Wind Tunnel Operations Division and Support Contractor

Safety Manual

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Ames Research Center,
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Record of Changes

Change	Change Date	Change Description	Initiator
NA	October, 2000	Initial release.	Scott Nikodym
DCR 0025	April, 2001	Added Confined-Space Entry Chapter.	Joe Hourigan
CR 1821	August 24, 2001	Added the Hearing Conservation Chapter. Added the same Document Control section to the Introduction in each chapter. Added a References section at the end of each chapter that didn't already have one.	Gayle Frank
CR1821 Addendum	August 25, 2001	Changes to the Hearing Conservation Chapter	Morrow Whitcomb
CR 1813	October 22, 2001	Added SPA Chapter.	Morrow Whitcomb
CR 1837	April 29, 2002	Added the Lifts and Cranes Chapter	Jason Brown
CR 2859	November 1, 2002	1. Revisions to the Lockout and Tagout Chapter to correct errors and omissions. 2. Changed references to AHB 1700.1 to APG 1700.1 throughout the manual. 3. Added three new chapters: Working Alone, Mishap Response and Reporting, and Disaster Prevention	Scott Nikodym
CR 2870	January 21, 2003	Added Safety Observations chapter. Changes to Lockout and Tagout chapter: Made changes to the Removal Procedure section to clarify approval methods.	Scott Nikodym
CR 3013	January 23, 2004	Added Chapter 17, Energized Electrical Work. Revised the retraining requirements in Chapter 6.	Thomas R. Vahle
CR 3042	January 26, 2006	Added Chapter 18, Chapter 19 and forms: AO1, AO2, AO3 and AO4.	Scott Nikodym

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List of Acronyms and Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
AL	action level
ANSI	American National Standards Institute
ARC	Ames Research Center
BAAQMD	Bay Area Air Quality Management District
BEAP	Building Emergency Action Plan
CCR	Title 22 California Code of Regulations
CCTV	closed-circuit television
CEPP	Chemical Emergency Preparedness Program
CFR	Title 40 Code of Federal Regulations
cm	centimeter
CO	carbon monoxide
dB	decibel
dBA	A-weighted decibel
DHHS	Department of Health and Human Services
EHS	Environment, Health, and Safety
EPA	Environmental Protection Agency
ERT	Emergency Response Team
ES&H	Environmental, Safety and Health
FSM	facility service manager
ft	foot or feet
HBV	hepatitis B virus
HCV	hepatitis C virus
HIV,	human immunodeficiency virus
HPD	hearing protection device
hr	hour(s)
i.e.	that is

IDLH	immediately dangerous to life or health
in	inch or inches
lbs	pounds
LEL	lower explosive limit
LFL	lower flammable limit
LOTO	Lockout Tagout
m	meter or meters
mR	milliroentgen
MSDS	material safety data sheet
NASA	National Aeronautics and Space Administration
NFPA	National Fire Protection Association
NIOSH	The National Institutes for Occupational Safety and Health
NRC	Nuclear Regulatory Commission
NRR	noise reduction rating
OJT	on-the-job training
OSHA	Federal Occupational Safety and Health Administration
PEL	permissible exposure level
PPE	personal protective equipment
RCRA	Resource Conservation Recovery Act
REL	recommended exposure limit
RSO	Ames radiation safety officer
S&QA	Safety and Quality Assurance
SARA	Super Fund Amendments and Reauthorization Act
SEMA	Safety, Environment and Mission Assurance
SOR	Safety Observatoin Report (SOR), FO25
SPA	Safe Plan of Action (SPA), FO13
SPC	single point of contact
STS	standard threshold shift

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SPA	Safe Plan of Action (SPA), FO13
SPC	single point of contact
STS	standard threshold shift

SWT	supersonic wind tunnel
TLV	threshold limit value
TWA	time-weighted average
TWT	transonic wind tunnel
UEL	upper explosive limit
UFL	upper flammable limit
V	volts
VOC	volatile organic compound

1. Introduction

1.1. Description

Purpose

All Wind Tunnel Operations Division personnel are responsible for following the requirements contained in the Ames Health and Safety Manual, APG 1700.1. This manual was developed in accordance with that manual and Occupational Safety and Health Administration (OSHA) regulations. Each chapter of this safety manual describes specific Division requirements and guidelines that supplement and help ensure uniform compliance with established Ames and OSHA safety requirements.

Scope

This manual applies to Division civil servant and support contractor personnel, subcontractors, temporary workers, and visitors under the authority of the Wind Tunnel Operations Division.

For safety topics not described within this manual, refer to the on-line Ames Health and Safety Manual, APG 1700.1, available on the Ames Research Center Intranet at http://arcweb.arc.nasa.gov/, or contact the Division Safety Office for assistance.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at `http://pubsgroup.arc.nasa.gov/`.

1.2. References

NASA/HQ

This manual complies with, or refers to additional information provided in the current revisions of the following NASA/HQ documents:

- NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping, NASA NPG 8621.1.

Ames and Division Documents

This manual complies with, or refers to additional information provided in the current revisions of the following Ames and Division documents:

- Ames Environmental Procedures and Guidelines, APG 8800.3
- Ames Health and Safety Manual, APG 1700.1
- Ames Safety Accountability Program, Bloodborne Pathogens
- Building Emergency Action Plan (BEAP), all Wind Tunnel Operations Division Buildings
- The Division Environmental Compliance Plan, A327-9291-XS1
- The Hazard Communication Program, Wind Tunnel Operations Division

- Wind Tunnel Operations Division Configuration Management Procedures, A027-9391-XB4
- Wind Tunnel Operations Division Document Control Procedures, A027-9991-XR1

Forms

The following forms are referred to in this manual and are available on the Division Documents Web site at http://pubsgroup.arc.nasa.gov/.

- Alternate Confined Space Entry Procedures Authorization Form, F011
- Building Evacuation and Emergency Response Evaluation, FO29
- CAUTION - SPECIAL CONDITIONS Tag, ARC317
- Change Request Form, CR-1
- DANGER - DO NOT OPERATE Tag, ARC316
- Employee Safety Suggestion, F07
- Energy Control Log Sheets, SS17
- Entry Permit for Permit Required Confined Spaces, ARC 230
- Fall-Protection Work Plan, FO3
- Hazardous Energy Control Procedure Development Worksheet, SS14
- Hazardous Material Pickup Request Form, Form A
- Hazardous Materials Safe Work Procedure, FO8
- Hot Work Permit, issued by the Ames Office of Safety and Mission Assurance
- Lockout Device and Tag Removal Request, FO32
- NASA Mishap Report, NF 1627
- New Chemical Purchase Approval Form, FO9
- On-the-Job Training (OJT) Record, SS13
- Purchase Request/Purchase Order—Special Approvers Routing Information
- Purchase Requisition Form
- Safe Plan of Action, FO13
- Safe Plan of Action (SPA) for Normal Lifts, FO21
- Safety Observation Report (SOR), FO25
- Standard Threshold Shift (STS) Review, FO20
- Weekly Inspection—Hazardous Materials and Waste Storage, FO4
- Written Hazardous Energy Control Procedure Needs Assessment, FO30

External Documents

The following external documents are referred to in this manual:

- American Conference of Governmental Industrial Hygienists (ACGIH), 2000 TLVs® and BEIs®, Threshold Limit Values for Chemical Substances and Physical Agents
- California Code of Regulations, Title 8, GISO, § 5193
- California Code of Regulations Title 22: Hazardous Waste in California
- California Health and Safety Code
- Code of Federal Regulations Title 40: Protection of the Environment
- Hazard Identification System, NFPA 704
- National Safety Council Data Sheet 1-704-85
- NIOSH Training and Resource Manual—Safety and Health in Confined Workspaces for the Construction Industry.
- NIOSH 87-113, A Guide to Safety in Confined Spaces
- OSHA Standard 29 CFR 1904: Recording and Reporting Occupational Injuries and Illnesses
- OSHA Standard 29 CFR 1910.95: Occupational Noise Exposure
- OSHA Standard 29 CFR 1904.10: Recording Criteria for Cases Involving Occupational Hearing Loss
- OSHA Standard 29 CFR 1910.1020: Access to Employee Exposure and Medical Records
- OSHA Standard 29 CFR 1910: Code of Federal Regulations
- OSHA Standard 29 CFR 1910, Subpart E: Means of Egress
- OSHA Standard 29 CFR 1910.146: Permit-Required Confined Spaces
- OSHA Standard 29 CFR 1910.157: Portable Fire Extinguishers
- OSHA Standard 29 CFR 1910.1030: Occupational Exposure to Bloodborne Pathogens
- OSHA Standard CFR 29 Part 1910.1200: Hazard Communication
- Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9B

End of Chapter

2. Hazard Communication and Handling Hazardous Materials

2.1. Description

Purpose

The purpose of this chapter is to reduce injury and illness caused by exposure to hazardous materials by describing requirements for communicating information about hazardous materials, and for handling them. It's purpose is also to comply with and fulfill the Federal Occupational Safety and Health Administration (OSHA) and NASA hazard communication requirements.

For other regulations and requirements regarding hazardous materials, refer to the chapter on Environmental Compliance. For more detailed information, refer to the Division Hazard Communication Program and regulatory documents available in the Division Safety Office.

Scope

This chapter applies to anyone under the authority of the Wind Tunnel Operations Division, including civil servant, support contractor, and temporary personnel whose activities put them at risk for hazardous materials related injuries or illnesses.

Division Safety Office approval is required for any deviations from the requirements of this chapter.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at `http://pubsgroup.arc.nasa.gov/`.

2.2. Rights and Responsibilities

Employee Rights

Employee rights include the following:

- To receive information regarding hazardous materials in work areas.
- To have access to the Hazard Communication Program.
- To have access to the Hazardous Materials Inventory.
- To have access to a Material Safety Data Sheet (MSDS) for each hazardous material in work areas.

- To allow a physician or collective bargaining agent to access information regarding hazardous materials in the employee's workplace.
- To refuse to perform work without repercussion, such as being discharged or discriminated against, when information about hazardous materials is unavailable, or when conditions or practices associated with hazardous materials pose an imminent danger of injury or harm to personnel, facilities, or equipment.

Managers

Managers' responsibilities include the following:

- To ensure that the requirements described in this chapter are met.
- To ensure that hazardous materials in areas under their control are used safely.
- To provide employees with required hazard communication training and resources.

Supervisors

Supervisors' responsibilities include the following*:*

- To ensure safe use and storage of hazardous materials.
- To ensure that personnel successfully complete hazard communication training prior to working with hazardous chemicals.
- To ensure that personnel receive job-specific instruction prior to working with hazardous chemicals.
- To ensure that personnel receive training regarding the limitations, use, maintenance, storage, and disposal of personal protective equipment (PPE), and that PPE is freely available and used by personnel whenever required.
- To ensure that an up-to-date MSDS is available to all shifts in each work area for each chemical used in that area.
- To ensure that all chemical containers and piping are properly labeled to identify their contents and hazardous properties.
- To ensure that the most recent Hazardous Materials Inventory is available to personnel, and that it's updated annually .
- To submit hazardous materials purchase requisitions to the Division Safety Office for authorization.
- To notify the Division Safety Office before new hazardous materials are introduced into the work area.
- To notify the Division Safety Office whenever a hazardous material is no longer used or stored in the work area.

- To complete the Hazardous Materials Non-Routine Task Form, FO8, for each non-routine task that requires using hazardous materials, and review it with personnel before they perform the task.
- To notify all personnel in the area who may be affected whenever there is potential for exposure to hazardous materials.

Employees

Employees' responsibilities include the following:

- To adhere to the requirements described in this chapter.
- To successfully complete hazard communication training before working with hazardous materials.
- To understand chemical hazards and their controls.
- To complete training and adhere to requirements regarding the limitations, use, maintenance, storage, and disposal of PPE.
- To read the MSDS and container label for each hazardous material they may be exposed to in their work areas, and to request clarification if needed.
- To promptly notify management about missing or defaced labels on hazardous materials containers.
- To clearly identify and describe the hazardous material and circumstances to emergency personnel in the event of personnel exposure or a spill.

Division Safety Office

The Division Safety Office's responsibilities include the following:

- To ensure compliance with OSHA and NASA hazard communication requirements.
- To annually review the content of this chapter, and to direct any necessary changes and updates.
- To annually review the Hazard Communication Program, and to direct any necessary changes and updates.
- To maintain employee hazard communication training records in a database.
- To assist supervisors with tracking employee hazard communication training records.
- To maintain a central MSDS file for all hazardous materials used or stored in all work areas.
- To provide labels for hazardous materials containers as needed.
- To perform work area audits to verify compliance with the requirements of this chapter.
- To review all purchase requisitions for hazardous materials, including each relevant MSDS, before authorizing hazardous materials purchases.

- To review proposed new chemicals and processes before they're introduced into the workplace.
- To submit an updated Hazardous Materials Inventory to the Ames Research Center (ARC) on an annual basis, or when any major change takes place.

Project Managers for Subcontractor Activities

Project managers for subcontractor activities have responsibilities that include the following:

- To notify the Division Safety Office of any scheduled subcontractor work involving hazardous materials.
- To ensure that the subcontractor performs all work activities in compliance with this chapter.
- To notify all personnel in the area who may be affected whenever there is potential for exposure to hazardous materials.
- To ensure that all shifts have access to an up-to-date MSDS for each chemical used in their work areas.
- To ensure that all shifts have access to an up-to-date Hazardous Materials Inventory of the chemicals used in their work areas.

Subcontractors

Subcontractor's responsibilities include the following:

- To obtain approval from the project manager and the Division Safety Office prior to using or storing hazardous materials in any work area.
- To provide the project manager with records demonstrating that subcontractor personnel receive hazard communication training that complies with OSHA, NASA, and the Division hazard communication requirements.
- To provide subcontractor personnel with job-specific instruction prior to working with hazardous chemicals.
- To ensure that subcontractor personnel receive training regarding the limitations, use, maintenance, storage, and disposal of PPE.
- To provide subcontractor personnel with PPE and safety devices unless the contract stipulates otherwise.
- To ensure that an up-to-date MSDS is available in each work area for each chemical used in that area.
- To notify the project manager, the Division Safety Office, and any affected groups or individuals whenever there is a potential for exposure to hazardous materials used or stored by subcontractor personnel.

- To remove subcontractor-owned hazardous materials from the site when the contracted period of work ends, unless the contract stipulates otherwise.
- To clearly identify and describe the hazardous material and circumstances to emergency personnel in the event of a hazardous materials spill or other hazardous materials exposure.

Purchasing

The Purchasing Department's responsibilities include the following:

- To verify that purchase requisition forms for hazardous materials have an appropriate Division Safety Office approval signature.
- To verify that a New Chemical Purchase Approval form, FO9, is submitted with each purchase requisition for a new chemical.
- To request that the vendor supply a current MSDS for each chemical purchased.

Shipping and Receiving

The Shipping and Receiving Department's responsibilities include the following:

- To refuse delivery of hazardous materials containers without proper labels.
- To only accept containers that are in good condition.
- To ensure that any required MSDS is included with the shipment, and to distribute copies to the hazardous material owner and the Division Safety Office.

