instruments shall be restricted in the laboratory for use only when then is no alternative. Plastic ware shall be substituted for glassware whenever possible. Only needle locking units or disposable syringe-needle units (needle is integral to the syringe) shall be used when needed.

7. Cultures, and other materials containing biological agents or potentially infectious wastes shall be placed in a container with a cover that prevents leakage during collection, handling, processing, storage, transport or shipping.

8. In addition to BSL-1 decontamination procedures, any equipment that could be contaminated shall be decontaminated according to any local, state or federal regulations before it is sent for repair or maintenance or packaged for transport before removal from the laboratory.

9. Spills and accidents that could result in exposures to infectious materials shall be immediately reported to the FSH. The employer shall provide medical evaluation, treatment and surveillance as appropriate and written records of the event shall be maintained.

Safety Equipment (primary barriers)

Safety equipment listed under BSL-1 in addition to

1. Class II Biological Safety Cabinets (BSC's) or other personal protective equipment and containment devices shall be used whenever work with BSL-2 agents can create aerosols or splashes. These activities could include centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, or opening containers of materials whose internal pressures may be different from ambient pressures. High concentrations or >10 liters of infectious agents shall also require containment to prevent spills or aerosol release. These materials shall be centrifuged in the open laboratory if sealed rotor heads or centrifuge safety cups are used and if these rotors or safety cups are opened only inside a biological safety cabinet. Biosafety cabinets shall be evaluated on an annual basis and comply with standards listed in National Science Foundation, Article 49, "Government Performance and Results Act."

2. Face protection (goggles, mask, face shields or other splatter guards) shall be used for anticipated splashes or sprays of infectious material when microorganisms must be manipulated outside the BSC.

3. Protective laboratory coats designated for laboratory use only shall be used while in the laboratory. Glove use shall also be required during manipulations. Disposable gloves shall not be washed and reused or used to touch “clean” surfaces such as keyboards, telephones, writing utensils or notebooks.

Facility Requirements (secondary barriers)

Facility requirements in addition to those listed under BSL-1

1. Install and locate biological safety cabinets to ensure that fluctuations of the room supply and exhaust air do not cause the cabinets to operate outside the regulated levels for containment bases on NSF-49.

2. Facilities that house restricted agents (as defined by 42 CFR 72.6, 42 CFR 73.3, and 42 CFR 73.4) shall provide lockable doors.

6.7.4 Addition of Biologically Active Materials to a Permitted Operation

a. New agents or projects shall be added by the Principal Investigator and the FSH by submitting a NASA Langley Form 118 and a NASA Langley Form 180, "Biological Agent Review Form," to the PHMC. Since biological agent research is of a continuously changing nature, the review of these materials shall be accomplished in 3 months to enable the research to remain flexible and workable.

6.7.5 Addition of Certified Workers

a. A list of Certified Workers shall be included in each NASA Langley Form 180. New workers shall be added by the FSH by submitting a NASA Langley Form 66 to the PHMC and OHCM OHS contractor. A copy of the NASA Langley Form 180 shall accompany the NASA Langley Form 66. The submission and approval of these forms shall be required before the person can conduct work with this agent. Upon approval, the PHMC and OHCM OHS contractor physician shall sign the form. Contractors shall submit equivalent information to the SFAB.

6.7.6 Recordkeeping for the Biological Agent Operations

a. The records required for Biological Agent Operations:

(1) The laboratory shall keep a copy of the current permit and a list of approved NASA Langley Form 180 in the laboratory. These forms shall be amended as required and submitted to the PHMC for review.
(2) A list of personnel trained to use the particular agent, the date of the training and the person conducting the training. These records shall be maintained in a computer database in the FSH or his/her designee's office and the dates of the training shall be listed on the NASA Langley Form 180 for the project.
(3) The time personnel will be working with the specific agents shall be specified. This information shall be logged on a NASA Langley Form 62, "Chemical Worker's Certification Card," attached to each fact sheet. Copies of this form shall be sent to the PHMC and to OHCM OHS contractor. This NASA Langley Form 62 shall be attached to the PHM permit behind each the NASA Langley Form 180.

b. Biological agent permits shall be reviewed annually during the SFAB IH audit.

6.8 STORAGE, USE AND DISPOSAL OF "SHARPS"

a. Exposure to chemicals and biological agents can occur by several different routes: (1) inhalation, (2) ingestion, (3) absorption through skin or eyes and (4) injection. The purpose of this section is to control exposures caused by injecting chemicals or biological agents through the skin barrier.

b. Exposure to toxic agents by injection does not happen frequently in the laboratory, but it can occur inadvertently by mishandling "sharps" such as glass, syringes or metals contaminated with toxic agents. The intravenous route is especially dangerous because it introduces the toxicant directly into the bloodstream, eliminating the process of absorption. Non-laboratory personnel such as custodial or maintenance workers, as well as laboratory workers shall be protected from this form of exposure.

c. Hand injuries are the most common injuries in laboratories. Keeping all cutting and puncturing devices fully protected, and employing utility knives instead of single edge razor blades as cutting tools can prevent many of these injuries. Syringes with

needles shall be used once, if possible, and then placed in a suitable disposal container. Injuries are more likely if the syringes are used more than once. Kevlar gloves of different thicknesses shall be made available and shall be used when handling sharp objects, such as metal foil or picking up broken glass. If a cutting tool does not do the job, users shall select a better tool and should not simply apply more pressure.

d. When ordering razor blades, foil or syringes with needles, order only the amount that will be used in the project. Do not stockpile these materials. Items shall be stored in protective boxes out of sight, inside drawers or cabinets, and shall not be left out on countertops or workstations where they could cause injury to others. Special holding devices shall be ordered if the needles are required to be used over and over. Always order the blunt tip needles for laboratory work, if possible. Beveled tip needles are usually used in medical situations where easy injection into the skin and tissues is desirable. Special attention shall be paid to the storage of disposable sterile hypodermic syringes that could be pilfered for illegal uses.

e. The janitorial/custodial staff shall not pick up glass, even unbroken glass drink containers, from the regular trash. Use large cardboard disposal boxes to dispose of broken glass, bottles, capillary tubes and Pasteur pipettes. These boxes shall be purchased specifically for this purpose and shall have printed on the exterior of the box “broken glass” warnings. When full, these boxes shall be taped shut, and placed in the hallway for pickup.

f. There are two types of red “sharps” containers that may be found in the work area, those labeled with the universal biohazard label and those not so labeled. The chemically contaminated sharps shall be collected separately from the biologically contaminated sharps. Biological agents shall never be placed inside the cardboard "broken glass" boxes. Used hypodermic syringes shall never be recapped and shall be dropped into the properly marked red “sharps” containers for disposal. Special one-handed safety devices shall be ordered if the recapping of needles is required by the project.

g. Razor blades and scalpels shall be placed in the red “sharps” containers after use. They shall not be left out on countertops in the work area.

h. All types of sharps containers shall be turned in to the Chemical Manager for proper disposal when almost full. Never overfill the box because this increases the possibility of accidental injury. The Chemical Manager shall issue a replacement container acceptable to the regulatory requirements with proper warning labels attached. Sharps shall not be collected in containers that have not been approved by the Chemical Manager or FSH.

APPENDIX A

GENERAL TECHNICAL INFORMATION ON TYPES OF POTENTIALLY HAZARDOUS MATERIALS (EXCLUDING GASES)

a. This appendix provides general technical data to assist LaRC employees in recognizing and controlling health and safety related problems that may arise from the use of PHM's. It contains information on solvents, acids, bases, OSHA carcinogens, and so forth. Information on selected gases is in Appendix B of this procedural requirement.

b. Additional information on PHM's can be found in the MSDS for items in use. This is typically the first reference for PHM users in facilities. Prior to the use or acquisition, site personnel shall check existing databases on PHM's to include current MSDS's on the materials proposed for use, or other existing facility process information. The Center has an on-line MSDS Library at:

http://osemant1.larc.nasa.gov/cmts/

Assistance in interpreting information on this site shall be obtained from the EMT, the SFAB IH staff, and the PHMC.

c. For research and development operations, additional review on the reaction products during the process, or possible accidental reaction process hazards, shall be performed prior to starting the operation. For example, work with gallium arsenide semiconductor chips may result in small releases of lethal arsine gas with little or no associated odor. Cyanide compounds used in metal etching or photographic processes can form lethal cyanide gas if a spill occurs with acids and cyanide compounds present. Also, work with hydrogen gases involves high flammability risks. All of these are examples of PHM with risks controllable through the use of training, process control (ventilation - fume hoods), gas leak testing and monitoring devices when these measures are put in place and used with PHM operations.

GENERAL INFORMATION ON CLASSES OF PHM

Flammable Liquids

a. The handling of solvents requires trained personnel. Because of the nature and variety of these chemicals, poisoning, evaporation, fire, and explosion hazards exist. Incompatible solvents shall not be stored together and all containers shall be properly sealed and kept in suitable areas. (Requirements for storage are provided in Chapter 6 of this procedural requirement.) Protective clothing shall be worn and the laboratory or use area shall be equipped with safety equipment commensurate with the hazards of the solvent. It may be necessary to also have a spill cleanup kit on hand and readily available to handle small spills (Chapter 6). Some operations involving the handling of solvents require shielding, special hoods or special protective clothing such as gloves,

aprons, face shields, goggles, coats, or other special garments. Information or assistance on the selection of these devices shall be obtained from the FSH or by contacting the SFAB IH staff.

Acids and Bases

a. The handling of acids, bases, corrosives, and toxic chemicals demands adequately trained personnel. Untrained persons shall not be granted access to the stores or permitted to handle such materials. Because of the nature and variety of these chemicals, their hazards range from poisoning, burning, and gassing through explosion. Care shall be exercised to assure that incompatible chemicals are not stored together. All containers shall be properly sealed and kept in appropriate storage areas. Suitable protective clothing shall be worn and the laboratory shall be equipped with safety equipment commensurate with the hazards of the acid or base, such as an eyewash station, a safety shower, and a fume hood. It shall be required to have a spill cleanup kit on hand and readily available to neutralize small spills. Most chemicals of this class are capable of inflicting severe burns when spilled on skin or clothing. Pending medical treatment, initial first aid for every chemical burn is to wash off the chemical by flooding the burned area with very large amounts of water as quickly as possible. This is the only method for limiting the severity of the burn, and the loss of even a few seconds can be vital. Following complete washing, the burn should be covered with a clean, preferably sterile, cloth or sheet, and the victim should be taken to a physician. No ointment, salve, grease, stimulant or other remedy shall be used without the physician's advice, except for the use of calcium gluconate for treatment of hydrofluoric acid burns. Dial 911 from any Center telephone or 864-2222 from a cellular telephone to obtain medical assistance. Some operations involving the handling of this class of chemicals shall require shielding, special hoods, or special protective clothing such as gloves, aprons, face shields, goggles, coats, or other special garments.

Acids

a. As a group, acids are highly reactive. This reactivity adds to their usefulness but it also demands that laboratory spills be given special attention. Three factors should be remembered when considering methods to clean up minor acid spills:

(1) Reactivity with water,
(2) Corrosiveness of the chemical and its decomposition products, and
(3) Irritability of the chemical and its decomposition products.

Problems associated with these factors can be easily solved with common sense and general laboratory safety.

b. Water **shall not** be used on most concentrated acid spills unless the water can be delivered in deluge quantities. Most concentrated acids react vigorously with water, producing corrosive products. In addition, the exothermic reaction will cause increased vaporization of the reagent, which may have a pungent irritating odor even under the best of ventilation conditions. Reagent spills shall first be absorbed with the appropriate

spill cleanup kit. The damp mixture can then be scraped up with a plastic, ceramic, or metal scoop. Successful use of this technique requires that the spill cleanup kit be readily accessible. The EMT shall be contacted for disposal of the cleanup material.

c. As in the handling of most chemical spills, safety glasses and rubber gloves are required to safely clean up acid spills. Gloves do not permit prolonged contact but they offer adequate protection for the removal of most spills. Splashes on the skin or in the eyes shall be rinsed immediately with a heavy flow of water. Clothing splashed with acids shall be removed and washed before reuse.

d. **Avoid acid mists in air.** Small spills, which occur in a clear open area, such as the floor or the center of a laboratory bench, can be cleaned by personnel with only a brief exposure to mists. Other spills may be larger or occur in an inconvenient spot with poor ventilation, causing higher exposures and necessitating use of a self-contained breathing apparatus.

e. The occurrence and effects of spills can be minimized by observing a few general precautions:

(1) Limit the size of reagent bottles in the laboratory. Generally, only a one-month supply of chemicals shall be kept in the laboratory area. Larger quantities shall be kept in approved facility storage vaults.
(2) Leave adequate headspace in bottles.
(3) Do not store reagents in a warm spot.
(4) Keep the bottles in a tray, preferably ceramic or glass lined.
(5) Keep an acid spill kit on-hand.
(6) Do not use water to fight a fire involving acids. Use a dry chemical or CO_2 extinguisher. Water can be used for small spill amounts if the water is delivered in deluge quantities.
(7) Use approved bottle carriers when necessary to transport chemicals.

Bases

a. The major hazard in the use of bases is their corrosive action on tissue. Severe, painful tissue damage can rapidly result from acute exposures in which significant amounts of bases are inhaled, splashed on the skin, or swallowed.

b. Contact with the skin or eyes are the most common hazard. Unlike inhalation exposures, contact injuries occur frequently in the laboratory. Only small amounts of concentrated bases are needed to cause damage, which may range from annoying irritation to deep flesh burns and permanent visual impairment. Mist or spray, which is too light to cause a skin break, may cause dermatitis. If the exposure is constant, more serious skin problems may develop, requiring prolonged medical treatment.

c. Workers shall be cautioned to check themselves over thoroughly after working around bases to ensure that no clothing or skin has been attacked. There is no warning

sting with bases, as with acids, and an unattended burn can make considerable headway before it is noticed.

d. The most important aspect of any spill is the prompt removal of the chemical, which contacts the skin or eyes. Concentrated bases are not easily rinsed from the skin and continuous flushing with water is needed. The same is true for material splashed in the eyes--use eyewash or a gentle flow of water from a hose. Flushing for at least 15 minutes is recommended. Small splashes on the fingers, hands, or arms usually will not cause any irritation if the material is promptly washed off. These body parts can be easily held in a heavy and continuous flow of water from a sink faucet. Other parts of the body will be more difficult to flush thoroughly and medical attention should be promptly obtained. Obtain medical attention for eye splashes by dialing 911 from any Center telephone or 864-2222 from a cellular telephone.

e. Ingestion is unlikely in the laboratory but sudden direct releases or an explosive reaction may cause involuntary swallowing of material sprayed in the face. Neutralizing solutions may be taken if they are immediately available and if prior medical approval has been granted for their use. If these solutions are not available, a large amount of water should be taken at once to afford dilution. Immediately obtain medical attention by dialing 911 from any Center telephone or 864-2222 from a cellular telephone.

f. Laboratory spills of bases shall be cleaned using the appropriate spill cleanup kit. The damp mixture can then be scraped up with a plastic, ceramic, or metal scoop. Spill cleanup kits shall be kept available throughout the laboratory. Personnel in the EMT shall be contacted for disposal of the cleanup materials.

g. For technical information on specific bases, refer to the MSDS or contact the SFAB IH staff or the EMT.

GENERAL LABORATORY SAFETY PROCEDURES

a. Laboratory fume hoods are in use at several locations at this Center. Basic posting guidelines for the safe use of laboratory hoods are in Figure A.1, "Work Practices for Laboratory Hoods." Additionally, a quick posting guide to general laboratory safety is shown in Figure A.2, "Recommended Unit Operations Laboratory Safety Rules."

No large, open-face hood with a low face velocity can provide complete safety for a worker standing at the face against all events that may occur in the hood. The hood may not adequately protect the worker from volatile or otherwise airborne contaminants with a TLV in the low-part-per-billion range. For more ordinary exposures, a properly designed hood in a properly ventilated room can provide adequate protection. However, certain work practices are necessary in order for the hood to perform capably. The following work practices are generally required; more stringent practices may be necessary in some circumstances.

1. Conduct all operations that may generate air contaminants at or above the appropriate TLV inside a hood.

2. Keep all apparatus at least 6 inches back from the face of the hood. A stripe on the bench surface is a good reminder.

3. Do not put your head in the hood when contaminants are being generated.

4. Do not use the hood as a waste disposal mechanism except for very small quantities of volatile materials.

5. Do not store chemicals or apparatus in the hood. Store hazardous chemicals in an approved safety cabinet.

6. Keep the hood sash closed as much as possible.

7. Keep the slots in the hood baffle free of obstruction by apparatus or containers.

8. Minimize foot traffic past the face of the hood.

9. Keep laboratory doors closed (exception: some laboratory designs require lab doors to be open).

10. Do not remove hood sash or panels except when necessary for apparatus set-up; replace sash or panels before operating.

11. Do not place electrical receptacles or other spark sources inside the hood when flammable liquids or gases are present. No permanent electrical receptacles are permitted in the hood.

12. Use an appropriate barricade if there is a chance of explosion or eruption.

13. Provide adequate maintenance for the hood exhaust system and the facility supply system. Use static pressure gauges on the hood throat, across any filters in the exhaust system, or other appropriate indicators to ensure that exhaust flow is appropriate.

14. If the hood sash is supposed to be partially closed for the operation, the hood should be so labeled and the appropriate closure point clearly indicated.

Figure A.1, Work Practices for Laboratory Hoods.

1. "Horseplay" is hazardous and shall not be tolerated.
2. Do not work alone in the laboratory at any time except to prepare flow diagrams and operating procedures for equipment.
3. Use required personal protective equipment (PPE) whenever specified by the laboratory director.
4. Do not wear contact lenses when vapors or fumes are present.
5. Wear safety glasses with side shields and plastic lenses (shall meet ANSI Standard Z87. 1) at all times. Wear splash goggles or face shields as prescribed by the director.
6. Do not wear sandals, open shoes, high-heeled shoes, shoes (or boots) with holes in the soles, or shoes with vas uppers; do not wear shorts or skirts. Wear shirts or blouses.
7. Secure long hair and loose items of jewelry or clothing when working with rotating machinery.
8. Know the use and location of all emergency equipment in the laboratories, shops, and storage areas.
9. Know to call 911 to summon emergency response personnel. This 911 number shall be posted at every phone throughout the facility.
10. Be familiar with all the elements of fire safety: alarm, evacuation and assembly, fire containment and suppression, rescue, and facilities evaluation.
11. Do not use ungrounded wiring and two-wire extension cords. Do not use worn or frayed extension cords or those with broken connections or exposed wiring. Check that electrical devices are grounded before they are turned on.
12. Be familiar with an approved emergency shutdown procedure before initiating any experiment.
13. Do not deviate from approved equipment operating procedures.
14. Keep all laboratory aisles and exits clear and unblocked.
15. Do not sniff, breathe, or inhale any gas or vapor unless directed to do so by the laboratory director.
16. Label all containers as to content and composition with an appropriate hazard warning. Label the container with the workers name and the date the container was filled.
17. Read and obey the instructions on all warning signs.
18. Segregate all liquid and solid waste for disposal according to the instructions of the laboratory director. Neutralization of all acidic and basic wastes is prohibited unless a permit is obtain from the DEQ. Place organic waste material in the designated waste disposal cans; do not pour into any sink or floor drain.
19. Practice good housekeeping in the laboratories, shops, and storage areas.
20. Do not eat, drink, use tobacco, chew gum, or apply makeup in the laboratories, shops, and storage areas.
21. Place only chemicals in the "Chemicals Only" refrigerator and place only food items in a "Food Only" refrigerator. Do not use ice from the ice machine for human consumption or to cool any food or drink
22. Report any glassware breakage or malfunctioning instruments or equipment to the teaching assistant.
23. Report all injuries, accidents, and "close calls" to the laboratory director. Complete the accident report as soon as possible.
24. Report spills of any chemicals to the laboratory director. Follow his/her directions for containment and cleanup. Report all mercury spills to the laboratory director. Follow the prescribed instructions for cleanup and decontamination of all spill areas.
25. All personnel shall wash hands their before leaving the laboratories or shops.
26. Do not toss tools, supplies, or any other items from one person to another.
27. Do not pipette or siphon any material, even water, by mouth.
28. Secure compressed gas cylinders at all times. Follow proper safety procedures when moving compressed gas cylinders.
29. Use only gauges that are marked "Use no oil" for oxygen cylinders. Do not use an oiled gauge for any oxidizing or reactive gas or any gas that has not been "water pumped."
30. Never play with compressed gas hoses or lines, or point their discharges at any person.
31. Do not use open flames or heating elements when volatile chemicals are exposed to air.
32. Only expose toxic chemicals to the air under a hood. Only expose flammable chemicals to the air under a hood or in an adequately ventilated area.
33. Limit personal items brought into the laboratory to those things necessary for the experiment.
34. Discourage casual visitors to the laboratory; obtain permission from the laboratory director for visitors to enter. All visitors and invited guests shall adhere to all laboratory safety rules, with adherence being the responsibility of the person visited.