2.3. Requirements

Hazard Identification and Evaluation

Personnel who work where hazardous materials are used or stored shall identify and evaluate hazards in the work area by taking precautions that include the following:

- Reading the labels on all containers used or stored in the work area.
- Reading the MSDS for each hazardous material used in the work area.
- Remaining alert for signs or symptoms of overexposure described in the MSDS for each hazardous material in the work area.

- Being aware of workplace conditions, such as unusual odors or tastes, spilled liquids, hissing sounds, opened containers, or damaged or deformed containers.
- Discussing and documenting pre-task planning, such as a Safety Plan of Action (SPA).

Other Division methods for identifying and evaluating hazardous materials in the workplace may include the following:

- Completing a Hazardous Materials Non-Routine Task Form, FO8, and providing training accordingly.
- Safety Office review and approval prior to hazardous materials purchases.
- Periodic MSDS review by the Safety Office.
- Periodic industrial hygiene sampling and analysis, such as air or wipe samples.
- Medical surveillance conducted on users while hazardous materials are in use.
- Reviewing published information prepared by OSHA, The National Institutes for Occupational Safety and Health (NIOSH), and the American Conference of Governmental Industrial Hygienists (ACGIH).
- Identifying trends by periodically reviewing accident and injury data.
- Evaluating employee suggestions and complaints.

If a new risk is identified, management shall be notified. Work shall cease until all hazards and controls are defined and satisfactorily addressed.

Hazard Controls

Various controls may be used for reducing or eliminating risks associated with using and storing hazardous materials. This section identifies preferred controls, however, it may sometimes be necessary to use temporary controls for intermittent conditions, or while permanent solutions are being designed, funded, or installed. For more detailed information regarding hazard controls, refer to the Hazard Communication Program.

The following hazard controls are listed in order of preference:

- Designing or substituting lower risk materials to use in place of more hazardous materials.
- Implementing engineering measures that reduce risk, such as local exhaust ventilation, chemical isolation, guards, enclosures, interlocks, and monitoring alarms.
- Developing operations and maintenance procedures that reduce risk.

- Using personal protective equipment that protects individuals from exposure to hazardous materials.
- Implementing administrative measures, such as a work rotation that reduces employee exposure to hazardous materials.

Labeling

Primary and secondary labels for hazardous materials containers are required. Some secondary labels are available from the Division Safety Office. Labels for other materials and containers, such as piping, tanks, and waste containers, are required as well. For more details, refer to the Hazard Communication Program.

Primary Labels

A primary label is the label on the original container provided by the manufacturer. It must provide the following information:

- The manufacturer's name and address.
- The identity of the hazardous material.
- An appropriate hazard warning.

Secondary Labels

A secondary label is used on a separate container when a hazardous material is transferred to it from the original container. It must provide the following information:

- The identity of the hazardous material.
- An appropriate hazard warning.

Other Labels

Other labeling requirements include the following:

- Containers of non-hazardous material, such as water, shall be labeled to eliminate confusion or misuse.
- Piping shall be labeled to identify its contents and associated hazards. Other methods of conveying this information may be established.
- Hazardous waste containers shall be labeled with hazardous waste labels and dated in accordance with the Ames Environmental Procedures and Guidelines, APG 8800.3, and the Division Environmental Compliance Plan, A327-9291-XS1.
- Labels shall not be removed or defaced.
- Damaged labels shall be promptly replaced.

- Labels must be legible, in English, and displayed prominently on the exterior of the container.
- Chemical storage areas, cabinets, and tanks shall be labeled in accordance with the National Fire Protection Association (NFPA) labeling system. Refer to the Hazard Communication Program for more details.

The Material Safety Data Sheet (MSDS)

Manufacturers of hazardous materials are required by law to evaluate the hazards associated with their products, and to provide users with relevant safety, health, and environmental information.

An MSDS is a document that provides safety, health, and environmental information about a hazardous material. Vendors generally include an MSDS with each shipment of hazardous material, and generally supply copies upon request. For more details about the information provided on an MSDS, refer to the Hazard Communication Program.

The following are MSDS requirements:

- Each area shall have a clearly labeled, easily accessible binder that contains an MSDS for each hazardous material used or stored in that area.
- Supervisors shall maintain the area-specific MSDS binders to ensure that they are complete and up-to-date.
- Supervisors shall ensure that employees are aware of the MSDS binders.
- The Division Safety Office shall maintain an MSDS master file for each hazardous material identified on the Hazardous Materials Inventory.
- The Division Safety Office may assist in obtaining an MSDS for a hazardous material.

The Hazardous Materials Inventory

The Hazardous Materials Inventory shall be available from the Division Safety Office, in the Building Emergency Action Plan (BEAP) located in the lobby of each building or available from the facilities service manager, and in each area-specific MSDS binder.

Supervisors shall perform the following:

- Maintain updated area-specific hazardous materials inventories.
- Notify the Division Safety Office or the hazardous materials manager of any major changes in the their Hazardous Materials Inventory. Major changes include the following:
  - Disposing of hazardous materials that will not be replaced.
  - Adding new hazardous materials.
  - Significantly reducing or increasing the quantity of hazardous materials already on the inventory.

Storing and Handling Hazardous Materials

Hazardous materials in any form shall be stored, handled and used in a safe manner as described in this chapter, in the chapter on Environmental Compliance, in the Hazard Communication Program, and in training for hazardous communication and handling hazardous materials.

Requirements for storing and handling hazardous materials include the following:

- Personnel shall use personal protective equipment (PPE) as required.
- Incompatible hazardous materials shall be stored in separate storage areas to minimize risk of fire, explosion, or toxic gas release.
- Hazardous materials containers shall be tightly closed.
- Hazardous materials containers shall be properly labeled.
- Secondary containment shall be used for storing liquid hazardous materials.
- All hazardous conditions, such as leaks, spills, and reactivity, shall be promptly corrected.

Hazardous materials that are no longer in use shall be removed from storage, and disposed of or recycled through the Ames hazardous waste contractor.

Subcontractors are required to remove all their hazardous materials from the work site upon completion of the job, unless the contract stipulates otherwise.

Hazardous Materials Storage Area Inspections

Weekly hazardous materials storage area inspections are mandated by the Ames Health and Safety Manual, APG 1700.1; the Division Environmental Compliance Plan; and county, state, and federal regulations. Each department that uses or stores hazardous materials is responsible for performing and documenting weekly inspections of all their hazardous materials storage areas.

Hazardous materials storage areas include the following:

- Above ground storage tanks.
- Chemical storage lockers or cabinets.
- Secondary containment systems.
- Hazardous waste storage areas.

Contractor-Conducted Inspections

The Maximo maintenance database generates preventative maintenance work orders that are issued to those who conduct hazardous materials storage area inspections for maintenance operations. The inspection process is the following:

- The Weekly Inspection—Hazardous Materials and Waste Storage form, FO4, shall be completed and submitted to the supervisor each week.
- The supervisor updates the Maximo database by entering an inspection completion date.
- The supervisor forwards a copy of the completed inspection form to the Division Safety Office.
- The Division Safety Office retains completed inspection forms for 3 years.

Civil Servant-Conducted Inspections

The Division hazardous materials manager tracks hazardous materials storage area inspections conducted by civil servants. The inspection process is the following:

- The Weekly Inspection—Hazardous Materials and Waste Storage form, FO4, shall be completed and submitted to the supervisor each week.
- The hazmat manager performs weekly storage inspections, and retains completed inspection forms for 3 years.

Hazardous Material Donation or Disposal

Hazardous materials requirements apply to all hazardous materials, including hazardous waste. For more information about hazardous waste, refer to the Labeling section and to the Storing and Handling Hazardous Materials section. Also refer to the chapter on Environmental Compliance, as well as the Environmental Compliance Plan. For questions regarding hazardous waste, contact the Division Safety Office.

The following applies to empty containers:

- Hazardous materials containers that are empty are hazardous waste.
- It is prohibited to use empty hazardous materials containers for collecting any other material or waste.

To donate or dispose of hazardous materials that are no longer needed, use the Hazardous Material Pickup Request Form, Form A, and submit the completed form to the Ames hazardous waste contractor.

Unless the contract stipulates otherwise, subcontractors who generate hazardous waste on-site may dispose of it by contacting the Ames hazardous waste contractor.

Emergency Response for Spills, Leaks, and Releases

This section describes emergency and communication requirements for handling hazardous materials spills, leaks, and releases. For more information about hazardous materials spills, leaks, and releases, refer to the Environmental Compliance chapter, the Hazard Communication Program, and the Building Emergency Action Plan (BEAP).

In general, emergency response steps following a hazardous materials spill, leak, or release include the following in order of preference:

- Dial 9-1-1 if health or the environment is threatened. From a cellular phone, dial (650) 604-5555.
- Notify the area supervisor or manager.
- Notify the Division Safety Office, which in turn notifies the Ames environmental staff to ensure reporting to the appropriate authorities.
- Evacuate and deny entry to the affected area.
- Control the spill, leak, or release, but only if it can be safely controlled.
- Contain the spill, leak, or release, but only if it can be safely contained.
- Relay appropriate information and identify the hazardous material(s) to emergency response personnel.

There are three different levels of hazardous materials spills or releases depending on severity. These levels are reportable/recordable spills, non-reportable/recordable spills, and non-reportable/non-recordable spills. These spills are described below:

Level 1: Reportable/Recordable Spills

A reportable/recordable spill is hazardous to health or the environment. A spill is reportable/recordable when a hazardous material is no longer in a primary container, and one or more of the following occurs:

- It reaches the environment.
- It enters the sewer or storm drain.

- It causes real or potential injury to persons or to the environment.
- It contacts asphalt, particularly if the hazardous material is a solvent.
- It requires more than 8 hours to clean up, even if it is contained by secondary containment and doesn't affect the environment.
- It escapes secondary containment.

If there is a reportable/recordable spill, do the following:

- Call 9-1-1. The 9-1-1 dispatch notifies the ARC authorities, who in turn evaluate the situation and notify the appropriate emergency and regulatory agencies.
- Notify the area supervisor or manager.
- Notify the Division Safety Office, which in turn notifies the Ames environmental staff to ensure reporting to the appropriate authorities.
- Obtain Safety Office assistance in recording the spill on the Recordable Spill Log in the BEAP, located in the building lobby, or in the facilities service manager's possession.

Level 2: Non-Reportable/Recordable Spills

A non-reportable/recordable spill is minor and poses no hazard to health or the environment. A spill is non-reportable/recordable when a hazardous material is no longer in a primary container, and all the following are true:

- None of the material reaches the environment.
- None of the material enters the sewer or storm drain.
- It causes no real or potential injury to persons or to the environment.
- None of the material contacts asphalt.
- It requires less than 8 hours to clean up.
- It remains contained within secondary containment.

Non-reportable/recordable spills may be cleaned by trained individuals. The following are ARC guidelines for cleaning a non-reportable spill:

- The individual cleaning the spill must be competent and specifically trained to clean the hazardous material.
- Spill clean-up equipment and PPE must be available.
- The spill clean-up takes less than 2 hours. (If the spill clean-up approaches this 2-hour limit, the Division Safety Office shall consult with the ARC Office of Safety and Mission Assurance.)
- The individual cleaning the spill must feel safe.
- Call 9-1-1 if in doubt.

A non-reportable/recordable spill does not need to be reported by calling 9-1-1, but unless the spill meets the criteria for non-reportable/non-recordable spills, it must be recorded. If the spill is recordable, do the following:

- Notify the Division Safety Office. The Division Safety Office maintains a file of all recordable spills.
- Obtain Safety Office assistance in recording the spill on the Recordable Spill Log in the BEAP, located in the building lobby, or in the facilities service manager's possession.

Level 3: Non-Reportable/Non-Recordable Spills

A non-reportable/non-recordable spill is less than one ounce and poses no hazard to health or the environment. There is no need to notify the Division Safety Office or record the spill in the Recordable Spill Log if it is non-recordable, however, the same ARC guidelines for cleaning a non-reportable/recordable spill apply to non-recordable spills.

A non-recordable spill is defined by the following:

- The spill is non-reportable.
- The spilled material weighs less than 1 oz.
- The spill can be cleaned up within 15 minutes.
- The primary container is not deteriorated.
- The material user is trained and equipped to clean up the spill.

Emergency Response for Personal Contamination

Direct, indirect, and suspected personal hazardous material contamination must to be treated immediately. For assistance, call 9-1-1. Provide emergency response personnel the relevant MSDS and all information regarding the contamination.

Standard immediate treatment includes the following:

- Flushing the affected area with water for a minimum of 15 minutes.
- Removing contaminated clothing as soon as possible.

Depending on the level of injury, notify the following:

- The Duty Office at 9-1-1 dispatch.
- The Ames Health Unit at extension 4-5287.
- The area supervisor or manager.
- The Division Safety Office.

Purchasing Hazardous Materials

Division Safety Office approval is required to purchase hazardous materials in order to ensure proper training and documentation, safe storage, handling, and disposal of hazardous materials, and to avoid OSHA, EPA, or local authority citations and penalties.

Before approving purchase requisitions for hazardous materials that are new to the work site, the Division Safety Office must review the new hazardous materials. The review shall determine if health and safety parameters are reasonable.

If you have questions about ordering a hazardous material, or if you're not sure a hazardous material has been approved, contact the Division Safety Office for assistance.

The step-action tables in this section describe the procedure for ordering hazardous materials through the Purchasing Department, including Preliminary Steps, Obtaining Approval for New Hazardous Materials, Submitting a Purchase Requisition, and Receiving Hazardous Materials.

Preliminary Steps

Follow these steps before completing any purchase requisition forms:

Preliminary Steps for Purchasing Hazardous Materials

Step	Action
1	Determine if the hazardous material is already listed on the area-specific Hazardous Materials Inventory .
2	Determine if the MSDS for the hazardous material is in the work area binder.
3	If the material is listed on the inventory, but there is no MSDS, or if there is an MSDS, but the material is not listed on the inventory, consult with the Division Safety Office.
4	If the hazardous material is not listed on the area-specific Hazardous Materials Inventory, and if there is no MSDS for it in the work area binder, proceed to the steps for obtaining approval for new hazardous materials.
5	If the hazardous material is already listed on the Hazardous Materials Inventory, and the MSDS is in the work area binder, proceed to the steps for submitting the purchase requisition.

Obtaining Approval for New Hazardous Materials

Follow these steps for obtaining approval for new hazardous materials:

Obtaining Approval for New Hazardous Materials

Step	Action
1	Contact the distributor or manufacturer, and request a copy of the MSDS for the hazardous material.
2	Complete page 1 of the New Chemical Purchase Approval Form, FO9.

Obtaining Approval for New Hazardous Materials

Step	Action
3	On page 2 of the Purchase Requisition, SB9, check the box for Caustic, corrosive, toxic or flammable materials/gasses (including paints, coatings, chlorofluorcarbons or Halons), and complete the form.
4	Submit both forms and the MSDS to the Division Safety Office.
5	After obtaining approval signatures from the Division Safety Office on both forms, proceed to the steps for submitting a purchase requisition to the Purchasing Department.

Submitting a Purchase Requisition to the Purchasing Department

Follow these steps for submitting a purchase requisition to the Purchasing Department:

Submitting a Purchase Requisition to the Purchasing Department

Step	Action
1	Complete a Purchase Requisition, SB9, if you have not already done so.
2	Obtain all approval signatures on the Purchase Requisition Form, including a Division Safety Office signature.
3	Submit both pages of the Purchase Requisition Form to the Purchasing Department and, if ordering a new hazardous material, also submit the approved New Chemical Purchase Approval Form.
4	If ordering a new hazardous material, put copies of the signed New Chemical Purchase Approval Form and the respective MSDS in the area-specific binder.

Receiving Hazardous Materials

Follow these steps upon receiving hazardous material:

Receiving Hazardous Materials

Step	Action
1	Shipping and Receiving verifies that containers are properly labeled and in good condition. Shipments of damaged containers or improperly labeled hazardous materials shall not be accepted.
2	Shipping and Receiving ensures that there is a corresponding MSDS for the shipment, forwards a copy to the Division Safety Office, and ensures that the owner receives a copy.

Receiving Hazardous Materials

Step	Action
3	Upon receiving hazardous materials from Shipping and Receiving, inspect and verify that the containers are properly labeled, in good condition, and that there is a corresponding MSDS.
4	If any requirements identified in the previous step are not met, notify the supervisor and the Division Safety Office immediately and await further instructions before using the hazardous materials.
5	Add the new quantity to the work area Hazardous Materials Inventory.
6	Notify the Division Safety Office to add the new quantity to the master Hazardous Materials Inventory.

Bankcard Purchases of Hazardous Materials

Hazardous materials purchased by bankcard must meet all the requirements for on-site hazardous materials as described in this chapter, including the requirements for an MSDS, inventories, and labeling.

Bankcard holders may only purchase safety-restricted hazardous materials with a written pre-authorization agreement from Safety, Environmental and Mission Assurance (SEMA). The SEMA web site is located at http://dq.arc.nasa.gov.

Safety-restricted hazardous materials include the following:

- Products identified as health and safety hazards, such as caustic, corrosive, toxic, flammable, or reactive products.
- Products that may pollute the air, such as regulated gases or volatile solvents, including chlorofluorocarbons or halons, and paints or coatings with volatile organic compounds (VOCs).

2.4. Training

Hazard Communication Training

Personnel who use or may be exposed to hazardous materials in the work area, whether on a routine basis or as the result of an emergency, shall receive hazard communication training.

The Division Safety Office provides assistance in registering for initial hazard communication training which includes the following:

- Review of the scope, purpose, and requirements of this chapter.
- The Employee Right-to-Know law and other employee rights.
- The potential physical and health effects from exposure to the hazardous materials in the work area.

- Explanation of the content in a MSDS.
- Using controls for reducing or eliminating risks associated with using and storing hazardous materials, including using PPE.
- Labeling requirements for hazardous materials and waste.
- Recognizing hazards, including using methods and observation techniques for determining the presence or release of hazardous materials.
- Emergency procedures, including how to respond a to a chemical spill, leak, or other exposure to hazardous materials.

Task-Specific Training

Supervisors provide employees with task-specific training in hazardous communication and hazardous materials handling.

Task-specific training is more detailed and provides information on the tasks the employee shall perform, including the engineering work practices and the required PPE the employee shall use. This training should be incorporated into written operating and maintenance procedures for both routine and non-routine tasks.

Update Training

Personnel shall receive update training on hazard communication whenever the following occurs:

- A new hazardous material or process is introduced at the work site.
- There is new or updated information concerning materials used at the work site.
- Hazardous materials handling requirements or work practices change.
- Refresher training recommended by ARC.

Training for Non-Routine Tasks

Whenever employees are to perform non-routine tasks using or working near hazardous materials, their managers or supervisors shall complete the Hazardous Materials Non-Routine Task Form, FO8, and use the completed form for training the employees.

Examples of non-routine tasks include the following:

- Using a site-approved chemical in a new operation.
- Using a site-approved chemical with different equipment.
- Applying a site-approved chemical under different parameters.

The Division Safety Office shall provide assistance in completing the Hazardous Materials Non-Routine Task Form, and in determining what safeguards and training are required for performing a non-routine task. For more information about completing the Hazardous Materials Non-Routine Task Form, refer to the Hazard Communication Program.

Completed Hazardous Materials Non-Routine Task Forms shall include the following:

- A task description.
- Identification of the hazardous materials required to perform the task.
- The required protective and safety measures for performing the task.
- A description of the measures management is taking to reduce the hazards at the work site.

Managers or supervisors shall:

- Use completed Hazardous Materials Non-Routine Task Forms to review with employees the hazards they may be exposed to while performing non-routine tasks.
- Ensure that employees receive appropriate training before beginning non-routine work.
- Maintain file copies of all completed Hazardous Materials Non-Routine Task Forms.

2.5. Records

Training Records

The Division Safety Office maintains formal Hazard Communication training and attendance records in the TNC database. The TNC database contains all Division safety training records, and is available to managers and supervisors to assist them in complying with training requirements.

The ARC Safety, Environmental and Mission Assurance Office also provides the past three years of site safety and hazard communication training records on their Web site at http://q.arc.nasa.gov/qh/training/ .

Each department maintains records of task-specific training and safety meetings.

Training records may be subject to periodic inspection.

Hygiene Sampling and Analysis Records

The Division Safety Office maintains all industrial and hygiene sampling and analysis records.

Medical Records

Specific medical test results are kept at the Ames Health Unit or the Camino Medical Group. All employee medical records are confidential and retained, transferred and made available in accordance with NASA ARC policies, and with the Code of Federal Regulations/ OSHA, 29 CFR 1910.20.

2.6. Definitions

Corrosive	A chemical that causes visible destruction of, or irreversible changes in, living tissue, such as discoloration, burning, blistering, or inflammation at the site of contact, or that has a severe corrosion rate on structural materials, such as metal. Acids and bases are corrosive.
Division Safety Office	The safety office staffed by employees of the contracting company that supports the Wind Tunnel Operations Division on health, safety and environmental issues.
Flammable	A material that may ignite and burn rapidly under ordinary conditions. Liquids with a flashpoint below 1000° F and solids that ignite readily are flammable.
Hazard Communication Program	A document that provides more detailed information about hazards, hazardous materials, hazard recognition, hazard controls, physical and health effects of hazardous materials, emergency procedures, MSDS documents, and hazardous materials labeling. The Hazard Communication Program is maintained by, and available from, the Division Safety Office.
Hazardous Material	As defined in Section 25501 of Chapter 6.95 of the California Health and Safety Code, a hazardous material is "any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment." Hazardous waste is a hazardous material, as well as chemicals or a mixture of chemicals that can produce adverse physical effects, such as a fire or explosion; adverse health effects, such as dermatitis, irritation, or cancer; or environmental damage.
Health Hazards	Any material for which there is scientific evidence that acute or chronic health effects may occur in exposed persons. Carcinogens are health hazards, as well as toxic agents; reproductive toxins, such as mutagens and teratogens; irritants; corrosives; sensitizers; hepatotoxins (toxins that affect the liver); nephrotoxins (toxins that affect the kidney); neurotoxins (toxins that affect the nervous system); agents that act on the hematopoietic (blood) system; and agents that damage the lungs, skin, eyes, or mucous membranes.
Local Exhaust Ventilation	A ventilation method, such as a fume hood or a fume extractor, for removing contaminated air at the point where the contaminants are generated.
Material Safety Data Sheet (MSDS)	A document prepared by the chemical manufacturer to provide safety, health, and environmental information for a hazardous material.

National Fire Protection Association (NFPA)	The NFPA provides information on fire protection and prevention, and sets the standards for placard waning signs, such as signs using diamond-shaped symbols and numerals to identify hazardous materials and indicate the degree of hazard.
National Institute for Occupational Safety and Health (NIOSH)	NIOSH is an agency of the Public Health Service, U.S. Department of Health and Human Services (DHHS). NIOSH tests and certifies respiratory devices, recommends occupational exposure limits (REL), and assists OSHA by conducting research and investigations.
Occupational Safety and Health Administration (OSHA)	The government agency that develops and enforces occupational safety and health standards for most U.S. industry and business.
Oxidizer	A material that causes ignition of combustible materials without an external source of ignition. When combined with burning materials, an oxidizer increases the rate of burning. Oxidizers are fire hazards, usually unstable or reactive, often contain oxygen, and therefore can burn in an oxygen-free atmosphere.
Personal Protective Equipment (PPE)	Equipment that individuals wear to protect themselves against hazards in the environment. Respirators, gloves, safety glasses, safety shoes, harnesses for fall arrest, and hearing protectors are PPE.
Physical Hazard	Any combustible liquid, compressed gas, organic peroxide, or oxidizer that is explosive, flammable, pyrophoric, unstable (reactive), or water-reactive.
Reactivity	The ease with which a material can undergo change by reacting with another substance or by breaking down. Highly reactive materials may explode.
Respiratory Protective Equipment	Air cleaning equipment, such as a filter or a chemical absorbent cartridge, or air supply respirators that protect an individual from breathing airborne toxic materials.
Secondary Containment	A containment system that uses an impermeable, chemically-compatible secondary container to contain potential spills and leaks from a primary container. Secondary containment systems include bermed pads, trays, bins, or overpack drums. For details regarding capacity requirements for secondary containment, refer to the Division Hazard Communication Program.

Toxicity	All the adverse biological effects resulting from exposure to a hazardous material. Toxicity is determined by laboratory testing data on animals, and on human data from past accidental exposures.
Volatile Organic Compound (VOC)	Solvent compounds that evaporate into the air and affect the Earth's ozone layer.

2.7. References

Ames and Division Documents	Ames Environmental Procedures and Guidelines, APG 8800.3
	Ames Health and Safety Manual, APG 1700.1
	Building Emergency Action Plan (BEAP), all Wind Tunnel Operations Division Buildings
	The Division Environmental Compliance Plan, A327-9291-XS1
	The Hazard Communication Program, Wind Tunnel Operations Division
Forms	Hazardous Material Pickup Request Form, Form A
	Hazardous Materials Safe Work Procedure, FO8
	New Chemical Purchase Approval Form, FO9
	Purchase Request/Purchase Order—Special Approvers Routing Information
	Purchase Requisition Form
	Safe Plan of Action, FO13
	Weekly Inspection —Hazardous Materials and Waste Storage, FO4
External Documents	California Health and Safety Code
	OSHA Standard 29CFR 1910: Code of Federal Regulations
	Hazard Identification System, NFPA 704

End of Chapter

3. Safety Suggestion Program

3.1. Description

Purpose

The purpose of the Safety Suggestion process is to encourage staff to identify opportunities for workplace safety enhancement and communicate them to management for appropriate action.

Scope

This chapter applies to all employees, temporary workers, and support contractor personnel working under the authority of the Wind Tunnel Operations Division.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

Limitations

Personnel should not submit safety suggestions for emergencies or in situations where conditions or activities pose an imminent danger to personnel, property, or the environment. These situations should be reported to Moffett Dispatch at extension 911, supervision, or the Division Safety Office as appropriate to ensure their timely correction.

3.2. Responsibilities

Managers

Managers are responsible for the following:

- Review submitted safety suggestions to determine appropriate actions.
- Make resources available within their authority to implement accepted safety suggestions.
- Ensure that no one takes actions to discriminate against or penalize personnel who submit safety suggestions.
- Implement interim corrective or protective actions when permanent actions will be delayed due to personnel, material, or funding restraints.

Supervisors

Supervisors are responsible for the following:

- Evaluate submitted suggestions to identify situations that pose an imminent hazard to personnel, facilities, or the environment.
- Take immediate action to control or correct hazards that pose an imminent hazard.

- Determine if submitted suggestions accurately describe the situation.
- Determine if corrective actions are within the limits of the individual's job assignment and authority to correct.
- Recommend whether or not to implement suggestions.
- Initiate actions within the limits of their responsibility and authority to control or correct the circumstances that resulted in the suggestion.
- Forward all safety suggestions to the Division Safety Office.

Employees

Employees are responsible for the following:

- Identify workplace hazards and initiate action to correct those that are within the limits of their work assignment and authority.
- Report emergencies or imminent danger situations to Moffett Dispatch, supervision, or the Division Safety Office immediately.
- Submit safety suggestions as appropriate to identify personnel, process, facility, or equipment improvements.

Division Safety Office

The Division Safety Office is responsible for the following:

- Establish and maintain safety suggestion process and the requirements of this chapter.
- Track and report status of submitted safety suggestions.
- Assist management in evaluating suggestions and identifying appropriate actions.
- Maintain the confidentiality of personnel who submit safety suggestions directly to the Division Safety Office and wish to remain anonymous.

3.3. Suggestion Process

General

Personnel covered by the scope of this chapter may submit suggestions to either of two safety suggestion processes. The Ames Research Center process managed by the Safety, Health, and Medical Services Division or the Wind Tunnel Operations Division process managed by the Division Safety Office. Personnel submitting suggestions to the Center process may be eligible for a cash award. Personnel submitting suggestions to the Division process will be eligible for Division recognition. The Division process is preferred over the Center process for issues that exist under Division authority because there are fewer processing delays.

All employees are responsible for identifying and correcting hazards that are present in the workplace within the limits of their work assignments and authority. Therefore, safety suggestions are generally limited to hazards in the workplace that cannot be corrected within these limits. The suggestion

process contains provisions that allow confidential or anonymous submissions directly to the Division Safety Office in those instances where personnel have concerns about the potential for retribution from staff or management resulting from their suggestion.

There may be delays in implementing permanent corrective actions or process improvements do to personnel, material, or funding restraints. In these instances, management shall evaluate the risk posed by existing circumstances or conditions and implement appropriate interim corrective or protective actions until implementation of a permanent solution.

Center Suggestion Process

Refer to the Ames Research Center Safety, Health, and Medical Services web site for instructions on submitting a safety suggestion to the Center Safety Suggestion process.

Division Suggestion Process

Employees shall proceed as follows to submit an employee safety suggestion using the Wind Tunnel Operations Division process.

Submitting a Division Safety Suggestion

Step	Action
1	Employees initiate a suggestion by completing the Employee Safety Suggestion form, FO7 and submitting it to their immediate supervisor for review.
	NOTE Employees who wish their suggestion to be anonymous or confidential may do so by: • Submitting form to Supervisor without their name. • Submitting form to Division Safety Office without their name. • Submitting form to Division Safety Office with their name, but the confidential box checked.
2	The supervisor reviews and evaluates the suggestion for accuracy and to determine whether an imminent danger to personnel, equipment, or the environment exists.
3	The supervisor takes immediate action to correct or temporarily control imminent danger situations.
4	The supervisor completes the Supervisor Review Information portion of the form, including comments and recommendations.

Submitting a Division Safety Suggestion

Step	Action
	NOTE The supervisor does not have the authority to approve or disapprove a suggestion, but may record their recommendations of implementation and the reasons for their recommendations on the form.
5	The supervisor forwards the suggestion to the Division Safety Office.
6	The Division Safety Office records the suggestion in a tracking system and works with others to evaluate the recommendations, assign actions as appropriate, track status, and report on processing status.