Figure A.2, Recommended Unit Operations Laboratory Safety Rules.

APPENDIX B

GENERAL TECHNICAL INFORMATION ON GASES AND CRYOGENS

a. Most gases including inert gases have some hazards associated with their use. ALL CYLINDERS ARE TO BE CONSIDERED PHM AND TRACKED THROUGH THE CMTS. Any gas stored or used from a compressed gas cylinder has the hazard normally associated with that of high-pressure vessels or systems, that is, rupture and/or explosive force on release. Some gases have chemical properties, which make them hazardous in other ways, for example, gases that may be flammable, toxic, or explosive when released in a working environment. Other gases (i.e., liquid nitrogen or Helium), though chemically inert, can displace the oxygen of the air and cause asphyxiation of personnel in an area not well ventilated with fresh outside air. Also, any gas, which reacts with O_2, can cause suffocation under circumstances where O_2 is not replenished. The gases, which are flammable over wide composition ranges with air or oxygen, include hydrogen, carbon monoxide, methane, ethane, acetylene, and propane. The same gases may form explosive mixtures with air or O_2 under certain conditions.

Toxic Gases and Cryogens

a. Some gases normally used in the form of cryogenic liquids or solids have other hazards associated with their use. The low temperatures present local freezing hazards to personnel exposed for a sufficient length of time. Liquid H_2, O_2, and F_2 are very hazardous materials due to the high local concentration of these normally active gases. The powerful oxidizers, liquid O_2 and F_2, shall be protected from contact with organic materials or fuels as explosive reactions may result. Liquid N_2, although a relatively inert gas, has its hazards also: (1) the low temperature, (2) (in common with other liquefied gases) if spilled or allowed to evaporate quickly in large quantities in confined areas, can so dilute or replace the O_2 of the air that asphyxiation will ensue, and (3) the liquid N_2 can condense the O_2 from the air making a mixture of liquid N_2 and O_2 which may assume some of the hazards of liquid O_2, that is, violent reaction with organic compounds.

b. General safety precautions, for most of the gases covered herein, are to provide good positive ventilation and in the case of the flammable and explosive gases, provide spark and explosion-proof fan motors and electrical equipment. The ventilation system shall be designed with the density of the gas relative to air as a prime consideration. For minor leakage, the gas will follow air streams. For large leaks, separation of gases from air due to density will occur. Normal design for catastrophic failure is for density effects. The American Conference of Governmental Industrial Hygienists (ACGIH) industrial ventilation manual can be used as a technical reference, or contact the SFAB IH staff. It is recommended that gas bottles being used be secured in outside, covered but not enclosed areas, and appropriate lines be used to pipe the gases to the use point. Detection alarm monitors and automatic cut-off valves are also recommended when operating inside the facilities where the hazardous gas is being used. The Fire Department shall conduct all rescue operations requiring Self-Contained Breathing

Apparatus (SCBA). The prime safety precaution shall be to limit concentration of these gases so that the risk of damage is minimized at all times.

c. For cryogenic liquid gases the precautions shall be to use equipment (e.g. cryogenic gloves, aprons, eye protection) to guard against freezing and avoid spills or very rapid evaporation into an enclosed area. Oxygen deficiency alarm monitors shall be located in areas where spills may occur.

d. The information furnished here may not provide enough detail for some of the gases listed, particularly H_2 gas and cryogenic liquids. Additional data is available from SFAB, SMAO.

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH) CONCENTRATIONS FOR GASES AND SELECTED HAZARDOUS SUBSTANCES

a. Immediately Dangerous to Life or Health (IDLH) concentrations of gases represent the exposure concentrations at which, in the event of a respirator or ventilation system failure, the exposure is likely to cause death, immediate or delayed permanent adverse health effects, or prevent escape from such an environment. Information on IDLH gas concentrations can be obtained from the National Institute of Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards. As a guide, processes involving gases with IDLH's of 5,000 ppm or less shall have a NASA Langley Form 498. For example, operations involving 0.5 percent (5,000 ppm) methyl bromide (IDLH of 250 ppm) shall require a NASA Langley Form 498. Others above 5,000 may require a NASA Langley Form 498 depending on the volume and use conditions.

b. For additional information on these substances, contact SFAB,SMAO.

Appendix C

CENTERWIDE CHEMICAL HYGIENE PLAN

TABLE OF CONTENTS

I. PURPOSE

a. These Chemical Hygiene Plan (CHP) requirements have been developed in accordance with OSHA 29 CFR 1910.1450. The CHP outlines specific workplace practices and procedures to ensure that all employees are protected from health hazards associated with the use of chemicals with which they work.

b. These CHP requirements have been prepared expressly for LaRC. The purpose of the CHP is to inform personnel (especially new employees, co-ops, grantees, contractors, and technicians) of a facility's safety organization, its requirements, its resources, and particular hazards that a worker can expect to find. It is not a substitute for existing safety handbooks, regulations, or operating procedures – but rather a summary or a supplement, relevant to LaRC laboratories.

c. It is important for all personnel to read this plan and a number of other required safety-related documents. No one is expected to retain all of this material. Everyone is expected to know: (1) who to contact concerning safety related matters, and (2) where to find safety-related documentation and reference materials.

II. RESPONSIBILITY

a. The CHP is a part of LaRC's overall safety program. The following is an outline of individual responsibilities:

LaRC Safety Manager - Head, Safety and Facility Assurance Branch

(1) Responsible for the development of safety programs as outlined in LaRC directives and procedural requirements, including overall responsibility for CHP.
(2) Monitor the procurement, use and disposal of chemicals used.
(3) Approve all safety permits and chemical worker certifications.
(4) Provide regular, formal chemical hygiene and housekeeping inspections, including routine inspections of emergency equipment.
(5) Assist project directors develop precautions and adequate facilities.
(6) Determine the required levels of protective apparel and safety equipment.
(7) Conduct periodic ventilation measurements to assure proper functioning of fume hoods and other local exhaust ventilation equipment.

Chemical Hygiene Officer - Facility Safety Head

(1) See that appropriate audits are conducted.
(2) Know the current legal requirements concerning regulated substances.
(3) Seek ways to improve the chemical hygiene program.

(4) Coordinate necessary training in accordance with the CHP.
(5) Establish and review normal and emergency operating procedures.
(6) Consult with the SFAB IH staff concerning chemical control measures including ventilation and personal protective equipment.

Laboratory Supervisors

(1) Ensure that workers know and follow the chemical hygiene rules that personal protective equipment is available and in working order and that appropriate training has been provided.
(2) Plan each operation in accordance with the facility's chemical hygiene procedures.
(3) Know the current legal requirements concerning regulated substances.

Laboratory Personnel

(1) Each individual shall be required to have read and understand this CHP and supplements applicable to their work areas.
(2) Conduct each operation in accordance with the facility's chemical hygiene procedures.
(3) Know the hazards associated with each chemical used by the individual by reviewing MSDS information prior to use and periodically as deemed appropriate.
(4) Know and use required personal protective equipment for each operation.
(5) Develop good personal hygiene habits.

III. GENERAL SAFE LABORATORY PRACTICES

To achieve safe conditions for the laboratory and laboratory workers the following safety procedures shall be followed:

A. DRESS CODE

Clothing worn by laboratory personnel will protect the body from chemical exposure or burns. Shorts, cut-off sleeves, fish net shirts and tank tops shall not be permitted at any time. No employees shall be permitted to work bareback or barefoot. Personnel are encouraged not to wear sandals in the laboratory. Wearing laboratory coats over street clothing is also recommended, to prevent the transfer of hazardous materials from the work to home environment.

B. EATING

Consumption of food and/or beverages shall not be permitted in the laboratory and process areas. Glassware or utensils that have been used for laboratory operations shall never be used for food or beverages. Laboratory

refrigerators and ice machines shall not be used for food storage. The crushed ice from these machines shall not be used in beverages. Labels shall be posted on all refrigerators and ice machines indicating whether or not they are safe for food use.

C. EMERGENCY REPORTING

All emergencies shall be reported by dialing 911 from any Center telephone or 864-2222 from a cellular telephone or by contacting the SFAB, SMAO at 864-7233. All telephones have labels bearing emergency number.

1. First-Aid

In the event of a medical emergency, Fire Department personnel will respond. The location of all safety showers and eye wash stations are indicated in the laboratory specific supplement. Basic first aid procedures to be used are as follows:

a. Eye Contact - Promptly flush eyes at an eyewash station for at least 15 minutes. Be sure to open lids while flushing.

b. Skin Contact - Promptly flush and wash the affected area with soap and water. If only the face is involved, the eye/face wash fountains can be used to flush the area with water. Remove all contaminated clothing in a manner that will not cause further contact with the skin.

c. Inhalation - Immediately remove from the exposure area to fresh air.

2. Accidents

In the event of a serious accident or illness, proceed immediately to the OHCM OHS contractor located at 10 West Taylor Street (Building 1149), for treatment. If possible, all minor incidents should be reported to the FSH and supervisor before reporting to OHCM OHS contractor location. If not possibly the incident shall immediately be reported to the FSH and supervisor upon returning from the OHCM OHS contractor location. The FSH shall be responsible for notifying the SFAB, SMAO all accidents, close calls, health related incidents or spills that could cause serious health hazards, therefore, all incidents shall be reported as soon as possible.