3.4. References

Ames and Division Documents	Ames Health and Safety Manual, APG 1700.1
Forms	Employee Safety Suggestion, F07

End of Chapter

4. Fall-Protection and Working at Heights

4.1. Description

Purpose

Wind Tunnel Operations Division policy is to eliminate or control the potential for personnel injury resulting from falls from elevated work locations, falls into unguarded dangerous equipment, or by being struck by objects or materials that fall from elevated work locations. This shall be accomplished where feasible through installation of standard railings and through the installation of appropriate covers over floor and wall holes and openings. In instances where this is not feasible, personnel shall be protected by using fall-protection systems and by placement of temporary physical barricades to exclude personnel from hazardous areas. Any deviations from or exceptions to the requirements of this chapter must be approved in writing by the Wind Tunnel Operations Division Chief or the Support Contractor General Manager, or their designees, as appropriate.

Scope

This chapter applies to all employees, temporary workers, visitors, support contractor personnel, and subcontractor personnel working under the authority of the Wind Tunnel Operations Division who, due to work locations and assignments, could experience one of the following:

- A fall six or more feet to the ground or the next lower level. This includes falls from unprotected sides and edges, from leading edges, from or through hoist areas, and through holes in roofs and floors, including skylights and observation ports.
- A fall into an uncontrolled hazard such as dangerous stationary or moving equipment, spaces with converging interior surfaces, containers of hazardous materials, or water that is deep enough for an individual to drown in. (This requirement applies regardless of the height of the fall.)
- Injure others by dropping materials, tools, or equipment from heights onto personnel passing or working below them.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

Authority

All personnel are authorized to refuse to perform work when conditions or practices associated with fall-protection or working at heights pose an imminent danger of injury or harm to personnel, facilities, or equipment.

Penalties

Failure to follow the requirements of this chapter is grounds for disciplinary action up to and including discharge from employment.

4.2. Responsibilities

Managers

Managers have the following fall-protection responsibilities:

- Assure overall implementation and compliance with this chapter and any associated procedures.
- Assure the availability of fall-protection equipment to support activities involving working at heights.
- Assure that supervisors and employees are trained in working at heights and in using and caring for fall-protection equipment and systems.

Supervisors and Leads

Supervisors and leads have the following fall-protection responsibilities:

- Monitor work activities to assure compliance with this chapter.
- Ensure personnel under their authority are trained and qualified to recognize potential fall hazards, and to select, use, and maintain fall-protection equipment and systems before assigning them to tasks covered by the scope of this chapter.
- Ensure each job has been properly evaluated for fall hazards, and that those identified hazards have been controlled or eliminated before the start of work activities.
- Participate in job planning for all work performed at elevation.
- Ensure completion of Fall-Protection Work Plans as required.
- Ensure evaluation of anchorages before their use.
- Ensure “keep-out” zones are marked and personnel who enter them wear the appropriate personal protective equipment.
- Participate in the investigation of accidents involving fall-protection equipment and falling debris.
- Prevent visitor access to fall hazard areas until they receive training or until their training and knowledge is verified.

Employees

Employees have the following fall-protection responsibilities:

- Perform their work in accordance with the requirements of this chapter and their training.
- Maintain awareness of hazards associated with working at heights and ensure that these hazards are addressed properly before starting work.
- Report any newly identified hazards associated with working at heights to their supervisor so they can be fully evaluated and controlled.

- Know the uses and limitations of fall-protection equipment.
- Inspect fall-protection equipment before each use and immediately remove any defective equipment from service.
- Maintain fall-protection equipment in accordance with this chapter and their training.
- Annually submit fall-protection equipment issued for their personal use to the designated Fall-Protection Specialist for inspection.
- Report all falls covered by the scope of this chapter to the supervisor.
- Immediately remove from use any fall-protection equipment subjected to a fall, and give it to the Division Safety Office so the designated Fall-Protection Specialist or equipment manufacturer can inspect it.

Division Safety Office

The Division Safety Office has the following fall-protection responsibilities:

- Provide overall guidance for the fall protection and working at heights program.
- Provide assistance to site management in implementing the fall-protection program, training personnel, and monitoring work activities.
- Provide the expertise and guidance necessary to help ensure adequate fall hazard protection.
- Specify, purchase, and issue fall-protection equipment.
- Assist supervisors with fall-protection assessment of their work activities.
- Work with management to designate the “Designated Fall-Protection Specialist.”

The Designated Fall-Protection Specialist

The designated Fall-Protection Specialist has the following fall-protection responsibilities:

- Perform annual inspections of fall-protection equipment issued to individuals and issued through the tool cribs.
- Perform inspections of damaged equipment turned into the tool crib.
- Evaluate fall-protection equipment use.
- Assist in job planning and the review of Fall-protection Work Plans.
- Evaluate any substitutions or changes to a personal fall-arrest system before they are implemented to ensure that they meet the requirements of this chapter.
- Lead investigations of accidents involving fall-protection equipment and falling debris.

Tool Crib Attendants

Tool crib attendants have the following fall-protection responsibilities:

- Perform visual and functional inspections of fall-protection equipment before each issuance.
- Perform visual and functional inspections of fall-protection equipment upon its return to the tool crib.
- Submit damaged or defective fall-protection equipment to the Designated Fall-Protection Specialist.
- Assist the Designated Fall-Protection Specialist with the annual inspection of fall-protection equipment issued through the tool crib.

Subcontractors

Subcontractors have the following fall-protection responsibilities:

- Demonstrate that they have trained their employees in the requirements and procedures that apply to fall protection and working at heights.
- Perform work in accordance with the requirements contained within this chapter.

Visitors

Visitors have the following fall-protection responsibilities:

- Obey signs and barricades erected to exclude personnel from areas with falling-material hazards.
- Refrain from using personal fall-protection equipment unless specifically trained and authorized to do so by a representative of the Wind Tunnel Operations Division.

4.3. Fall-Protection Requirements

Job Planning

Managers, supervisors, shift leaders, and group leads shall ensure that each task involving working at heights is thoroughly planned and that the associated hazards are identified and controlled or eliminated before work begins. They shall also conduct additional planning, as necessary, in response to changes in the work scope. Job planning is the most important step in preventing exposure to the hazards associated with working at heights. Planning helps to define the scope of work, identify work site and work activity hazards, develop hazard elimination or control strategies, and complete the work efficiently.

The scope of work extends beyond the specific work task, such as replacing a limit switch, inspecting a vane set, or installing instrumentation on a model. It also includes:

- Obtaining and staging the materials or equipment specifically required to do the job (pumps, breakers, valves, paint, etc.).
- Obtaining and staging the required tools and supporting equipment (wrenches, ladders, personal protective equipment, aerial lifts, etc.).
- Identifying the specific sequence of steps and methods to be used to complete the task.
- Setting up to do the work (installing barricades and warning signs, disassembling equipment, rigging fall-protection anchorages, setting up cranes or aerial lifts, etc.).
- Reassembling equipment and cleaning-up (cleaning tools and equipment, packaging and labeling waste, removing barricades, removing rigging, etc.).

Once defined, the scope of work shall be used as the basis for hazard analyses and risk assessments, and for establishing boundaries on the activities to be performed.

Job Site Inspection

Job planning should always include visual inspections of the work area and the areas that immediately surround it. The purpose of the inspection is to identify potential hazards that will be directly associated with the work activities being planned and to identify conditions surrounding the work area that could result in injury or equipment damage. Consider the following hazards and questions while performing the inspection:

Work Area Access

- Who will require access to the work area?
- How will personnel gain access to the work location?
- Will personnel performing the work have to pass through areas that pose threats of injury due to hazardous conditions, materials, or processes?
- Can mobile equipment required to support the work activity reach the work area? Consider aerial lifts, cranes, scooters, etc.
- Can emergency response vehicles access the work area to assist in rescuing stranded or injured personnel?
- How will emergency response personnel gain access to injured or stranded personnel to perform a rescue?
- Are stairs, walkways, ladders, etc. in good condition and equipped with appropriate guardrails and handrails?
- Are there sufficient means of egress?

Falling Material Hazards (Impact Protection)

- Will it be possible to drop tools, equipment, or hazardous materials onto personnel working or passing below the elevated work area?
- Will existing conditions or other work activities in adjacent areas create falling material hazards for personnel performing the work activity?

Personnel Fall Hazards

- What type of fall hazards does the work activity pose? Falls to the same level? Falls to a different level? Falls into hazardous equipment? Others?
- Are there unguarded floor holes or openings, wall holes or openings, leading edges, open sided floors, etc?
- Will personnel be working from aerial lift devices?
- Are there appropriate anchorages for personal fall-arrest systems?
- Does the work pose any unique fall hazards that require the development of special fall-protection strategies?
- Will the risk of falls increase due to cold, wet, icy, hot, or windy conditions?
- Is there adequate lighting?

Adjacent Hazards

- Will there be hazards due to adjacent work activities? Consider falling objects or materials, noise, chemical exposure.
- Are there vehicle traffic hazards?
- Does equipment or projections on the structure pose striking or contact hazards to personnel?
- Are there housekeeping issues?

Fall-Protection Work Plan

The Fall-Protection Work Plan, form FO3 is a tool to assist supervisors and the work crew in planning work that poses fall hazards or falling-debris hazards. Supervisors, shift leaders, and group leads shall ensure a Fall-Protection Work Plan is completed for each work activity that has potential for personnel to fall at least 6 feet or into hazardous equipment, and when one or more of the following is true:

- It is likely that the scope of work will change substantially once it begins.
- There are no permanent or designated anchorage points for the attachment of a fall-arrest system.
- Personnel rescue will require the assistance of specially trained and equipped emergency response personnel.
- It will be necessary to design and install special fall-restraint or fall-arrest systems to support the work activity.

- It will be necessary to climb to the work location using existing structural components (such as columns, beams, and ledges) rather than stairs, ladders, walkways, and aerial lifts.
- The work will pose unique fall hazards or take place in unique work locations with which the work crews have little or no experience.

Supervisors, shift leaders, and group leads shall:

- Review completed plans with all work crewmembers before work begins and following any plan revisions.
- Review and revise plans as appropriate following changes in work scope.
- Post completed plans in the associated work area.
- Ensure that personnel perform their assigned tasks in accordance with the posted plans.

Personnel Rescue

Activities requiring personal fall-arrest equipment shall not begin unless there are means available to rescue victims within 15 minutes of a fall. Each job requiring fall-arrest equipment shall be evaluated to identify credible fall victim rescue scenarios. Once identified, each scenario must be reviewed to determine the required response actions. The review must also identify the need for special rescue skills, material, or equipment, and determine the availability of the emergency responders.

Work shall not commence until the work crew obtains and positions the rescue materials and equipment required and verifies the availability of emergency responders. Work in progress shall stop during any periods when resources required to perform a rescue are not available.

Equipment that may be required to support a rescue includes: aerial lifts, ladders, self-rescue devices such as automatic descent devices and friction devices, ropes, block and tackle apparatus, etc.

4.4. Hazard Elimination and Control

Description

There are two general methods for preventing injuries and damage due to falls and falling objects or debris:

- Take steps to eliminate or control the unsafe conditions and acts that create the hazards.
- Take steps to control the severity of the outcomes of a fall and falling debris.

Methods used to control the outcomes of accidents are subject to variable workplace conditions and the potential for human error. Therefore, the preferred method of preventing injuries and damage due to falls and falling debris shall be to eliminate or control the unsafe conditions or acts that cause or contribute to these accidents whenever feasible. The following sections describe ways of implementing accident prevention and control strategies.

Staying Within Scope of Work and Job Planning

Once work begins, employees and supervisors must remain aware of the planned work scope and identify changes in work locations, methods, or tasks that are beyond the original planning. Supervisors and employees must fully evaluate the effect of these changes and incorporate appropriate revisions into the planning documents, hazard elimination strategies, and hazard control strategies.

Impact Damage Prevention and Control

Personnel shall take the following steps to eliminate the potential for objects to fall:

- Cover floor holes and openings.
- Cover wall openings.
- Tether tools and equipment.
- Install standard toeboards or barricades around floor holes, openings, and along exposed edges.
- If toeboards are inadequate, then install paneling from the floor to an intermediate rail or to the top rail where standard toeboards will not be effective because material is piled above them.

Personnel shall take the following steps to control the severity of injuries or damage caused by falling debris:

- Install warning signs and barricades to exclude personnel from areas where falling debris may land.
- Install impact protection over equipment that may be damaged by falling objects.
- Require personnel to use personal protective equipment such as hard hats and safety glasses.
- Place objects that are too large or heavy to be deflected by hard hats or other barriers away from edges and secure them to prevent falling when not in use.

Fall-Restraint Systems

Fall-Restraint Systems shall be used whenever feasible to eliminate fall hazards. Fall-restraint systems include physical barriers, warning lines, and systems comprised of a body harness, a connector, and an anchorage to restrain an individual from falling. Strength and design requirements for fall-restraint systems are less than those for fall-arrest systems.

Physical Barriers

Physical barriers include permanent or temporary standard railing systems, floor opening covers, manhole covers, wall opening screens, picket fences, half doors, swing gates, skylight screens, and permanent or temporary walls.

Warning Lines

Warning lines warn workers that they are approaching the edge of a fall hazard before they get close enough to fall. Warning line systems shall only be used in situations where it is not feasible to use guardrails, safety nets, or personal fall-protection equipment, and when working on flat surfaces and surfaces with a pitch less than 4in of drop per 12in of run.

Body Harness Systems

The body harness system consists of a body harness, connectors, and an anchorage. The body harness and connectors used for the fall-restraint application shall meet the same design and strength requirements as those specified for Fall-arrest Systems. Lifelines and connectors used with body harnesses shall limit the travel of personnel in a way that prevents them from reaching any sides and edges of the walking or working surface.

Fall-Arrest Systems

Fall-Arrest Systems break falls. Personnel shall use Fall-arrest Systems whenever there is a potential for a free-fall, and when using fall-restraint systems are not feasible. There are two types of fall-arrest systems that may be used in Wind Tunnel Operations Division Facilities: body harnesses systems and safety net systems.

All fall arrest systems shall be designed to deploy and completely stop a fall without allowing the user to contact the next lower level. The design must also include shock absorbing devices to minimize the stopping forces experienced by the user and to minimize the potential for bouncing or swinging that may cause the user to strike nearby objects.

Body Harness Systems

Body harness system components are similar to those used for fall-restraint systems in that they are composed of a body harness, connector devices, and anchorages. The primary difference is in the strength requirements of the anchorages.

Safety Net

Safety net systems are not commonly used within Wind Tunnel Operations Division facilities. However, they can be used effectively to protect personnel from injuries due to falls when there are no fall-protection anchorages available at the work location.

4.5. Fall-Protection System Design Requirements

Description

Fall-protection systems and components must meet the design requirements specified below. Qualified engineering personnel and the Designated Fall-Protection Specialist shall design fall-restraint systems for each application. Features such as guardrails, handrails, and anchorages should be included as part of the overall design of a facility, tooling, support equipment, and models.