3. Chemical Spills

a. In the event of a small-scale spill (less than 1 liter) or airborne release of a non-toxic chemical, notify the FSH, his/her designee or alternate immediately. The location of all spill kits shall be indicated on the facility diagrams in the laboratory specific supplement. All laboratory personnel working with chemicals shall be familiar with the proper use of these spill kits and their location.

b. Determine the severity of the spill and possible means of temporarily containing the spill with spill pads, absorbent booms or socks. If the spill is too large to handle on an individual basis, notify personnel in the immediate area to evacuate the facility. After contacting emergency personnel, including the FSH, his/her designee or alternate, keep the area clear and await further instructions.

c. In addition to notifying the FSH, his/her designee or alternate, the EMT shall be notified, at 864-3500, in the event of a toxic chemical or oil spill which may end up contaminating the sewer system or, which represents a serious health hazard. Spill responses are mentioned in Chapter 15 of LPR 8800.1. User responsibilities as outlined in this CHP are to maintain containment and clean-up supplies, identify the material and estimate the volume, and clean up the spill (Class I); use special precautions or seek assistance for Class II spills. In the case of toxic spills, the area shall be cleared and the Fire Department notified immediately by dialing 911 from any Center telephone or by dialing 864-5600 from a cellular telephone. This CHP does not supersede LPR 8800.1 or other LaRC directives and procedural requirements concerning spill control.

D. HYGIENE/HOUSEKEEPING

a. Do not use mouth suction to pipe chemicals or to start a siphon; a pipette bulb or an aspirator shall be used to provide vacuum.

b. Always wash hands and exposed skin with soap before leaving the laboratory area and before and after glove use. Do not use solvents for washing skin. They remove the natural protective oils from the skin and can cause irritation and inflammation. In some cases, washing with a solvent might facilitate absorption of toxic chemicals. Use protective gloves and clothing to keep chemicals off skin.

c. The laboratory area shall be kept clean and free from obstructions. Clean up shall follow the completion of any operation at the end of the day.

d. Access to exits, emergency equipment and/or controls shall never be blocked.

e. All chemicals and containers shall be properly identified and labeled with CMTS inventory numbers, hazard warning labels and NFPA diamond labels. The NFPA diamond label with the material name or trade name shall be placed on transfer containers (e.g., beakers, flasks) whenever possible. Unlabeled containers shall not be permitted in the laboratory. MSDS's shall accompany all laboratory chemicals when entering or exiting the facility. See Chapter 3 of this procedural requirement for the proper methods to bring chemicals into or ship chemicals out of a facility.

f. Wastes shall be labeled properly and deposited in appropriate containers. Waste labels are available from the EMT (864-3500).

E. LABORATORY HOODS

a. Operations involving toxic gases, vapors, aerosols, and dusts shall be performed in a hood. Laboratory hoods offer significant employee protection. They prevent toxic, offensive or flammable vapors from entering the general laboratory atmosphere, they place a physical barrier between the workers and the chemical environment, and they provide an effective containment device for accidental spills of chemicals. Laboratory hoods shall remain on at all times and the sash shall be lowered when not in use or when physical protection is needed.

F. MATERIAL SAFETY DATA SHEETS (MSDS's)

a. OSHA requires all employers to maintain a complete and accurate MSDS for each hazardous chemical that is used at their worksite. Manufacturers/ suppliers shall supply this information when a material is purchased. These MSDS's shall be updated whenever new and significant information becomes available concerning a product's hazards or ways to protect against these hazards. All chemicals entering a facility shall be accompanied by a MSDS, whether the material was purchased or obtained as a complimentary sample. If the MSDS's are missing, it shall be the individual's responsibility to obtain these from the manufacturer and supply copies to the FSH or his/her designee.

b. These MSDS's provide an excellent source of specific information about chemicals, which employees handle. MSDS's shall be readily available in designated notebooks. In addition, MSDS's shall be found on the web at the following web sites:

http://osemant1.larc.nasa.gov/cmts/
http://www.fishersci.com

http://www.ilpi.com/msds/index.chtml.

c. These sites can be bookmarked in your computer for quick and easy access. It shall be each employee's responsibility to review the hazards associated with all chemicals that they use. Additional MSDS's and information on possible hazards shall be obtained from the SFAB IH staff at 864-7233.

d. A MSDS and a NASA Langley Form 44 shall accompany any chemical substance, either commercial or experimental, leaving or entering a facility. If a MSDS for the compound does not exist, then it shall be the individual's responsibility to create one with the support of the SFAB IH staff.

G. MEDICAL CONSULTATION/EXAMINATION

a. Personnel at LaRC are entitled to medical attention because of their potential exposure to hazardous materials in accordance with various LaRC health and safety requirements. In general, personnel identified as chemical workers shall receive examinations from the OHCM OHS contractor or other qualified medical personnel. The exact requirements are in other directives, but these medical services are generally outlined as follows:

(1) New employee physical examinations. If possible, exit exams upon termination of employment.

(2) Examination for chemical worker certification.

(3) When an employee develops signs or symptoms associated with a hazardous chemical that he or she may have been exposed to in a laboratory.

(4) When an occurrence, such as a spill, leak, explosion, or other type of emergency occurs in a laboratory resulting in the likelihood of hazardous exposure.

(5) When monitoring indicates an exposure level exceeding the Action Level or Permissible Exposure Limit for a chemical as cited by OSHA, ACGIH or NIOSH.

b. Consultation with a medical professional shall be provided free to the employee, as is any examination or other attention recommended by the consulting physician, at a reasonable time and place. This laboratory standard also requires the keeping of records of medical consultations and exposure evaluations. Any individual, including civil servants, apprentices, co-ops, and temporary employees, working with PHM's shall be certified

through the safety and certification process. Contact the CHO for the appropriate certification forms.

H. PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment that shall be worn in laboratories includes, but is not limited to:

1. Gloves - When handling any chemical, gloves shall be worn. The specific chemical characteristics shall determine the glove type to be worn. Contact the SFAB IH staff at 864-7233, for glove selection guidelines and chemical incompatibilities.

2. Hard Hats - Hardhats shall be required in designated hardhat areas.

3. Hearing Protection - Whenever employee noise exposure exceeds the 8-hour time weighted average of 85 decibels, the employee shall wear hearing protection. All high noise areas and equipment generating high noise levels shall be posted. Hearing protection shall be worn if operating any posted equipment or if working in a high noise area.

4. Respirators - When exposures to dust, fumes, mist, radionuclides, gases and vapors exceed established limits of exposure, respiratory protection shall be required.

5. Safety Glasses - To protect eyes from laboratory hazards, employees shall wear safety glasses with side shields at all times in laboratories, any laboratory with a fume hood, when working with hazardous materials, and the shop areas. Operations that require improved protection against impact, liquid splash and other eye hazards shall require safety goggles and/or face shields. Safety glasses can be obtained from the FSH. All visitors entering laboratories shall be required to wear plastic safety glasses.

   Contact lenses shall not be worn in work areas. If contact lenses are needed for medical reasons, they shall be used in conjunction with goggles and during an emergency shall be removed before eye irrigation. Contact the FSH or SFAB IH staff if you have a doctor's recommendation to wear contact lenses.

I. ROUTES OF EXPOSURE

Exposure to hazardous chemicals can be minimized by understanding the common routes of exposure.

1. Inhalation - Inhalation of toxic vapors, mists, gases or dusts can produce poisoning by absorption through the mucous membrane of the mouth, throat and lungs and can seriously damage these tissues by local action. The degree of injury resulting from inhalation exposure depends upon the toxicity of the material and its solubility in tissue fluids, the depth of respiration and the amount of blood circulation. To prevent inhalation exposure, adequate ventilation shall be provided.

   The American Conference of Governmental Industrial Hygienists (ACGIH) produces annual lists of Threshold Limit Values (TLV's) and Short Term Exposure Limits (Steels) for common chemicals used in laboratories. The National Institute of Occupational safety and Health (NIOSH) has developed recommended exposure standards. OSHA has also developed regulatory standards (PEL's) for employee exposure. These standards represent conditions, which nearly all workers can be exposed without adverse health effects.

2. Ingestion - Many chemicals used in the laboratory are extremely dangerous if they enter the mouth and are swallowed. To prevent entry of toxic chemicals into the mouth, laboratory workers shall wash their hands before eating, smoking, or applying cosmetics, immediately after use of any toxic substance, and before leaving the laboratory. Chemicals shall not be tasted and pipetting shall never be done by mouth. Eating, drinking and the application of cosmetics shall not be allowed in a laboratory or process areas of a facility.

3. Skin and Eye Absorption - Contact with the skin is a common mode of chemical injury. Chemicals enter the skin through hair follicles, sweat glands, and cuts or abrasions on outer layers of the skin. Some chemicals can be absorbed directly through the skin into the bloodstream. Skin can also be damaged by corrosives, which then allows chemicals to enter the body. Skin contact can be prevented by use of appropriate protective equipment.

4. Injection - Exposure to chemicals through injection is the least common exposure route. However, it is possible through mechanical injury from glass or sharp metal, (such as needles or razor blades) contaminated with chemicals. Safe work practices are the best preventive measure for avoiding exposure through injection. Broken glass shall be carefully placed in the cardboard disposal boxes located in each wet laboratory. Used razor blades shall be disposed of in special containers located in each laboratory and not thrown in the trash. Contact the Chemical Manager for special containers for needle disposal. Needles shall not be recapped prior to disposal. There are two types of red "Sharps" containers available for the work area, those labeled with the universal biohazard label and those without. Biologically contaminated sharps

shall be collected in "Sharps" containers bearing the biohazard-warning label and separate from the chemically contaminated sharps. All types of sharps containers shall be turned in for proper disposal when almost full. Never overfill the container as this increases the possibility for accidental injury.

J. SMOKING

Smoking is prohibited in all laboratories. Smoking is only permitted outside a facility.