Body Harnesses

All body harnesses shall meet the design and testing requirements of ANSI Standard Z359.1 entitled "Safety Requirements for Personal Fall-arrest Systems, Subsystems, and Components." Body harnesses are available in many different configurations to support a variety of work activities. Contact the Division Safety Office to obtain assistance in selecting a harness that is appropriate for your need.

Connectors

- Connectors shall be drop forged, pressed or formed steel, or made of equivalent materials.
- Connectors shall have a corrosion-resistant finish and all surfaces and edges shall be smooth to prevent damage to interfacing parts of the system.
- Lanyards and vertical lifelines which tie-off one employee shall have a minimum breaking strength of 5,000lbs.
- D-rings and snap-hooks shall be capable of sustaining a minimum tensile load of 5,000lbs.
- Connectors such as lanyards, snap hooks, and carabiners shall be a locking type designed to prevent disengagement when the keeper contacts the connected member.

Fall-Arrest Anchorages

An anchorage for personal fall-arrest equipment shall be capable of supporting ≥ 5,000lbs per employee attached to it. An anchorage shall be designed, installed, and used under the supervision of a qualified person as part of a complete personal fall-arrest system that maintains a safety factor of at least two.

Fall Restraint and Positioning Anchorages

Anchorages used for fall restraint and positioning purposes shall be capable of supporting at least twice the potential impact load of an individual's fall or 3,000lbs, whichever is greater. If the anchorage will be used concurrently by more than one person, the number of concurrent users shall multiply the 3,000lbs requirement.

Floor Opening Covers

Floor opening covers may be constructed of any material that meets the following strength requirements:

- Covers shall be capable of supporting at least twice the weight of employees, equipment, and materials that may be imposed on the cover at any one time.
- Covers shall not project more than 1 inch above the floor level. Cover edges shall be chamfered to an angle ≤ 30°. All hinges, handles, bolts, or other parts shall be set flush with the floor or cover surface.
- All covers shall be secured when installed so as to prevent accidental displacement by the wind, equipment, or employees.
- All covers shall be color coded or marked with the word "HOLE" or "COVER" to provide warning of the hazard.

Horizontal Lifelines

Lifelines shall be attached to anchorages that are independent of all other equipment. Horizontal lifelines are anchoring lines rigged between two anchorages on the same level. They provide the user with a great deal of mobility and continuous fall protection across large distances. However, the design of horizontal lifeline systems is extremely critical due to the number of variables that can affect their safety and effectiveness. These variables include the design load, the length of the lifeline between supports, the clearance above and below the work area, the size and type of lifeline used (i.e. steel cable, synthetic rope), and the type of connectors used.

- A qualified person shall design horizontal lifeline systems for each individual application.
- The design must provide a safety factor of at least two under all use conditions.

Safety Nets

Safety nets shall be installed as close as practicable below the surface where employees are walking or working, but in no case more than 30ft below such level. Safety nets shall extend outward from the outermost projection of the work surface as follows:

Table 4.1: Safety Net Installation

Vertical distance from working level to horizontal plane of the outer edge of the net.	Minimum required horizontal distance from the edge of the working surface.
5 feet or less	8 feet
Between 5 and 10 feet	10 feet
10 feet or more	13 feet

Safety nets shall be installed with sufficient clearance under them to prevent contact with the surface or structures below when subjected to an impact force equal to the drop test specified below.

Safety nets and their installations shall be capable of absorbing an impact force equal to that produced by the drop test specified below.

Safety nets and safety net installations shall be drop tested at the job site after initial installation and before being used as a fall-protection system, whenever relocated, after major repair, and at 6-month intervals if left in one place. The drop test shall consist of a 400lbs bag of sand 30 ± 2in in diameter dropped into the net from the highest surface at which employees are exposed to fall hazards. In all drop tests, the bag shall be dropped from a minimum distance of 42in above the safety net.

The maximum size of each safety net mesh opening shall not exceed 36in2 nor longer than 6in on any side, and the opening, measured center-to-center of mesh ropes or webbing, shall not be longer than 6in. All mesh crossings shall be secured to prevent enlargement of the mesh opening.

Each safety net (or section of it) shall have a border rope for webbing with a minimum breaking strength of 5,000lbs.

Connections between safety net panels shall be as strong as integral net components and shall be spaced not more than 6in apart.

Skylight Screens

Skylight screens shall be capable of withstanding a load of at least 200lbs applied perpendicularly to any one area on the screen. They shall be of such construction and mounting that under ordinary loads or impacts, they will not deflect downward and break the glass below them. The construction shall be grillwork with openings no more than 4in long or slatwork with openings no more than 2in wide.

Standard Railings

Standard railings shall meet the following requirements:

- Standard railings shall consist of a top rail, an intermediate rail, and posts.
- The top rail shall be smooth with its upper surface 42in from the floor, platform, runway, or ramp level.
- Protection between top rail and floor, platform, runway, ramp, or stair treads, equivalent at least to that provided by an intermediate rail.
- The intermediate rail shall be approximately halfway between the top rail and the floor, platform, runway, or ramp.
- The rail ends shall not overhang the terminal posts except where such overhang does not constitute a projection hazard.
- The anchoring of posts and framing of members for railings of all types shall be constructed to withstand a load of at least 200lbs applied in any direction at any point on the top rail.
- Mid-rails shall be capable of withstanding a force of at least 150lbs applied in any downward or outward direction.

When constructed of wood, the posts shall be 2in by 4in stock and spaced at 6ft or less intervals. The top and intermediate rails shall be 2in by 4in stock. If the top rail is made of two of 1in by 4in stock at right angles, posts may be spaced on 8ft centers, with a 2in by 4in intermediate rail.

When constructed of pipe, posts and top and intermediate railings shall be at least 11/2in nominal diameter with posts spaced not more than 8ft on centers.

When constructed of structural steel, posts and top and intermediate rails shall be of 2in by 2in by 3/8in angles or other metal shapes of equivalent bending strength with posts spaced not more than 8ft on centers.

Standard Toeboards

Standard toeboards may be of any substantial material that is either solid or has openings ≤ 1in. They shall be 4in from the top edge to the floor, platform, runway, or ramp. They shall be securely fastened with ≤ 1/4in clearance above floor level. Toeboards shall withstand a force of at least 50lbs applied in any downward or outward direction.

Where material is piled to such height that a standard toeboard does not provide protection, paneling from the floor to the intermediate rail or to the top rail shall be provided.

Vertical Lifelines

Lifelines shall be attached to anchorages that are independent of all other equipment.

- Vertical lifelines must be equipped with a formed eye termination connector at one end for attachment to the anchorage.
- The components of self-retracting lifelines and lanyards that limit free-fall distance to ≤ 2ft shall be capable of sustaining a minimum static tensile load of 3,000lbs.
- Self-retracting lifelines and lanyards that do not limit free-fall distance to ≤ 2ft, ripstitch lanyards, and tearing and deforming lanyards shall be capable of sustaining a minimum tensile load of 5,000lbs.
- Vertical lifelines which tie-off one employee shall have a minimum breaking strength of 5,000lbs.

Wall Opening Barriers

Wall opening barriers (rails, rollers, picket fences, and half doors) shall be constructed and mounted to withstand a load of ≥ 200lbs, applied in any direction at any point on the top rail or a corresponding member.

Wall Opening Screens

Wall opening screens shall be constructed and mounted to withstand a load ≥200lbs horizontally applied at any point on the near side of the screen. They shall be of solid construction either of grillwork with openings ≤ 8in long or of unrestricted length slats with openings ≤ 4in wide with.

Warning Lines

Warning line systems shall be used only on flat surfaces and surfaces with a pitch ≤ 4in of drop per 12in of run. They shall be erected ≥ 6ft from the edge around all sides of a fall-hazard. Warning lines shall consist of ropes, wires, or chains, and supporting stanchions erected as follows:

- The rope, wire, or chain shall be flagged with high visibility material at ≤ 6ft intervals.
- The rope, wire, or chain shall be rigged and supported so its lowest point is ≥ 34in above the surface. At its highest point, the rope, wire, or chain shall be ≤ 39in above the surface.
- The stanchions (with rope, wire, or chain attached) shall withstand a force ≥16lbs applied horizontally against the stanchion at 30in above the surface, in the direction of the surface edge and perpendicular to the warning line.
- The rope, wire, or chain shall have a tensile strength ≥ 500lbs.
- The rope, wire, or chain shall support the loads (as specified above) applied to the stanchions without breaking.
- The rope, wire, or chain shall be attached at each stanchion so pulling on a section between stanchions does not result in slack being taken up in adjacent sections.

4.6. Use of Fall-Protection Equipment

Description

Standard-issue personal fall-protection systems and components shall not be used when the combined weight of the user and any tools and equipment they will be carrying exceeds 310lbs. When the combined weight exceeds 310lbs, a special engineering evaluation will be required to ensure that the system meets or exceeds minimum safety factor requirements. Individuals whose weight exceeds 310lbs shall not use personal fall-protection systems unless specifically authorized by management and a Designated Fall-Protection Specialist.

Following is a list of general fall-protection equipment use requirements. Requirements that apply specifically to fall-restraint or arrest equipment, or to special situations are listed in the appropriate subsections.

- Fall-protection equipment and systems must be designed, purchased, and used in accordance with the applicable manufacturer's specifications, regulatory requirements, and the requirements contained within this chapter.
- Only equipment that is provided by or approved by the Designated Fall-Protection Specialist shall be used for fall-protection purposes.
- Fall-protection equipment that may be suitable for other purposes, such as cables, ropes, lanyards, beam trolleys, beam clamps, etc. shall be used for the designated fall-protection functions only.
- Only full-body harnesses shall be used for fall protection.

- Only back-mounted D-rings shall be used for fall-arrest purposes.
- Front-mounted D-rings shall only be used for attaching to climbing systems (such as ladder safety devices).
- Shoulder-mounted D-rings shall be used only for lowering, raising and rescue purposes.
- Side-mounted D-rings shall only be used for positioning purposes.
- Users shall inspect fall-protection equipment before each use.
- Users shall maintain fall-protection equipment in good condition at all times.
- Users shall remove damaged or dysfunctional equipment from service immediately and give it to the designated Fall-Protection Specialist for inspection.
- Users shall remove any fall-protection equipment that was subjected to a fall from service immediately and give it to the Designated Fall-Protection Specialist for inspection.
- Only anchorages that have been evaluated and approved by the Designated Fall-Protection Specialist or a qualified engineer shall be used for fall-restraint or fall-arrest protection.

Aerial Lifts

The following shall apply when aerial lifts are used:

- Each individual in the basket shall wear a body harness and lanyard attached to the basket or boom.
- Users shall not attach lanyards to adjacent structures or equipment while working from aerial lifts.
- Harnesses and lanyards are not required for occupants of scissors-lifts that have properly installed and functional guardrails.

Deceleration Devices

Deceleration or shock-absorbing devices shall be used with all personal fall-arrest systems except those with self-retracting lifelines or lanyards, or where lanyards are installed to limit a free-fall to less than 42in. Multiple deceleration devices shall not be used in series in a personal fall-arrest system.

Fall-Restraint Versus Fall-Arrest Systems

Fall-restraint systems shall be used as the preferred method of preventing personnel injury due to falls. In instances where it is not feasible to install fall-restraint systems, fall-arrest systems shall be used to reduce the risk of injury due to falls. Fall-arrest systems shall be used to reduce the risk of injury in all situations where a fall hazard exists and it is not feasible to install fall-restraint systems or during interim periods while fall-restraint systems are being designed and installed.

Ladders, Fixed

The following shall apply when fixed ladders are used:

- Cages or other permanent fall-protection devices (such as sliding rail systems) shall be installed on fixed ladders that are higher than 20ft.
- Where a cage or other permanent fall-protection device is not feasible, a temporary fall-protection system, such as a vertical or self-retracting lifeline, shall be installed to support the work activity.

Ladders, Portable

It is not possible to use fall-restraint or fall-arrest equipment in many temporary work locations where personnel must use portable ladders. The following shall apply when using portable ladders:

- Use the correct type and size of ladder for the job.
- Inspect ladders before use to ensure that they are in good condition and working properly.
- Do not use damaged ladders. Remove them from service immediately.
- Secure extension ladders at the top and bottom whenever possible to prevent them from moving. If this is not possible, assign a second individual to hold the ladder in place.
- Install extension ladders at the correct angle of 1ft out from the base for every 4ft of elevation.
- Extend the rails of extension ladders 3ft above the walking or working surface.
- Use a rope or line to hoist tools and materials to the work location rather than carrying them up the ladder.
- Do not tie ladders together.
- Use stepladders in the fully opened and locked position only..
- Do not use ladders in a horizontal position as a scaffold plank or work platform.
- Keep the access areas to ladders free of debris and stored materials.

Lanyards

The following shall apply when lanyards are used:

- Always use the shortest possible lanyard length.
- Lanyards shall be sized, adjusted, or installed so the maximum fall distance is 6ft.
- Lanyards must be used in conjunction with shock absorbers or a shock absorbing system, except when they are self-retracting, or where they are installed to limit a free-fall to less than 42in.
- Lanyards must never contain knots.
- No more than one person may be attached to a single lanyard.

- Lanyards that are not in use shall be secured to prevent tripping or entanglement.
- Only non-conductive lanyards shall be used when performing work near energized electrical equipment.

Lifelines, Horizontal

The following shall apply when horizontal lifelines are used:

- Only one individual at a time may use a horizontal lifeline system, unless it is specifically designed for use by more than one individual.
- When horizontal lifelines may become vertical lifelines (such as due to a component failure), the rope grab device used to connect to the lifeline shall be capable of locking in both directions on the lifeline.

Lifelines, Self-Retracting

The following shall apply when self-retracting lifelines are used:

- Self-retracting lifelines shall be installed and used so the lifeline maintains an angle that is less than 45° from the vertical.
- Self-retracting lifelines requiring periodic inspections by the manufacturer shall not be used unless the inspection certification is current.

Lifelines, Vertical

The following shall apply when vertical lifelines are used:

- Vertical lifelines shall only be used by one individual at a time.
- The bottom end of a vertical lifeline must extend below the lowest level of vertical travel, and be attached to a second anchorage, or weighted to provide stability.
- “Rope Grab” devices used with vertical lifelines must be selected to be compatible with the type and size of the lifeline being used.
- Rope grabs shall remain positioned above shoulder height during use.
- The length of lanyards used with vertical lifelines must meet the manufacturer’s specifications for the rope grab being used.

Safety Nets

The following shall apply when safety nets are used:

- Defective nets shall not be used.
- Materials, scrap pieces, equipment, and tools which have fallen into the safety net shall be removed as soon as possible from the net and before the next work shift.
- Defective components shall be removed from service immediately.