K. TRAINING

a. LaRC has made provisions for informing and training employees about potential health hazards and measures they can take to protect themselves when working with chemicals in a laboratory environment. Training is in accordance with OSHA 29 CFR 1910.1450, as well as OSHA 29 CFR 1910.1200. Training requirements of all the standards are similar.

b. All new employees shall receive instruction, utilizing both audiovisual material and classroom training. All employees shall be required to be familiar with the CHP for their facility. Supervisors and safety heads shall be trained regarding hazards and appropriate protective measures so they can be available to answer questions from employees and provide daily monitoring of safe work practices. As new hazards are introduced additional training shall be provided.

c. Currently, laboratory personnel, shall be required to attend a chemical hygiene training class, as required by and in accordance with OSHA 29 CFR 1910.1200 and OSHA 29 CFR 1910.1450, provided by the FSH and to attend regular safety meetings. In addition, all workers in the laboratory and process areas shall be required to attend a PPE training class as required by and in accordance with OSHA 29 CFR 1910.132, "General Requirements." Laboratory and process area workers shall also be required to attend glove use training, respirator training, or additional PHM permit training as necessary. Contact the FSH for the schedule of training classes offered.

d. The training program shall emphasize the following:

(1) Summary of OSHA 29 CFR 1910.1200, "Hazard Communication." All employees shall be required to watch a video explaining the purpose of a CHP. The current video, which is in the LaRC Safety Awareness Library, shall be obtained from the SFAB, SMAO located on the second floor of Building 1232.

(2) Chemical and physical properties of PHM's (e.g., flash point, reactivity, potential for fire or explosion).

(3) Health hazards, including signs and symptoms of exposure, associated with exposure to chemicals and any medical condition known to be aggravated by exposure to chemicals.

(4) Procedures to protect against hazards (e.g., personal protective equipment required, proper use and maintenance, work practices or methods to ensure proper use and handling of chemicals, and procedures for emergency response).

(5) Work procedures to follow to ensure protection when cleaning hazardous chemical spills and leaks, including location and proper use of spill kits.

(6) Where MSDS's are located, how to read and interpret the information on both labels and MSDS's, and how employees may obtain additional hazard information.

(7) OSHA's Permissible Exposure Levels (PEL's) and American Conference of Governmental Industrial Hygienists' Threshold Limit Values (TLV's).

e. For more information on PHM's contact the SFAB IH staff at 864-7233.

L. WASTE HANDLING AND DISPOSAL

The laboratory shall be required by federal and state regulations to manage all hazardous waste in a specific manner.

1. General

a. All containers, which contain materials, designated as hazardous waste shall be marked with the words "Hazardous Waste" and the identity of the waste. All hazardous waste containers shall be accumulated in a Satellite Accumulation Area (SAA). Specific SAA requirements can be found in LPR 8800.1.

b. Only chemically compatible containers of sufficient strength shall be used to accumulate waste. The containers shall be kept closed at all times except to add waste. The containers shall be arranged so that easy access to them exists. This will ensure that containers will not be damaged during handling. Care shall be taken during all handling to maintain the integrity of the container.

c. Containers used for accumulation of waste shall be labeled from the outset so that anyone working in the area will be aware of

the contents. It is best to keep waste separated based on particular operations as much as possible, (i.e. do not mix all solvents from different operations or chemical syntheses together). Containers shall not be filled completely to allow for expansion of contents.

d. A NASA Langley Form 163, "Waste Material Data Sheet," shall be filled out on each item to be disposed of by the generator of the waste .Specific waste disposal procedures can be found in LPR 8800.1...

e. The FEC or EMT shall be contacted whenever questions occur about the proper disposal methods for an item.

2. Petroleum Hydrocarbons

Petroleum hydrocarbons constitute a major portion of the waste stream at LaRC. Used oils (from vacuum pumps) shall be kept separate from other chemical wastes. All hydraulic fluids or other synthetic silicone oils and vacuum pump oils shall be kept in separate containers.

IV. RULES FOR WORKING WITH SPECIFIC CHEMICAL CLASSES

A corrosive is defined as a chemical with a pH greater than 12 or less than 2.5.

1. Acids

a. General Information - An acid is a substance that yields hydrogen ions when dissolved in water. Acids commonly encountered in laboratory environments include:

Name	Formula	Gloves
hydrochloric acid	HCl	neoprene or butyl rubber
nitric acid	HNO_3	neoprene or butyl rubber
hydrofluoric acid	HF	nitrile or butyl rubber
sulfuric acid	H_2SO_4	natural rubber
acetic acid	CH_3CO_2H	neoprene or butyl rubber

b. Safety Precautions - Use acids under well-ventilated conditions. Prevent all contact of vapor or liquid with skin, eyes, or mucous membranes. PPE shall include safety glasses, goggles, or a face shield. Contact lenses shall NOT be worn. Full-length sleeves and the appropriate gloves (see above or contact the SFAB IH staff, 864-7233) shall be worn. Wear aprons shall be made of acid resistant material. Respirators shall be used when required. When diluting acids with water, be sure to add the acid to the water, not

the water to the acid. Be aware of the nearest safety shower and eye wash station before beginning work.

c. Accident Response - In case of a medical emergency exposure, dial extension 911 from any Center telephone or 864-2222 from a cellular telephone. Have an appropriate spill plan for large (> 1L) and small (< 1L) quantities. Anticipate potential spills and use spill pads to make clean up easier. Have appropriate containment materials on hand in case of large spills. Notify the FSH or his/her designee immediately.

d. Transfer and Transport - Use the appropriate PPE as mentioned above and check chemical compatibility of transfer pumps and receiving vessels. When transporting small quantities use bottle carriers to prevent breakage and to act as a containment vessel should breakage occur.

e. Storage - Acids shall be segregated, preferably in separate cabinets, from active metals, oxidizing acids, organic acids, flammables and combustibles, bases and chemicals which react with acids to form toxic gases.

2. Bases/Caustics

a. General Information - Bases are substances, which yield hydroxyl ions when dissolved in water. Bases typically encountered under laboratory conditions include:

Name	Formula	Gloves
potassium hydroxide	KOH	nitrile or neoprene
sodium hydroxide	NaOH	nitrile, neoprene, natural rubber
ammonia	NH_3	nitrile, neoprene, natural rubber

b. Safety Precautions - Bases are extremely corrosive and shall be handled similar to acids with chemical specific changes. Prevent all contact of vapor or liquid with skin, eyes, or mucous membranes. PPE shall include safety glasses, goggles, and/or a face shield. Full-length sleeves and appropriate gloves (see above or contact the SFAB IH staff, 864-7233) shall be worn. Wear aprons made of base resistant material. Respirators shall be worn if necessary. Be aware of the nearest safety shower and eye wash station before beginning work.

c. Accident Response - In case of a medical emergency exposure dial 911 from any Center telephone or 864-2222 from a cellular telephone. Have an appropriate spill plan for large (> 1L) and small (< 1L) quantities. Anticipate potential spills and use chemically resistant tray and spill pads to make clean up easier. Have appropriate containment materials on hand in case of large spills. Notify the FSH or his/her designee immediately.

d. Transfer and Transport - Use the appropriate PPE as mentioned above, determine chemical compatibility of transfer pumps and receiving vessels. When transporting small quantities use bottle carriers to prevent breakage and to act as a containment vessel should breakage occur.

e. Storage - Don't store bases with acids. The reaction between the two will generate large quantities of heat. As most bases are non-volatile, special storage cabinets are not necessary.

3. Oxidizers

a. General Information - These compounds will react violently with flammables and combustibles, and shall be separated from these substances as well as reducing agents. Oxidizers often seen in laboratories include:

Name	Formula	Gloves
perchloric acid	$HClO_4$	nitrile, neoprene, PVC
chromic acid	CrO_3	butyl rubber
nitric acid	HNO_3	neoprene, butyl rubber
30% hydrogen peroxide	H_2O_2	butyl rubber

b. Safety Precautions - Unintentional contact with organic and other oxidizable substances shall be avoided. Reaction vessels containing significant quantities of these reagents shall be heated using fiberglass mantles or sand baths rather than oil baths. Prevent all contact of vapor or liquid with skin, eyes, or mucous membranes. PPE shall include safety glasses, goggles, and/or a face shield. Contact lenses shall NOT be worn. Full-length sleeves and the appropriate gloves (see above or contact the SFAB IH staff, 864-7233) shall be worn. Wear aprons of the appropriate resistant material. Respirators shall be used when required. Be aware of the nearest safety shower and eye wash station before beginning work.

c. Accident Response - In case of a medical emergency exposure dial 911 from any Center telephone or 864-2222 from a cellular telephone. Have an appropriate spill plan for large (> 1L) and small (< 1L) quantities. Anticipate potential spills and use chemically resistant trays and spill pads to make clean up easier. Stock amounts reflective of quantities likely to be encountered in spill situations. Have appropriate containment materials on hand in case of larger spills. Notify the FSH or designee immediately.

d. Transfer and Transport - Use the appropriate PPE as mentioned above, check chemical compatibility of transfer pumps and receiving vessels. When transporting small quantities use bottle carriers to prevent breakage and to act as a containment vessel should breakage occur.

e. Storage - Oxidizers shall not be stored with organics or other oxidizable compounds as they present fire and explosion hazards. They shall be stored in glass or unbreakable, inert containers. Corks and rubber stoppers shall NOT be used.

B. TOXICS

Always handle these compounds with adequate ventilation. Store in properly labeled, non-breakable containers. These substances have been divided into a number of categories.

1. Reproductive Hazards

a. General Information - Exposure of both male and female workers to specific chemicals during the reproductive cycle can have an effect on the development of the fetus. In women, toxic chemicals can have a direct effect on the female reproductive system, affect conception, cause changes in maternal hormone secretions, cause genetic damage to the egg cell, or pass through the placenta to directly affect the fetus. In men, toxic chemicals can cause changes in the testes, interfere with the production of male hormones, or cause genetic damage to the sperm cells. These conditions can act on a developing child to cause death, spontaneous abortion, malformation, retarded growth and postnatal functional deficits. In particular, an embryo toxin or fetotoxin is a substance that causes death or abnormal development of one or more body systems of the unborn child. A mutagen is a substance that causes a genetic change in the unborn child. A teratogenic agent is a substance that causes physical defects in the developing baby.

b. Safety Precautions - The period of greatest susceptibility to reproductive hazards is prior to conception and during the first twelve weeks of pregnancy, when the majority of the baby's organ systems are formed. This is also the period when a woman may not know she is pregnant, therefore special precautions shall be taken at all times. Both men and women of childbearing age shall always take adequate precautions to guard against inhalation, direct skin contact or accidental ingestion of chemicals known to be reproductive hazards. Operations shall always be carried out using impermeable containers in adequately ventilated areas (inside laboratory fume hoods or ventilated equipment.) Appropriate PPE shall be worn, especially gloves. Laboratory hoods shall be inspected for proper operation before works begins.