Scaffolds

The following shall apply when using scaffolds:

- Each employee on a scaffold more than 6ft above a lower level shall be protected from falling to that lower level.
- Standard guardrails or fall-arrest systems shall be used to protect personnel wherever the front edge of a platform is more than 14in from the face of the work.
- Fall-arrest systems or positioning devices shall be used where the integral prefabricated scaffold access frames with rungs shorter than 111/2in are used as work platforms.
- Fall-arrest systems or windscreens may be used to protect personnel working on scaffolds during storms and in high winds when the designated Fall-Protection Specialist has determined that it is safe to do so.
- Windscreens shall not be used unless the scaffold is secured against the anticipated wind forces.
- The designated Fall-Protection Specialist shall determine the feasibility and safety of providing fall protection for employees erecting or dismantling supported scaffolds.
- Fall-arrest systems used on scaffolds shall be attached by lanyard to a vertical lifeline, horizontal lifeline, or scaffold structural member.
- When vertical lifelines are used, they shall be fastened to a fixed safe point of anchorage that is independent of the scaffold and shall be protected from sharp edges and abrasion.
- Structural members of buildings shall be used as safe points of anchorage, but standpipes, vents, other piping systems, electrical conduit, outrigger beams, or counterweights shall not be used.
- Vertical lifelines, independent support lines, and suspension ropes shall not be attached to each other, to the same point of anchorage, or to the same point on the scaffold or fall-arrest system.

Travelling Between Locations

Personnel traveling between locations while working at a height shall use fall-protection systems such as standard guardrails, vertical or horizontal lifelines, ladder cages, or other ladder safety devices, or the use of either two lanyards or a “Y” lanyard. When using two lanyards or “Y” lanyards, one of the lanyards or lanyard legs shall be attached to an anchorage at all times.

4.7. Inspections

User Inspections

Users shall inspect fall-arrest equipment for damage or defects before each use. Any damaged or defective equipment shall be removed from service immediately and given to the Support Contractor Safety Department to be evaluated. Users shall specifically inspect harnesses, lanyards, and connectors for the damage and defects listed in the inspection criteria sections below.

Designated Fall-Protection Specialist Inspections

The Designated Fall-Protection Specialist shall perform annual inspections of all fall-protection equipment. This includes equipment issued to individuals for personal use and equipment issued through the tool cribs. These inspections will verify that fall-protection equipment is in good condition and operates correctly, and ensures equipment is being sent to manufacturers for inspections and servicing as required. The inspections performed on equipment issued for personal use shall include discussions with the users to evaluate their knowledge of equipment limitations and inspection requirements.

The Designated Fall-Protection Specialist shall inspect safety nets at least once a week for wear, damage, and other deterioration. They shall also inspect them immediately following any occurrence that could affect the integrity of the safety net system.

Tool Crib Attendant Inspections

Tool crib attendants shall inspect fall-protection equipment for obvious defects or damage before issuing it and when it's returned. Tool crib attendants shall not issue equipment that shows signs of defects or damage. Defective or damaged equipment shall be marked as damaged or defective and segregated from other equipment and shall not be issued until the Designated Fall-Protection Specialist inspects it and approves its continued use.

Inspection Criteria for Body Harness Systems

Inspection criteria for body harness systems includes inspecting belts, buckles, D-rings, and webbing.

Belts

Inspect belts for the following damage or defects:

- Loose or distorted tongue.
- Missing grommets.
- Extra holes.
- Transverse cracks that form when webbing is bent over a mandrel.
- Loss of elasticity.

Buckles

Inspect buckles for the following damage or defects:

- Tongue buckles that are distorted in shape or movement.
- Tongues that do not overlap the buckle frame.
- Tongues that do not move freely back and forth in the socket.
- Buckle rollers that do not turn freely, are distorted, or have sharp edges.
- Friction buckles that are distorted, have bent or distorted outer and center bars, or bent or distorted corners.

D-Rings

Inspect D-rings for the following damage or defects:

- Distorted metal wear pads.
- Cracks, breaks, or rough or sharp edges.
- D-rings that are not perpendicular to the belt or do not pivot freely.

Webbing

Inspect webbing for the following damage or defects:

- Frayed edges, broken or cut fibers, holes, or pulled or loose stitches.
- D-ring and buckle attachments that show unusual wear or that have frayed or cut fibers.
- Heat-damaged areas that are brittle and break when flexed, or that have a shriveled brownish appearance.
- Chemical damage that may appear as brown smears or smudges, the formation of transverse cracks where webbing bends over a mandrel, or the loss of elasticity.
- Strands that are fused together, have hard shiny spots, or feel hard and brittle.
- Paint damage that penetrates and restricts movement of the fibers.

Inspection Criteria for Lanyards and Lifelines

Inspection criteria for lanyards and lifelines includes inspecting rip-stop arresting devices, cables, connectors and fittings, ropes, and webbing.

Rip-Stop Arresting Devices

Inspect rip-stop arresting devices for the following damage or defects:

- Burn holes and tears.
- Loose strands, rips, and deterioration of stitching on areas where the pack is sewn to D-rings, belts, or lanyards.

Cables

Inspect cables for the following damage or defects:

- Cuts, frayed areas, or unusual wearing patterns on the wire.
- Broken strands that separate from the body of the cable when twisted.

Connectors and Fittings

Inspect connectors and fittings for the following damage or defects:

- Snaps that have hook and eye distortions, cracks, corrosion, or pitted surfaces.
- Keepers that are distorted or obstructed and do not seat into the nose without binding.
- Keeper springs that exert insufficient force to firmly close the keeper.
- Keeper locks that prevent the keeper from opening.
- Thimbles that do not seat firmly in the in the eye of a splice.
- Splices that have loose or cut strands.
- Thimbles that have sharp edges, distortions, or cracks.

Ropes

Inspect ropes for the following damage or defects:

- Fuzzy, worn, broken, or cut fibers that appear as the rope is rotated from end-to-end.
- Noticeable changes in the original diameter. (Following a short break-in period, the rope diameter should be uniform throughout its length.)

Webbing

Inspect webbing for the following damage or defects:

- Cuts, snags, or breaks that appear while bending the webbing over a pipe or mandrel.
- Swelling, discoloration, cracks, charring or obvious signs of chemical or heat damage.
- Any breaks in the stitching.
- Any activation of warning flags built into Miller Manyards®.

4.8. Accident Investigation

Description

The Designated Fall-Protection Specialist and appropriate supervisor shall investigate all accidents involving fall-protection equipment and debris falling from overhead work. The purpose of the investigation shall be to identify accident causes; to identify actions required to prevent future occurrences, and to evaluate the effectiveness of the methods used for personnel and equipment protection.

4.9. Training

Initial Training

Personnel shall receive initial fall protection and working at heights training prior to being assigned to tasks covered by the scope of this chapter. The training shall include:

- The contents of this chapter.
- Limitations on the use of fall-protection equipment.
- The nature of fall hazards in the work area.
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall-protection system to be used.
- The use and operation of personal fall-arrest systems and other protection to be used. This shall include: proper anchoring and tie-off techniques; estimation of free fall distance, including determination of deceleration distance, and total fall distance to prevent striking a lower level; the severity of consequences of improper use (such as using knots, tying around sharp edges, etc.)
- The correct procedures for the inspection, handling, and storage of equipment and materials.
- The role of employees in fall-protection plans.
- The OSHA standards pertaining to fall protection.

Refresher Training

Refresher training shall be provided whenever:

- A change in job assignments poses the potential for new hazards associated with fall protection or working at heights.
- There is a change in the requirements of this chapter or the associated equipment or processes.
- An individual demonstrates a lack of knowledge or understanding of hazards associated with the use of fall-protection equipment or working at heights.

4.10. Definitions

Aerial Device

Any vehicle-mounted device, telescoping or articulating, or both, which is used to position personnel. This includes scissors-lifts and telescopic or extensible boom lifts such as “JLGs.”

Authorized Personnel

Individuals whose work assignments or locations meet the criteria specified by the scope of this chapter, are trained in, and have demonstrated competence in the selection, use, and care of fall-protection equipment and systems.

Anchorage	A secure point of attachment for lifelines, lanyards or deceleration devices that is capable of withstanding the loads specified by this chapter. Examples include eyebolts and welded eyes, structural steel, and welded steel pipe.
Body Harness	Fall-protection equipment consisting of straps which may be secured about the individual in a manner that will distribute the fall-arrest forces over the thighs, pelvis, waist, chest and shoulders.
Connector	A device used to connect parts of the personal fall-arrest system and positioning device systems together. Connectors may be an independent component of the system such as a carabiner, or an integral component, such as a buckle or D-ring sewn into a body belt or body harness, or a snap-hook spliced or sewn to a lanyard or self-retracting lanyard.
Dangerous Equipment	Equipment such as rotating machinery, electrical equipment, and other units which as a result of form or function may be hazardous to employees who fall onto or into such equipment.
Deceleration Device	Any mechanism, such as a rope grab, rip-stitch lanyard, specially-woven lanyard, tearing or deforming lanyards, automatic self-retracting lifelines or lanyards, etc., which dissipates energy during a fall arrest, or otherwise limits the energy imposed on an employee during fall arrest.
Designated Fall-Protection Specialist	To satisfy regulatory requirements for a “Competent Person”, an individual who is capable of identifying hazardous conditions regarding fall-protection equipment, is knowledgeable in the application and use of the equipment, and has the authority to take prompt corrective actions is designated as a Fall-Protection Specialist.
Fall-arrest System	A system composed of multiple approved safety equipment components that are interconnected and rigged to stop a free fall such as body harnesses, lanyards, deceleration devices, drop lines, horizontal or vertical lifelines and anchorages.
Fall-restraint System	Components that function together to prevent an individual from falling to a lower level or into dangerous equipment. Fall-restraint devices include permanent and temporary guardrails, monitors, and positioning devices.
Floor Hole	A gap or void ≥ 2in (5.1 cm) in a floor, roof, or other walking or working surface.
Floor Opening	An opening measuring ≥ 12in in any floor, platform, pavement, or yard such as a hatchway, stair or ladder opening, pit, or large manhole. Floor openings occupied by elevators, dumb waiters, conveyors, machinery, or containers are excluded.
Free Fall Distance	The distance the harness D-ring travels from the onset of a fall to the time when the fall-arrest system activates. (It excludes any deceleration distance and any system elongation.)

Imminent Danger	Any conditions or practices posing an immediate danger which could be expected to cause death, serious physical harm, or serious damage to facilities or equipment.
Leading Edge	The unprotected edge of a floor, roof, decking, or forms for a floor or other walking or working surface as it is being constructed.
Life Line	A flexible line connected to an anchorage at one end as a vertical lifeline, or connected at both ends as a horizontal lifeline and to which other elements of a fall-arrest system are attached.
Lower Levels	Any areas or surfaces to which an employee can fall.
Personal Fall-arrest System	A system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, a body belt or body harness and may include a lanyard, deceleration device, lifeline, or suitable combinations of these.
Positioning Device System	A body harness system to support an employee on an elevated vertical surface such as a wall to allow work with both hands free.
Qualified Person	An individual with a recognized degree or professional certificate and extensive knowledge in the applicable field who is capable of designing, analyzing, evaluating, and specifying the fall-protection structures or equipment required to support activities involving working at heights.
Rope Grab	A deceleration device that travels on a lifeline and uses friction to automatically engage the lifeline to arrest the fall. A rope grab usually employs the principle of inertial locking, cam or level locking, or both.
Wall Opening	A gap or void ≥ 30in high and ≥ 18in wide in a wall or partition through which an individual could fall.

4.11. References

Ames and Division Documents	Ames Health and Safety Manual, APG 1700.1
Forms	Fall-Protection Work Plan, FO3

End of Chapter

5. Environmental Compliance

5.1. Description

Purpose

The purpose of this chapter is to describe requirements and processes that implement the Division policy to protect the environment, general public, and all personnel from the hazards posed by improperly controlled hazardous materials.

For other requirements regarding hazardous materials, refer to the chapter on Hazard Communication and Handling Hazardous Materials. For more detailed information, refer to the Division Hazard Communication Program and regulatory documents available in the Division Safety Office.

Scope

This chapter applies to anyone under the authority of the Wind Tunnel Operations Division, including civil servant, support contractor, and temporary personnel whose activities involve using or disposing of hazardous materials.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at `http://pubsgroup.arc.nasa.gov/`.

5.2. Responsibilities

Managers

Managers' responsibilities include the following:

- To implement the procedures described in this chapter.
- To be aware that complying with environmental compliance regulations is a statutory obligation.
- To ensure that personnel reporting to them comply with the requirements of this chapter.
- To ensure all environmental and safety issues are properly handled.
- To provide personnel all training and resources that comply with the requirements of this chapter.

Supervisors

Supervisors' responsibilities include the following:

- To ensure that personnel reporting to them comply with the requirements of this chapter.
- To ensure that personnel are aware that complying with environmental compliance regulations is a statutory obligation.

- To ensure the safe handling of hazardous materials by the people under their supervision.
- To assure that personnel are familiar with and act in accordance with required procedures.
- To properly train personnel who acquire, store, use, generate, and dispose of hazardous substances.
- To train employees on proper emergency response and spill-prevention procedures.
- To ensure that an Material Safety Data Sheet (MSDS) is obtained for each hazardous substance that is acquired and that an MSDS work place file is maintained.
- To ensure that all employees are properly trained annually and the training records for those employees are kept to 30 years.
- To assure that each employee has ready access to the MSDS file and has read and reviewed the file contents.
- To indicate which of the substances used and waste generated by their personnel are hazardous.
- To assure that only “safe” amounts of various hazardous substances are authorized to be kept in the work station/ laboratory. A safe amount is generally considered to be one-week supply or less.
- To assure that labeling is appropriate (adequate to identify material and its hazard) on each chemical container and that the container is properly stored (flammable locker, secondary containment, compatible chemicals, etc.).
- To conduct an annual chemical inventory to be submitted to the ARC Safety, Environmental and Mission Assurance Office.
- To personally attend annually 8 hours of chemical/hazardous material training courses to comply with Occupational Safety and Health Administration (OSHA) and EPA requirements. This training gives supervisors the ability to subsequently train their employees on hazardous material handling.
- To establish spill control stations for all areas where hazardous substances and wastes are accumulated.
- To assure that an Extremely Hazardous Substance Request/ Permit (APG 1700.1) and its associated MSDS are obtained and posted for extremely hazardous substances.
- To appoint one employee to make a weekly inspection of all hazardous substance storage areas and log the results on the appropriate form.
- To ensure that hazardous waste is disposed of properly.

Hazardous Material Users

Hazardous material users' responsibilities include the following:

- To comply with the requirements of this chapter.
- To be aware that complying with environmental compliance regulations is a statutory obligation.
- To never handle, use, clean up, or dispose of any hazardous material in which they are not properly trained.
- To be familiar with the properties of hazardous materials they use.
- To know the contents of the work area MSDS binder, and know its permanent location for ready access in the event of an emergency.
- To understand and comply with all procedures for handling hazardous substances.
- To know contingency actions that must be taken immediately if the unexpected occurs, e.g., a hazardous material spill.
- To attend annual required training and re-certification, e.g., hazardous materials management, hazard communications, etc.
- To report difficulties and recommend improvements to their supervisors on procedures for handling hazardous substances.
- To assure that all chemical containers are labeled as required and are secondarily contained.
- To fill out appropriate weekly logs.

5.3. Requirements

Bay Area Air Quality Management District Regulations

The EPA and the Bay Area Air Quality Management District (BAAQMD) require daily record keeping of permitted coating and solvent usage for all areas of Ames. Certain permits, issued by the BAAQMD, impose operating conditions such as solvent-use record keeping. In many cases, permits for solvent-use sources require daily records. Record keeping is also required for coating operations. Check the specific conditions for the sources operated in you area. The BAAQMD also regulates the solvent content of many consumer products such as paints, spray paints, resins, and adhesives. The BAAQMD prohibits the sale or use of materials in this area that do not meet their specifications for solvent content. Please check the MSDS of the material you intend to purchase for use and check its Volatile Organic Compound (VOC) content against the BAAQMD requirement for that material and application. Contact the Division Safety Office or the ARC Safety, Environmental and Mission Assurance Office for assistance.

General regulations include:

- Complete the appropriate forms every time one of these materials is used.
- The area supervisors are responsible for ensuring that their employees report all usage.

- These forms are to be sent to the Division Safety Office by the third of each month for the previous month's usage.
- All coatings must meet BAAQMD VOC limits.
- Any source of VOCs could require a permit. Check with the ARC Safety, Environmental and Mission Assurance Office.

Hazardous Waste Minimization

One of the most cost-effective approaches to the hazardous waste problem is waste minimization. Division policy is to minimize the generation of hazardous waste by implementing source reduction, reuse and recycling, and treatment, as described below:

Source Reduction

Whenever possible, non-hazardous materials should be substituted for hazardous materials, or the process should be modified to eliminate or reduce the quantity of hazardous waste generated. For example, Envirosolv is the preferred general-purpose cleaner to replace Freon.

Reuse and Recycling

To the extent that is feasible, spent hazardous materials must be reused or recycled for reuse. An example is recycling waste oils.

Treatment

Hazardous waste that cannot be reduced, reused, or recycled shall be treated, if technically and economically feasible, to reduce its volume and its hazardous properties. An example of such treatment is neutralizing corrosive materials.

Hazardous treatment waste units are subject to tiered permitting requirements. Notify the Division Safety Office and/or ARC Safety, Environmental and Mission Assurance Office prior to installing hazardous waste treatment units.

Waste Accumulation and Disposal

Waste materials must be separated into groups. Materials within a group may be mixed with other materials in the same group in a 55-gallon drum. Materials must not be mixed with materials from a different group due to extremely high cost of disposal when materials are mixed. these groups are:

Group 1

- Freons (halogenated solvents.)
- Trichlorotrifluoroethane.
- Fluorosolvent T.F.

Group 2

- Used oils and compatible hydrocarbons Mobile and other lubricating oils.
- Kerosene.
- Jet Fuel (JP5 or JP8).

Group 3

- Flammable solvents (nonhalogenated).
- Acetone.
- Turpentine.
- Petroleum naptha.
- Stoddard solvent.

Group 4

- Contaminated solids.
- Asbestos, paint, and other hazardous waste must be separated.

Container Management

All hazardous waste drums must be maintained in the following manner:

- Containers must be marked with accumulation start date, the words "Hazardous Waste," and a description of the contents i.e. "Acetone, flammable".
- Containers must be repacked if not in good condition, e.g., severe rusting, apparent structural defects.
- Containers must be compatible with the waste.
- Container must be securely closed unless waste is being added or removed.
- Containers must be inspected weekly for leakage and deterioration.
- Incompatible wastes must not be placed in the same container.
- Secondary containment of all containers is required. If the material is being placed in a bag for storage, then the material must be "double bagged." Both bags must have a hazardous waste label if needed.

Hazardous Waste Labeling

All waste containers must have the Hazardous Waste Accumulation label on the container. The label is to be filled out completely at the accumulation start date including physical state, hazard, and container contents.

Hazardous Waste Accumulation Time Restrictions	Accumulation time is limited to 90-day on site except when area is designed as a satellite accumulation area. Contact the ARC Safety, Environmental and Mission Assurance Office to obtain a satellite accumulation area designation. Containers limited to 90 days on site must be scheduled for pick-up within 50 days of the accumulation start date. If the drum is considered to be a satellite accumulation container, then it must be moved to the Division hazardous materials storage area within three days of reaching the quantity limits (55 gallons of hazardous waste or 1 quart of extremely hazardous materials) or within nine months of accumulation start date, whichever comes first.
Hazardous Waste Removal	When a container is full or the time restriction on the container is met, then a Hazardous Waste Pick-up Request is to be filled out and sent to the designated waste contractor. Prior to pick-up, assure containers are securely closed and there is no residual chemical/rainwater on outside of container.
Empty Containers (Drums)	An empty container is a recyclable 55-gallon steel container with less than 1-inch of residual known contents. When a drum previously containing a hazardous material becomes empty, place an empty label on the drum. The empty drum is then moved to the empty drum accumulation point. When 20 to 30 drums accumulate, the supervisor fills out the appropriate form for disposal. If the drum previously contained an acutely hazardous waste as listed in 40 CFR or an extremely hazardous waste as listed in Title 22 CCR, then it is not an empty container and must be managed as hazardous waste.
Disposal of Small Amounts of Hazardous Waste	The container or bag must be labeled with a description of the material. A hazardous waste accumulation label must be affixed to the container and filled out completely and accurately. Fill out an appropriate form for disposal.
Spill Procedures Emergency Response	The area supervisor sets up emergency response supplies at major hazardous material storage and waste accumulation locations. The supervisor alerts all personnel of the probable spill routes and instructs them on the procedures to follow to prevent the spilled material from reaching the environment. If the spill cannot be contained and it takes more that 2 person-hours to clean up, the Duty Office and the Division Safety Office must be called immediately. Dial 9-1-1 if you cannot get an immediate response or if the spill is extreme and out of control.

Spill Control

The following steps are to be followed for any type of spill. Control a spill or leak only if it is possible to do so safely:

- Notify the area supervisor and the Division Safety Office immediately. The Division safety offices should notify the ARC Safety, Environmental and Mission Assurance Office.
- Evacuate any affected personnel.
- Secure the area. use safety tape, cones, barricades, etc., so the area is visible and inaccessible to all employees in the area.
- Protect yourself. Before trying to identify or clean up the spill, determine what personal protection equipment is necessary.
- Contain the spill.
- Identify the spill through the use of visual and chemical means (color, odor, pH, viscosity).

Small Spill Cleanup

Spill Cleanup of less than 2 person-hours of clean up time.

- Put on appropriate personal protection equipment (gloves, goggles, face shields, aprons, etc.)
- Use appropriate spill cleanup wipes, pads, or absorbent to contain and cleanup the spill.
- Put all spill material in a plastic bag, secure the bag, and place that bag in another bag. Secure the second bag.
- Attach a correctly completed hazardous waste label to the bag and place in the appropriate secondary containment storage area for disposal.

Large Spill Cleanup

Spill Cleanup of more than 2 person-hours of clean up time.

- Call 9-1-1 to immediately notify the Duty Office. Also immediately notify the area supervisor and the Division Safety Office.
- Evacuate any affected personnel.
- Secure the area and try to prevent spill from going into any storm or sanitary sewer drains.

Hazardous Waste Regulations

EPA (40 CFR) and California Department of Health Services (Title 22 CCR) enforce specific regulations for hazardous wastes.

Hazardous Materials Regulations

Hazardous waste is also a hazardous material, therefore the following regulations apply:

Table 5.1: Hazardous Materials Regulations

Regulatory Agencies	Regulation(s)
Cities of Mountain View and Palo Alto	• Sanitary Sewer Ordinance
Santa Clara County Health Department, Toxic Substance Control	• Hazardous Materials Storage
California Regional Water Quality Control Board	• Title 23 CCR
California Office of Emergency Services	• Title 19 CCR
EPA	• Resource Conservation Recovery Act (RCRA) • SARA Title III • Clean Water Act
OSHA	• Hazard Communication Standard
Bay Area Air Quality Management District	• Regulation 8, Rules 16, 19, and 29 Regulation 11, Rules 1 and 2

5.4. Training

Emergency Response Training

Personnel who handle hazardous substances require the following training:

- Hazard communications.
- Hazardous waste management.
- Environment essentials.
- Emergency procedures including the cleanup of spills and the disposal of broken containers..

Other Training

Other training includes:

- The use of proper handling equipment, protective apparel, and safety equipment.
- Dangers of contacting chemicals by skin absorption, inhalation, or ingestion.
- Labeling.
- Proper methods of substance handling and storage including the sensitivity of some substances to heat, moisture, light, and other storage hazards.

- Secondary containment requirements and disposal procedures.
- How to read and understand a MSDS and other details of the hazard communication program.
- Hazards associated with flammable liquids, toxic gases and vapors, and oxygen displacement.
- Substances that react with water and other hazards that can create hazardous conditions.
- Packages that exhibit evidence that the inside container has been broken and/or has leaked its contents.

Training Responsibilities

Supervisors' training responsibilities include the following:

- To ensure that formal annual training is provided to employees.
- To attend a minimum of 4 hours training on hazardous materials and waste handling.
- To ensure employees are trained when a new chemical is being used or the process changes.
- To attend annual refresher courses.

5.5. Records

Solvent-Use and Coating Operations

Certain permits, issued by the BAAQMD, impose operating conditions such as solvent-use record keeping. In many cases, permits for solvent-use sources require daily records. Record keeping is also required for coating operations. Check the specific conditions for the sources operated in you area.

5.6. Definitions

Extremely Hazardous Material	Legally defined by Superfund Amendments and Reauthorization Act (SARA) Title III as any chemical on the Chemical Emergency Preparedness Program (CEPP) list administered by the Environmental Protection Agency (EPA). The most recent list contains 360 chemicals (55 Federal Register 5544, Feb. 15, 1990; amending 40 CFR part 355, appendices A and B).
Hazardous Material	Any material that represents a physical or health hazard or is hazardous to the environment. health hazards include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephroltoxins, neurotoxins, and agents that damage the lungs, skin, eyes, or mucous membranes. Detailed definitions are given in CFR title 29 part 1910.1200.
Hazardous Waste	Legally defined by Title 40 Code of Federal Regulations (CFR) and Title 22 California Code of Regulations (CCR) as a waste material that has any of the following properties: ignitable, corrosive, toxic, reactive, bio-accumulating, or is listed in Title 40 CFR or Title 22 CCR as a hazardous waste.

5.7. References

Ames and Division Documents	Ames Health and Safety Manual, APG 1700.1
External Documents	California Code of Regulations Title 22: Hazardous Waste in California Code of Federal Regulations Title 40: Protection of the Environment OSHA Standard CFR 29 Part 1910.1200: Hazard Communication

End of Chapter

6. Lockout and Tagout

6.1. Description

Purpose

It is Wind Tunnel Operations Division policy to eliminate or control the potential for injury or facility or equipment damage that could result from unexpected start-up of equipment or the release of stored energy. This policy is implemented through the use of effective hazardous energy-control procedures. This standard establishes requirements and processes to implement that policy.

Scope

This standard applies to all employees, temporary workers, support contractor personnel, and subcontractor personnel working under the authority of the Wind Tunnel Operations Division. It applies to all maintenance activities where there is a potential for injury or damage due to the unexpected start-up of equipment of the release of stored energy. It also applies to all operations where personnel must remove or bypass machine guards or other safety devices, place any part of their body in contact with operating equipment, or place any part of there body into a danger zone associated with a machine operating cycle.

The term “maintenance,” as used herein, includes workplace activities such as constructing, installing, setting-up, adjusting, inspecting, modifying, maintaining, or servicing equipment.

This standard does not apply to plug and cord supplied equipment where the plug is under the control of the person performing the maintenance, and the removal of the plug isolates all energy from the equipment.

Any deviations from, or exceptions to, these requirements shall be approved in writing by the Wind Tunnel Operations Division Chief and the Support Contractor General Manager, or their designees, as appropriate.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

Authority

All personnel are authorized to refuse to perform work without repercussion when conditions or practices associated with an energy-control activity pose an imminent danger of injury or harm to personnel, facilities, equipment, or the environment.

Penalties

The deliberate bypassing of tags or locks, unauthorized removal of tags or locks, the deliberate operation of tagged out or locked out equipment, failure to lockout or apply tags when required, and the failure to follow the requirements of this document are grounds for disciplinary action including discharge from employment.

6.2. Responsibilities

Managers

Managers have the following lockout and tagging responsibilities:

- Ensure that each affected and authorized employee understands the importance of following lockout and tagging procedures.
- Take all necessary steps to enforce tagging requirements.
- Designate logbook custodians, and provide a list of their names and the logbooks they monitor to the FO Safety Office.

Supervisors

Supervisors have the following lockout and tagging responsibilities:

- Ensure each of their authorized and affected employees complete required lockout and tagging training.
- Ensure that written energy-control procedures are developed for equipment under their authority as specified herein.
- Monitor work to ensure compliance with energy-control requirements and procedures.
- Ensure that an adequate supply of energy-isolation devices is available and provided to authorized employees.
- Conduct visual observations of energy-control procedures.
- Take actions to correct errors in procedures and failures of personnel to follow established procedures.
- Ensure that inspections are conducted at least annually of the written energy control procedures executed by their employees.
- Maintain records of formal written energy control procedure inspections.

Facility Managers, Chief Engineers, and Service Managers

Facility Managers, Chief Engineers, and Service Managers lockout and tagging responsibilities include coordinating with representatives of subcontractors or other NASA organizations to:

- Ensure the safety or Wind Tunnel Operations Division personnel.
- Minimize the potential for adverse effects on operations.
- Ensure the safety of equipment and facilities.

Logbook Custodians

Logbook Custodians have the following lockout and tagging responsibilities:

- Inspect their assigned logbooks periodically to ensure that entries are being performed completely and correctly, document inspection findings on Safety Observation Reports, and discuss findings with employees or supervisors as appropriate.
- Remove completed Energy Control Log Sheets, form SS17, from logbooks and retain them for a minimum period of six months.

Employees

Employees have the following lockout and tagout program responsibilities:

- Perform their assigned work in accordance with their training, these requirements, and specific lockout and tagging procedures.
- Assist supervision with the development and validation of lockout and tagging procedures.
- Report identified errors or omissions in procedures to supervision so that appropriate corrective actions can be taken.
- Remove personal locks and personal tags at the end of each shift and at other times when not available on site to remove them.

Division Safety Office

The Division Safety Office responsibilities include the following:

- Provide overall guidance for the hazardous energy-control program.
- Revise and maintain these energy-control requirements.
- Procure and issue personal and administrative locks, tags, and labels in accordance with these requirements.
- Assist supervision in performing inspections as requested.
- Maintain a repository for completed inspection checklists.
- Assist with the validation of lockout and tagging procedures as requested.
- Perform semi-annual reviews of written energy-control procedure inspection records to determine inspection requirements are being met.

Subcontractors

Subcontractors shall demonstrate that they have trained their employees in basic lockout and tagging requirements and procedures, and comply with the direction provided by Wind Tunnel Operation Division or Support Contractor when they must participate in activities addressed within the scope of these requirements

6.3. Energy Control Requirements

General

Lockout procedures shall be employed as the preferred method of establishing a zero energy state and securing energy-isolation devices in a safe configuration before initiating maintenance.