Chemicals, which may be reproductive hazards, shall be labeled. Some of the reproductive hazards that may be found in laboratories are classified below:

Metals:	Mercury, lead, arsenic, cadmium, aluminum, lithium (metals and salts), and chromium
Gases:	Ethylene oxide
Organic Chemicals:	N-methyl-2-pyrrolidone, N,N-dimethylacetamide, y-butyrolactone, polychlorinated biphenyls (PCBs), dibenzofurans, benzene, xylene, cyclohexanone, glycol ethers and glycol ether acetates, alkanesulfones, acetamides, formamides, dibromochloropropane, and methanol

The FSH and supervisor shall be notified of pregnancy as soon as possible. Pregnant employees shall only be allowed to work in the laboratory after a thorough evaluation of the hazards has been conducted by the supervisor and the employee's doctor.

c. Accident Response - In case of a medical emergency exposure dial 911 from any Center telephone or 864-2222 from a cellular telephone. Notify your supervisor and the FSH or his/her designee immediately concerning all incidents of exposure or spills.

d. Transfer and Transport - Use appropriate precautions whenever transferring or transporting these materials to eliminate exposure.

e. Storage - Store these substances, properly labeled, in a well-ventilated area, preferably in an unbreakable container.

2. Allergens or Sensitizers

   a. General Information - Allergens are substances, which produce skin and lung hypersensitivity. Examples include dianhydrides, most resin curing agents, diazomethane, chromium, nickel, bichromates, formaldehyde, isocyanates, and certain phenols. There is a wide variety of response from one individual to another so contact with chemicals of unknown activity should be avoided.

   b. Safety Precautions - Wear suitable gloves and clothing to prevent skin contact with allergens or substances of unknown allergenic potential. Work with adequate ventilation.

   c. Accident Response - In case of a medical emergency exposure dial 911 from any Center telephone or 864-2222 from a cellular telephone. If a major spill occurs outside a hood, evacuate the area and contact the FSH or his/her designee and EMT at 864-3500. Only individuals wearing the appropriate protective clothing shall clean up spills. If a spill involves a significant quantity of a toxic material, a full-face supplied air respirator shall be used.

   d. Transfer and Transport - Take normal precautions during transfer and transport to avoid exposure and breakage.

   e. Storage - Store breakable containers in chemically resistant trays. Store contaminated waste in labeled impervious containers. For liquid waste, store in glass or plastic bottles.

3. Chemicals of High Chronic Toxicity

   a. General Information - These substances include, but are not limited to, methanol, certain heavy metals, their derivatives, and potent carcinogens. Contact the FSH or his/her designee for more information concerning the safety permit or the use of suspected carcinogens.

   b. Safety Precautions - Use of these chemicals shall occur only in a controlled area (a laboratory, or portion of a laboratory or a facility such as an exhaust hood, which is designated for use of highly toxic substances). The controlled area shall be conspicuously marked with warning and restricted access signs. Use of this area shall not be limited to toxic substances but all personnel who have access to it shall be aware of the substances being used and the necessary precautions.

Protect vacuum pumps against contamination by scrubbers or cold traps and vent them into the hood. Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area. Decontaminate the work area before normal work is resumed.

On leaving a controlled area remove any protective apparel, place it in an appropriate labeled waste container, and thoroughly wash hands, forearms, face, and neck.

c. Accident Response - In case of a medical emergency exposure dial 911 from any Center telephone or 864-2222 from a cellular telephone. Contingency plans equipment, and materials to minimize exposures of people and property in case of an accident shall be readily available. Use chemical decontamination whenever possible. If dry powder is used, use wet mops or a High Efficiency Particulate Air (HEPA) exhausted vacuum cleaner instead of dry sweeping. Hand-held vacuum cleaners are not HEPA exhausted units. Ensure that containers of contaminated waste, including washings from contaminated flasks, are transferred from the controlled area in a secondary container.

d. Transfer and Transport - Conduct all transfers in the controlled area. Make sure all materials are properly labeled with chemical name and “high chronic toxicity” or "carcinogen" before being transported.

e. Storage - All containers shall be labeled with the appropriate identification and warning labels. Labels shall at the least include chemical name, NFPA code, and the words "Carcinogen" or “High Chronic Toxicity.” Store containers of these chemicals only in ventilated limited access areas in labeled, unbreakable, chemically resistant, secondary containers. Keep accurate records of the amounts of these substances stored and used, the dates of use, and the names of all users

C. FLAMMABLES/EXPLOSIVES

1. Flammables

a. General Information - Flammable substances are those, which catch fire readily and burn in air. Examples include acetone, ethanol, methanol, isopropanol, toluene, ethyl ether, dioxane and tetrahydrofuran.

b. Safety Precautions - These substances shall only be handled in areas free of ignition sources. They shall never be heated by using an open flame. Use a steam, water, oil or air bath or a heating mantle. Use adequate ventilation to prevent the formation of flammable atmospheres.

c. Accident Response - In case of a medical emergency exposure dial 911 from any Center telephone or 864-2222 from a cellular telephone. Follow appropriate first aid procedures. For small spills (< 1L), clean up promptly using appropriate absorbent materials and PPE. For large spills (> 1L) evacuate the area and notify the FSH or his/her designee immediately. Know the location of the nearest spill kit and how to use it.

d. Transfer and Transport - When transferring these substances in metal containers, static generated sparks shall be avoided by bonding and the use of ground straps

e. Storage - Store these materials in flammable solvent cans approved by NFPA. These substances shall be kept in special cabinets designed for this purpose.

2. Highly Reactive Chemicals and Explosives

a. General Information - This class of compounds includes peroxide forming compounds and explosives. Important to LaRC are the peroxide forming compounds. These react with oxygen present in the atmosphere to form peroxides. Peroxides are unstable and there are risks of explosion. The concentration of the peroxide contaminant plays an important role and can change through evaporation and distillation processes. Heat, shock, and friction can create dangerous situations, which can lead to explosions. Classes, which can form peroxides, include aldehydes, ethers, most alkenes, and vinyl and vinylidene compounds. Specific chemicals include cyclohexene, cyclooctene, decalin, p-dioxane, diethyl ether, diisopropyl ether, tetrahydrofuran (THF), and tetralin. Aging of the chemical is a significant factor in the production of

peroxides. These compounds often contain additives to prevent the formation of peroxides, however, the addition of additives does not eliminate the hazard and only delays it. The procurement, storage, handling, use, and disposal of explosive materials is referenced in LPR 1710.7, “Use and Handling of Explosives and Pyrotechnics.”

b. Safety Precautions - These substances shall be purchased in small quantities, not stockpiled. Unused peroxides shall not be returned to the container. Organic peroxide forming materials are issued by the Chemical Manager and shall be returned prior to the expiration date for testing. The sensitivity of most peroxides to shock and heat can be reduced by dilution with inert solvents, such as aliphatic hydrocarbons. Solutions of peroxides in volatile solvents shall be handled so as to prevent evaporation of the solvent as the peroxide concentration will increase. Metal spatulas shall not be used to handle peroxides because metal contamination can lead to explosive decomposition. Ignition sources shall not be permitted in the area. Friction, grinding, and other forms of impact shall be avoided. Any questions should be forwarded to the Explosives Support Engineer.

c. Accident Response - In case of a medical emergency exposure dial 911 from any Center telephone or 864-2222 from a cellular telephone. All spills shall be cleaned up immediately. Absorb liquids with vermiculite. Notify the FSH or his/her designee immediately.

d. Transfer and Transport - Small quantities of peroxides shall be handled so as to avoid ignition sources, shock and extreme temperature changes.

e. Storage - Peroxide formers shall be stored in airtight containers in a cool, dry, dark place. Glass containers that have glass stoppers shall not be used. Polyethylene shall be used, if possible. To minimize the rate of decomposition peroxides shall be stored at the lowest temperature consistent with their solubility or freezing point but not lower because they become more sensitive to shock and heat. They shall be properly labeled with the receiving date, the opening date, and the date recommended for disposal. These chemicals shall not be stored for long periods of time, but returned to the Chemical Manager after a given period if not used. Metal containers with screw lids shall be avoided. If old bottles of these materials are discovered, especially if they are in poor condition, contact the FSH, his/her designee or alternate immediately.

3. Pyrophorics

a. General Information and Storage Requirements - These are liquids or solids which will spontaneously ignite in air at temperatures less than 130°F. This includes oily rags, dust accumulations, organics mixed with strong oxidizers, alkali metals such as sodium, potassium, lithium and phosphorus, butyl lithium and tetraethyl aluminum solutions. These substances shall be treated with the same respect accorded all chemicals. Their storage requirements, however, require noting. These substances shall be stored in inert atmospheres or under kerosene.

D. COMPRESSED GASES

Compressed gases present the potential for exposure to both chemical and mechanical hazards depending on the particular gas. Compressed gases fit into one of six classifications:

1) Flammable– < 13% of gas mixed with air will ignite
2) Asphyxiant– can displace oxygen
3) Oxidizer
4) Corrosive
5) Toxic
6) Highly Toxic

If the gas in question is flammable, flash points lower than room temperature, compounded by high rates of diffusion, present fire and explosion hazards. There are also reactivity and oxygen displacement considerations. The large amount of potential energy present in the pressure used to compress gas makes for a potential rocket or fragmentation bomb. This creates the need for special handling procedures for compressed gases, the cylinders used to contain them, and the regulators and piping used to control and direct the flow.

1. General Information - The Department of Transportation defines a compressed gas as "any material or mixture in the container with an absolute pressure greater than 276 kPa (40 lbf/in^2) at 21°C or an absolute pressure greater than 717 kPa (104 lbf/in^2) at 54°C or both, or any liquid flammable material having a Reid vapor pressure greater than 276 kPa (40 lbf/in^2) at 38°C."

2. Safety Precautions - The contents of any compressed gas shall be clearly identified on the cylinder. All gas lines shall also be clearly labeled so as to identify the gas being transported. The labels shall be color coded to distinguish hazardous gases. Signs identifying flammable compressed gases shall be clearly posted.

Cylinders shall be firmly secured at all times using a clamp and belt or chain. Pressure release equipment for protecting devices attached to cylinders containing potentially hazardous gases shall be vented to a safe place.

Cylinders shall be placed in such a way that the cylinder valve is readily accessible at all times. The main cylinder valve shall be closed whenever the gas is not in use. This is not only necessary for safety reasons but also to prevent contamination and corrosion in empty cylinders from the diffusion of air and moisture into the cylinder.

The proper tools shall be used on cylinder hardware. Pliers shall not be used. Valves shall be opened slowly and it is never necessary to open the main valve all the way. When opening a cylinder containing toxic gas, stand upwind and to the side or use proper ventilation equipment. Be aware of the location of fellow workers in case a leak exists.

Do not use common brass pressure regulators with corrosive gases such as ammonia, boron trifluoride, chlorine, hydrogen chloride, hydrogen sulfide, and sulfur dioxide; special corrosion resistant regulators shall be used. Regulators used with carbon dioxide shall have special internal designs and special materials in order to prevent freeze-up and corrosion problems.

All pressure regulators shall be equipped with spring-loaded pressure relief valves. When used for hazardous gases of any type these valves shall be properly vented. Do not use internal bleed type regulators.

Sparks and flames shall be kept from the area of flammable gas cylinders. All piping, regulators, appliances, and hoses shall be kept tightly sealed and in good condition. Equipment used for flammables shall not be interchanged with similar equipment used for other gases.

Cylinders shall not be emptied less than 172 kPa (25 lbf/in^2) because the residuals may become contaminated if the valve is left open. Empty cylinders shall not be refilled, the regulator shall be removed and the valve cap replaced. Labels for cylinders, which designate whether they are full, in use or empty shall be used.

All pressure equipment shall be inspected periodically, more often where corrosive or hazardous gases are used.

3. Storage - Cylinders containing flammables and other hazardous gases shall be stored in a well-ventilated area. Cylinders of oxygen shall never be stored with cylinders containing flammables. Do not store empty and

full cylinders in the same location and do not lay empty cylinders on the ground.

E. WATER REACTIVE CHEMICALS

1. General Information and Storage Requirements - Examples include aluminum and magnesium powder, and calcium and lithium hydride. These chemicals can lead to the formation of flammable toxic gases or release of an extreme amount of energy following contact with water. This property shall be considered when handling. Areas where these compounds are present shall be posted in such a way that fire-fighting personnel are aware of their presence. They shall be stored in waterproof, polyethylene bags, in tightly sealed containers.

V. PROCEDURES, ACTIVITIES OR OTHER OPERATIONS WHICH WARRANT PRIOR APPROVAL BEFORE IMPLEMENTATION

A. GENERAL

In the interest of integrating safe laboratory practices, whenever a particular procedure, operation or activity is to involve the use of carcinogens, reproductive toxins and/or substances with a high degree of acute or chronic toxicity, the FSH and the SFAB at 864-7233 shall be informed during the planning stages. It shall be the responsibility of the Project Planner to investigate the toxicity of materials of interest and to inform the FSH in writing of the plans. In accordance with OSHA 29 CFR 1910.1450 prior approval shall be given before beginning work with hazardous materials.

Examples of activities and operations requiring prior review and approval before implementation are given below:

- Use of OSHA regulated carcinogens and gases with IDLHs < 5000 ppm.
- Any new or radically modified experiment, including scale-ups where greater than 4 liters of highly toxic substances are to be used.
- Any new activity, which will involve the use of high temperature and/or pressure.
- Any activity, which will utilize a toxic substance for an extended period of time. This includes storage as well as handling times.
- Any activity utilizing a substance requiring special disposal or storage requirements for itself or its derivatives.
- Any activity involving the use or synthesis of organometallic materials.

VI. DESIGNATED WORK AREAS

Designated work areas shall be established for work involving the use of carcinogens, reproductive toxins, and or substances with a high degree of acute toxicity. Laboratory hoods shall be identified throughout the area of such work. Signs can be obtained through the FSH or SFAB IH staff.

VII. LABORATORY HOOD PROGRAM

A. INTRODUCTION

This section establishes specifications and minimum requirements for the inspection of laboratory hoods. The section provides a quantitative procedure for testing hood performance and criteria for judging the acceptability of hoods.

The recommended practices for the safe use of laboratory hoods and basic information on hood function and performance are addressed. These practices are as important as good hood design and inspection procedures in achieving maximum protection of personnel.

B. VENTILATION SPECIFICATIONS

All new, existing or upgraded laboratory hoods intended for use with any material shall attain an average linear face velocity of 100 feet per minute (fpm), with the sash fully opened or lowered to a minimum, allowable working sash height of 12”.

If the hood face opening has to be reduced to achieve 100 fpm or a high velocity for a particular hood use, then visible markings shall clearly indicate the working sash height. (Directional arrow stickers shall be used on all hoods to designate the proper working sash height).

All hoods shall be designed and operated to maintain relatively uniform air velocity over the entire face. As a general rule, the velocity measured at any single point shall not vary more than 20 percent from the overall average.

C. LABORATORY HOOD GUIDELINES

The SFAB IH staff shall inspect existing laboratory hoods for proper use, air turbulence and adequate face velocity at least annually and after any adjustment, modification or maintenance service. New hoods shall be inspected at the time of installation and before use. Required laboratory hood inspections for both new and existing hoods are given below:

1. Hood Baffle Adjustment

Utilize the baffle adjustment controls to attain uniform face velocity. Most hoods have at least two adjustable baffle slots at the rear to assist in achieving an even distribution of airflow over the entire hood face.

Start baffle adjustment by positioning the bottom slot fully open, the top slot one-half open and the middle slot, where provided, in a slightly open position. These slots can also be adjusted to accommodate special hood use conditions such as high heat loads and heavier-than-air vapors.

a. High Heat Loads - High heat loads are best controlled by fully opening the top slot.

b. Heavier-than-Air Vapors - Heavier-than-air vapors are best controlled by increasing the bottom slot opening and decreasing the top slot opening.

Avoid shutting off an exhaust slot completely. All parts of the hood cavity require some air circulation to control vapor release. Closing off the top slot may cause a dead space in the upper section of the hood. As a result, contaminated air from the hood may escape along the upper edge of the sash.

Do not attempt to adjust the balancing dampers in the air ducts above a hood. System balance is critical and should be left to qualified personnel.

2. General Requirements

Large bulky objects and hood clutter are detrimental to hood performance. Too much equipment and bulky objects in the hood are common causes of poor air performance, i.e., air turbulence and dead space.

Place work well inside the hood. The forward six inches of the hood are most subject to draft and turbulence. Pour, transfer and weigh materials as far back as possible. Avoid placing your head inside the hood.

Maintain the hood sash at the smallest practical open area.

Keep the hood clean. Clean-up spills immediately to avoid build-up of contaminants within the hood.

A visual indicator is a desirable feature for laboratory hoods to warn if ventilation fails or is inadvertently turned off, or falls below a predetermined unacceptable value for the work being performed.

A hood suspected of not performing properly shall be promptly brought to the attention of the FSH, his/her designee or contact SFAB IH staff at 864-7233.

3. Evaluation of Hood Performance

Uniformity of airflow in the hood can best be determined with velometer measurements and smoke tube tests. The velometer shall be used for quantitative evaluations, whereas the smoke tubes are useful in detecting reverse flow and other undesirable flow conditions. The SFAB IH staff shall be responsible for these measurements on a periodic basis. These measurements shall be recorded on stickers and placed on the outside of the laboratory hoods.

a. Quantitative Evaluations

Make sure the hood fan is on, that all other hoods on the same system are in normal operation and that the system as a whole is balanced.

Open the sliding sashes to their maximum operating position.

Remove bulky items and obstructions that are not normally present when the hood is in use.

Determine the average linear face velocity of the hood using an instrument such as a velometer. Evaluate the uniformity of airflow at the hood face by comparison of individual velocity readings with the overall average. Non-uniformity is indicated by individual variations of greater than 20 percent relative to the average.

Velocity is defined in the laboratory hood as face velocity, which is the inward velocity of air at the open face of the hood, usually expressed in feet per minute (fpm). Face velocity is a function of total airflow rate expressed in cubic feet per minute (cfm) and open face area of the hood. The relationship between face velocity, airflow rate, and hood face area is shown by the following equation:

$$Q = AV$$

Q = air flow rate (cfm)
A = hood face area (square feet)
V = hood face velocity (fpm)

b. Qualitative Evaluation

Inspect hoods for excessive turbulence, reverse flow or dead space. This inspection shall be accomplished by use of smoke tubes. When

using smoke tubes, make a complete traverse of the hood face and along interior walls and work surfaces parallel to the plane of the hood face at a distance of six inches inside the hood. A visual indicator is located inside each fume hood and it shall be the individual's responsibility using the hood to notify the FSH or his/her designee if the ventilation fails.

VIII. MATERIAL SAFETY DATA SHEET (MSDS) PROGRAM

A. INTRODUCTION

OSHA requires that all employers maintain a complete and accurate MSDS for each hazardous chemical that is used on site. Manufacturers/suppliers shall supply this information when a material is purchased. These MSDSs shall be updated whenever new and significant information becomes available concerning a product's hazards or ways to protect against these hazards.

B. OBJECTIVE

These MSDSs provide an excellent source of specific information on the chemicals, which employees must handle. The MSDS will inform you so that you can protect yourself and respond to emergency situations.

C. LOCATION

MSDSs shall be readily available in each facility and MSDSs can also be found on the web at the following web sites:

http://osemant1.larc.nasa.gov/cmts/
http://www.fisher1.com/
http://www.ilpi.com/msds/index.chtml

It is important that these sites be bookmarked in your computer for easy and quick access. The SFAB IH staff can assist in updating the MSDS library, maintain an up-to-date computer list of MSDSs, and producing a hard copy when requested. MSDSs for new chemicals shall be obtained from the manufacturer when the chemicals are ordered.

D. READING AN MSDS

Each MSDS shall be on a fully completed OSHA Form 174, "Material Safety Data Sheet," or its equivalent. The OSHA Form 174 shall be included with an explanation of its components to help in the interpretation of MSDSs.

1. Section I. Chemical Identity

   The chemical name and common names/synonyms shall be provided for single component substances. The name shall be cross-referenced to the name on the product label.

2. Section II. Hazardous Ingredients

   If the product is a mixture that contains hazardous ingredients and has been tested as a whole, the chemicals and common names associated with the hazards shall be listed. If the mixture has not been tested as a whole, the chemical and common names of all ingredients determined to be health hazards and compromising 1 percent or more of the total composition shall be listed.

   The chemical and common names of all carcinogens shall be listed if they are present in the mixture at levels of 0.1 percent or more.

   All components that may present physical hazards shall be listed.

   Chemical and common names of all components which present health hazards and are present in quantities less than 1 percent or 0.1 percent for carcinogens shall also be listed if they can exceed Permissible Exposure Limits (PELs) or Threshold Limit Values (TLVs) or present a health risk to employees exposed to these concentrations.

3. Section III. Physical and Chemical Characteristics

   The boiling and freezing points, density, vapor pressure, specific gravity, solubility, volatility, and general appearance and odor of all hazardous ingredients are listed here. These characteristics help in the design of safe and healthful work practices.

4. Section IV. Fire and Explosion Hazard Data

   The compound's potential for ignition and explosion are characterized as well as the conditions under which this may occur. Fire extinguishing media and fire fighting methods are also described here.

5. Section V. Reactivity Data

   Chemical incompatibilities and any hazardous decomposition products are included here.

6. Section VI. Health Hazards

The acute and chronic health hazards of the chemical, together with signs and symptoms of exposure, shall be listed. In addition, any medical conditions aggravated by exposure, shall be listed. Specific hazard types include carcinogens, corrosives, toxins, irritants, sensitizers, mutagens, teratogens, and effects on target organs. Carcinogens are designated by OSHA, the National Toxicology Program, or the International Agency for Research on Cancer (IARC). If the health affects of this chemical have not been completely determined, then this shall be stated in this section.

The primary means of entry into the body are given in the route of entry section. These will be inhalation, dermal, and ingestion.

OSHA Permissible Exposure Levels (PELs) and ACGIH Threshold Limit Value (TLVs) and other exposure indices are given in this section.

7. Section VII. Precautions for Safe Handling and Use

Precautions for safe handling and use include industrial hygiene practices, precautions to be taken while repairing and conducting maintenance on equipment, and procedures for cleaning up spills and leaks. Environmental Protection Agency waste disposal methods as well as state and local requirements are often given in this section.

8. Section VIII. Control Measures

This section gives engineering controls, safe handling procedures, personal protective equipment, and the use of gloves, body suits, respirators, and face shields.

LABORATORY SPECIFIC CHP INFORMATION for **Bldg_____, Room_____**

The following required information shall be documented and maintained in each facility requiring a CHP. For additional information regarding compiling this information contact the SFAB IH staff at 864-7233.

The Laboratory Supervisor/Telephone No. is _____/_____

Emergency Information:

Emergency eyewashes/showers are located in _____

Material Safety Data Sheets (MSDS):

MSDSs are readily available in the notebook in Room _____
And MSDSs are also available online at http://osemant1.larc.nasa.gov.

Spill kits are available in _____

Waste disposal:

Chemical/biological wastes shall be properly labeled and deposited in the appropriate containers. Waste labels shall be available in _____ or from the Environmental Management Team.

Personal Protective Equipment:

Hearing protection - The following processes require hearing protection:

Process	Plugs	Muffs
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Hearing protection is available in Room _____

Glove Protection - The following processes require protective gloves:

Process	Chem	Heat	Cryo	Kevlar

Gloves are available from _____

Eye/Face Protection - The following processes require eye/face protection:

Process	Safety Glasses	Chemical Goggles	Face shield

Eye/Face protection are available from_____

Torso Protection - The following processes require torso protection:

Process	Lab Coats	Rubber Aprons	Tyvek Coveralls

Torso protection is available from _____

Respiratory Protection - The following processes require respiratory protection:

Process	Full Face	Half Face	Dust Mask
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Respiratory protection is available from_____

Other Protective Devices:

Laboratory hoods are located in _____

Weighted Bench-top Safety Shields are available from _____

NOTE: A facility diagram shall be included detailing the laboratory locations.

Appendix D

OSHA REGULATED SUSPECT AND POTENTIAL CARCINOGENS

The chemical listed herein are considered to be particularly hazardous substances as defined in 29 CFR 1910.1450, and they are considered regulated chemicals for the purpose of this handbook.

10.1 CHEMICAL-SPECIFIC OSHA REGULATIONS

The following chemical-specific OSHA regulations are found in 29 CFR 1910.

OSHA Regulation	Material	CAS Number
1910.1001	Asbestos	
	Tremolite	77536-68-6
	Anthophyllite	77536-67-5
	Actinolite	77536-66-4
	Amosite	12172-73-5
	Chrysolite	12001-29-5
	Crocidolite	12001-28-4
1910.1002	Coal Tar Pitch Volatiles (except Asphalt)	65996-93-2
1910.1003	4-Nitrobiphenyl	92-93-3
1910.1004	Alpha-Naphthylamine	134-32-7
1910.1006	Methyl Chloromethyl Ether	107-30-2
1910.1007	3,3'-Dichlorobenzidine (and salts)	91-94-1
1910.1008	bis-Chloromethyl Ether	542-88-1
1910.1009	beta-Naphthylamine	91-59-8
1910.1010	Benzidine	92-87-5
1910.1011	4-Aminobiphenyl	92-67-1
1910.1012	Ethyleneimine	151-56-4
1910.1013	beta-Propiolactone	57-57-8
1910.1014	2-Acetylaminofluorene	53-96-3
1910.1015	4-Dimethylaminoazobenzene	60-11-7
1910.1016	N-Nitrosodimethylamine	62-75-9
1910.1017	Vinyl Chloride	75-01-4
1910.1018	Inorganic Arsenic	7440-38-2
1910.1025	Lead	7439-92-1
1910.1027	Cadmium (MDA)	7440-43-9
1910.1028	Benzene	71-43-2
1910.1029	Coke oven emission	None
1910.1043	Cotton dust	None
1910.1044	1,2-dibromo-3-chloropropane (DBCP)	96-12-8
1910.1045	Acrylonitrile	107-13-1
1910.1047	Ethylene Oxide	75-21-8
1910.1048	Formaldehyde	50-00-0
1910.1050	Methylenedianiline (MDA)	101-77-9
1910.1051	1.3-Butadiene	106-99-0
1910.1052	Methylene Chloride	75-09-2

APPENDIX E

DEFINITIONS AND TERMINOLOGY

Acute Exposure	Short duration contact, typically minutes or hours.
Asphxiatory	Capable of causing injury by depriving the body of oxygen. Substances producing this effect by dilution of atmospheric oxygen are referred to as simple asphyxiants.
Autoignition Temperature	The temperature at which a material will self-ignite and sustain combustion in absence of a spark or flame.
CAM	Capital Assessment Management
Carcinogenic	Capable of causing cancer. (NOTE: MSDSs are required to list any carcinogens present.)
CHP	Chemical Hygiene Plan
Chronic Exposure	Long duration contact, typically days, months, or years.
Class I Spill	A Class I Spill is relatively small in volume and presents low hazard potential to personnel or the environment. It can be contained and cleaned up with only minor difficulty by the user/custodian. Outside support is not necessary. A Class I Spill results in: • No discharge of oil or hazardous materials to adjacent waters at LaRC and no violation of applicable water quality standards. • No sheen upon or discoloration of surface waters at LaRC. • A release of material that is *below* the Hazardous Substance Reportable Quantity.

Class II Spill

A Class II Spill involves a large volume of material and ma present significant hazard to personnel or the environment. Any spill reportable under EPA Regulations, 40 CFR 302, 355, or 372 shall be considered a Class II Spill. A Class II Spill results in:

- Discharge of oil or hazardous materials to adjacent waters at LaRC and/or is a violation of applicable water quality standards.
- Discoloration of or sheen upon surface waters at LaRC.
- Amount of released material is above the Hazardous Substance Reportable Quantity.

Cryogenic

Maintained at extremely low temperatures.

Explosive Range

Range of concentration of a gas or vapor in air above and below which the mixture will not burn. Usually described as Lower and Upper Explosive Limits (LEL and UEL) and expressed in percentage.

Flash Point

Lowest temperature at which a liquid will give off enough flammable vapor at or near its surface so that it will ignite upon introduction at an ignition source.

IDLH

Immediately Dangerous to Life or Health Concentration. Concentration at which serious health impairments, or irreversible biological effects possibly leading to death in a period of seconds or several days later, could occur.

Narcotic

Capable of causing depression of the central nervous system; drowsiness, stupor, loss of coordination, unconsciousness.

PEL (Permissible Exposure Level)

Airborne concentration exposure standards are specified by Federal Regulation (OSHA, 29 CFR). Concentrations may be for 8-hour workdays, or shorter periods (usually 15 minutes). (See also Threshold Limit Values.)

RCRA

The Resource Conservation and Recovery Act (RCRA) of 1976 gave the U.S. Environmental Protection Agency (EPA) the authority to control hazardous waste from “cradle-to-grave.” This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous wastes.

TLV (Threshold Limit Value)	Airborne concentration at or below which it is believed nearly all workers may be repeatedly exposed day after day with no adverse effect. Usually expressed in parts per million (ppm) for gases or vapors and milligrams per cubic meter (mg/m3) for dusts, fumes, and mists. Threshold Limit Values are specified by the American Conference of Governmental Industrial Hygienists and several have been adopted for use by OSHA.
Vapor Density	Ratio of the specific gravity of a vapor to that of air. Materials having a vapor density greater than one are heavier than air.
Vapor Pressure	The measure of tendency for a liquid to go into a gaseous state. Usually expressed in millimeters of mercury (mm Hg). More volatile materials have higher vapor pressures.