Energy isolating devices are mechanical devices that physically prevent the transmission or release of energy. They include devices such as manually operated circuit breakers, power disconnect switches, in-line valves, physical blocks, blanking plates, and any similar devices used to block or isolate energy. **Push buttons, selector switches, interlock switches, and other control circuit type devices do not generally qualify as energy isolating devices.**

Tagging out an energy-isolation device only provides a warning to indicate that it (and the associated equipment) should not be operated as long as the tag is in place. Tagging does not provide the same level of security as lockout against intentional or inadvertent operation of energy-isolation devices therefore lockout devices shall always be used instead of tags when it is possible to do so.

Each individual performing work requiring the application of locks or tags for personal protection shall apply their own lock or tag to the energy-isolation or group lockout device. Employees may not work under the protection of locks or tags applied by others, nor may they allow others to perform work under the protection of their personal lock or tag.

Persons desiring to inspect work in an area where personnel are being protected by lockout or tagging processes shall apply their own personal lock and tag to the energy-isolation device before entering the protected area. Each individual shall remove their personal lock and tag when exiting the protected area.

Locks and tags shall not be used to permanently secure equipment for which there is no planned future use. The use of locks and tags under these circumstances lessens the significance of all other locks and tag present in the workplace. To minimize the number of locks and tags present in the workplace for extended periods, when equipment is removed from service for a period exceeding 12 months, steps shall be taken to permanently isolate it from energy sources (i.e. decommission).

Equipment Design

Specifications for the purchase of new equipment shall include energy-isolation devices that can be locked.

Whenever equipment having energy-isolation devices that cannot be locked undergo major repair, modification, or renovation their energy-isolation devices shall either be altered to accept lockout devices or be replaced with devices that will accept a lockout device.

Equipment Labeling

Each machine, system, or subsystem requiring a written energy-isolation procedure, as identified by the criteria provided in the section for Written Energy Control (Lockout and Tagging) Procedures, shall be marked with a black and yellow label as shown.

Figure 6.1: Equipment Label (Caution)

6.4. Lockout and Tagout Equipment

Tags

Tags serve as a warning against the operation of an energy-isolation device and the associated equipment. They DO NOT physically prevent operation of the energy-isolation device the way lockout devices do. Therefore, tags shall be used as the sole means of preventing the operation of energy-isolation devices only in instances where it is impossible to apply a lockout device.

Danger Do Not Operate (Hold-Off or Danger, ARC Form 316) tags shall be used in conjunction with all activities where there is a need to ensure personnel protection during maintenance activities. This applies whether the activity involves lockout or tagout. Three variations of these tags are used within Wind Tunnel Operations Division facilities: personal, master, and referral danger tags. These tags serve to facilitate tracking of lockout events and to warn of danger to personnel.

Personal danger tags shall be applied to energy-isolation devices or group lockout devices by each individual performing a maintenance activity exposing themselves to hazards posed by the unexpected energizing of equipment or the release of stored energy.

There are two types of personal danger tags; those prepared for regular employees and those use by visitors. Regular employees, who have successfully completed lockout and tagging training, will receive laminated tags that contain their photograph, their name, and the name of their employer. Visitors receive laminated tags with spaces to write their name and the name of their employer.

Figure 6.2: Employee and Visitor Personal Danger Tags (Do Not Operate)

Master danger tags are unmodified Danger Do Not Operate (ARC form 316) tags. Master danger tags serve to:

- Facilitate logging and tracking of lockout devices and tags.
- Maintain the continuity of an energy-isolation configuration when a hazardous energy-control activity will extend beyond the end of the work shift of the employees who applied the lockout devices and tags.
- Provide single work group control when multiple work groups will be locking or tagging the same energy-isolation device simultaneously to support different work activities.

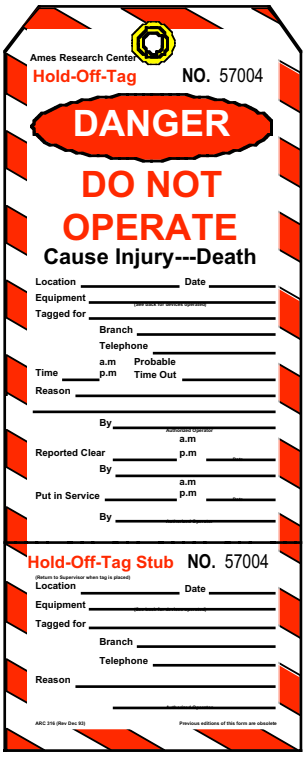


Figure 6.3: Master Danger Tag (Do Not Operate)

Referral tags are used reduce the administrative burden associated with creating logbook entries for hazardous energy-isolation activities that involve more than one energy-isolation device. They shall always be used in conjunction with a master danger tag.

Figure 6.4: Referral Tag (Do Not Operate)

Caution Special Conditions tags, ARC form 317, shall be used solely in conjunction with the administrative or operational control of equipment. They SHALL NOT be used in situations where a violation of the lock or tag could result in injury to personnel who are performing maintenance. Caution tags are used to warn that equipment has been placed in, or must remain in, a specific operating condition. Caution tags shall be used with locks to prevent unauthorized use of equipment. These limitations may include prohibitions on any operation, requirements for remaining on at all times, reasons why equipment was taken out of service, or specific conditions under which the equipment may be operated.

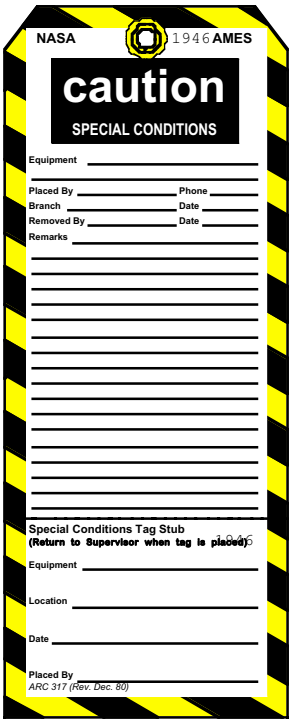


Figure 6.5: Caution Special Conditions Tag

General Tagout Requirements

Whenever tags must be used as the sole means (i.e. no locks) of preventing the operation of energy-isolation devices on equipment, additional means shall be used to ensure the same level of protection as the application of a lockout device. This is to be accomplished by using a second means of isolating the hazardous energy source from the equipment. The energy path shall be broken in at least two locations, with danger tags applied at both locations. Such means may include isolating another serial circuit element, blocking a controlling switch, opening an extra disconnecting device, or removing a valve handle.

All tag attachment methods shall be non-reusable, attachable by hand, self locking, resistant to the environmental conditions in which they will be placed (wet, corrosive, etc.), and have a minimum unlocking and breaking strength of 50 pounds. Nylon cable ties that are at least 3/16 wide meet these requirements, strings and cords do not.

Written procedures shall be developed for all energy-isolation activities where tags (rather than lockout devices) are used as the sole means of controlling an energy-isolating device. Written procedures are required since all exceptions to the requirements for written procedures apply only to machines that are capable of being locked-out.

Lockout Devices

The only lockout devices that may be used for hazardous energy-control and administrative locking are those specifically issued by the employer (civil service or contractor) for that purpose. Lockout devices, including, locks, hasps, group lockout boxes, etc. can be obtained from the FO Safety Office.

Locks used at the Ames Research Center for personnel protection (personal locks) shall be red in color. Locks manufactured by the American Lock Co. (such as model # 1106R) are the standard locks issued within the Wind Tunnel Operations Division.

Personal locks were issued in a variety of colors before July 1999. The owners of these locks may continue to use them providing they apply a standard label to them that identifies them as locks being used for personnel protection (see example). Red shrink-wrap covers are also available for this purpose. The labels and shrink-wrap covers are available from the FO Safety Office.

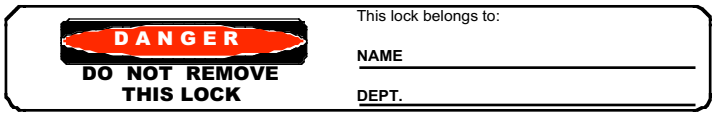


Figure 6.6: Personal Lock Label (Do Not Remove This Lock)

Only one key will be issued for each personal lock. Additional keys are destroyed at the time the lock is issued. Each lock used for personnel protection shall indicate the identity of the individual who applied it. This shall be accomplished in Wind Tunnel Operations Division facilities by attaching personal danger tags to the locks. Locks identified by stamping owner's name may continue to be used when they are applied in conjunction with a personal danger tag. The application of a single personal lock and single personal danger tag per individual is the minimum acceptable protection for those involved in a maintenance activity involving hazardous energy control.

Supervisor, Equipment, and Administrative Locks

Other types of locks used within the Wind Tunnel Operations Division include supervisor, equipment, and administrative locks. Supervisor locks are gold in color and issued to supervisors, shift leaders, facility managers, facility chief engineers, etc. They are used to ensure the continuity of an energy-isolation configuration through shift change periods and to provide individual work group control when multiple work groups are concurrently using the same energy isolation devices to support different work activities. Individual locks may have multiple keys since these locks do not provide protection to individual workers.

Equipment locks are red in color and used in conjunction with referral tags for hazardous energy-control activities involving the application of multiple energy-isolation devices. Each lock has a single key that is either retained by the individual who applied it or secured in a group lock box for the duration of the work activity.

Administrative locks are a color other than red or gold and are used for purposes other than personal protection. Administrative locking applications include securing valves or switches in a specific position, preventing unauthorized use of equipment, securing areas, etc. A single lock may have many keys.

Temporary and Visitor Locks and Tags

Personal locks and danger tags may be issued to visitors on a temporary basis as long as authorized employees escort the visitors when entering a protected location. Groups of visitors may enter areas where energy-control protection is in effect without applying individual locks or tags, as long as an authorized employee who has affixed a personal lock and personal danger tag to the appropriate energy-isolation device(s) escorts them. The escort is responsible for ensuring that all visitors that they are accompanying have left the protected area before removing their lock or tag.

Visitors, including subcontractors, who are directly involved in maintenance activities and may be injured by the unexpected energizing or startup of equipment, or the release of stored energy, shall apply personal locks and personal danger tags to the appropriate energy-isolation device.

6.5. Application of Lockout and Tagging

Standard Energy Control Process

The process for isolating equipment from their energy sources and securing them in a safe configuration, and reactivating them following maintenance is described below. This process shall be incorporated into all written procedures and should be followed even when the work does not specifically require the use of a written procedure.

- Notify employees affected by equipment shutdown.
- Identify types and magnitudes of energy.
- Identify the hazards posed by the energy to be controlled.
- Identify the methods and means to be used to control the energy.
- Shutdown equipment.
- Locate and position all of the required isolation devices to isolate energy from the equipment.
- Apply locks and tags as required to secure the energy-isolating devices in their safe, or off, position.
- Relieve, disconnect, or restrain sources of potentially hazardous stored energy.
- Monitor and re-verify that equipment remains at a zero energy state when there is a possibility that energy may re-accumulate.
- Verify that energy sources are isolated by operating equipment controls or by taking measurements of voltages, temperatures, pressures, etc.

6.6. Fluid and Pressure System Isolation Means

Description

The methods used to isolate portions of fluid and pressure systems can be extremely important, especially when working with high energy systems (i.e., high pressure and/or high volume), those containing highly hazardous materials, and those being isolated for confined-space entry purposes. These systems are of particular concern because the primary components used for isolating them are valves whose seals can wear over time and develop leaks. Depending on the material and the circumstances, these leaks could have catastrophic effects on personnel, equipment, and the environment. Unplanned releases from high-energy systems can result in serious personnel injuries and equipment damage. Unplanned releases of highly hazardous materials may result in serious personnel injuries, equipment damage, and environmental harm. Unplanned releases of any substance into an occupied confined space may result in serious personnel injuries. This section establishes preferred methods of isolating fluid and gas systems for general operational and safety purposes, and for confined-space entry purposes. Use of the prescribed methods should minimize the potential for these very undesirable outcomes.

Fluid/Gas Isolation Methods for Confined-Space Entry

Any fluid/gas lines containing substances whose unexpected release into a confined space could pose the threat of serious personnel injury, due to their hazardous physical properties or quantity, must be excluded from entry through a positive isolation method. The only methods allowed include blanking/blinding; removing system components such as pipes, valves, or ducts; or employing double-block and bleed. Examples of these isolation methods are provided below. The examples, as drawn, do not show locks and tags; however, locks and tags or other methods must be used to prevent operation of all isolation valves or flanges used to support a confined-space entry.

General Fluid/Gas System Isolation

Existing system valves may be used to isolate fluid systems for operational and administrative purposes unless there are unusual circumstances. They should not be used to isolate hazardous substances from confined spaces into which personnel will enter. In general, single valve isolation (block, or block and bleed) may be used for low and medium hazard situations and double-valve isolation should be used for high hazard situations. The double-valve method (double block and bleed) is the preferred means of isolating portions of the Division's high-pressure air distribution system (HPADS). When using these methods, the open bleed valve prevents re-pressurization of the system in the event of a primary isolation valve leak. Examples of single and double valve isolation methods are provided below. These examples, as drawn, do not show locks and tags; however, locks and tags or other methods must be used to prevent operation of the isolation valves or flanges.

Examples of Fluid/Gas Isolation Methods that May be Used for Confined-Space Entry, Operational Energy Isolation, or Administrative Purposes

Note: Locks and/or tags must be applied to each of the blind locations to meet LOTO program requirements.

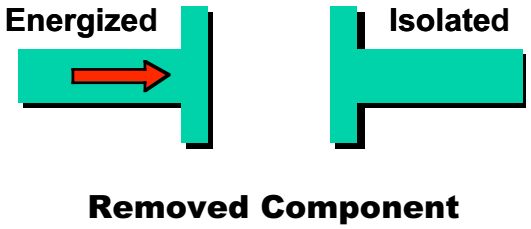


Figure 6.7: Removed Component

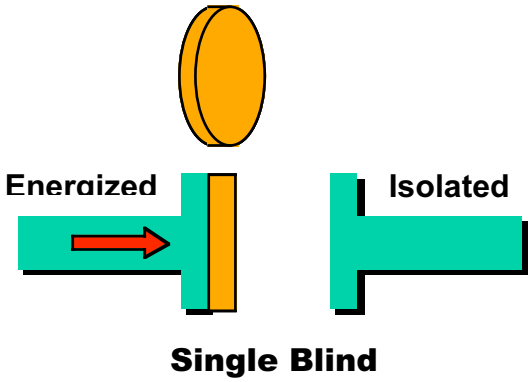
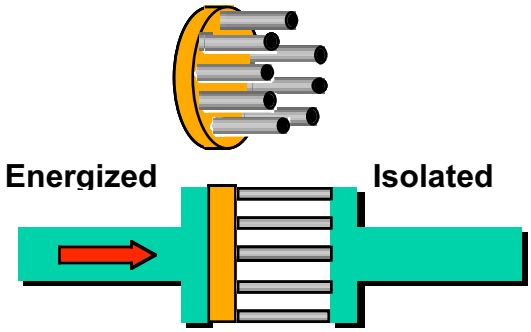
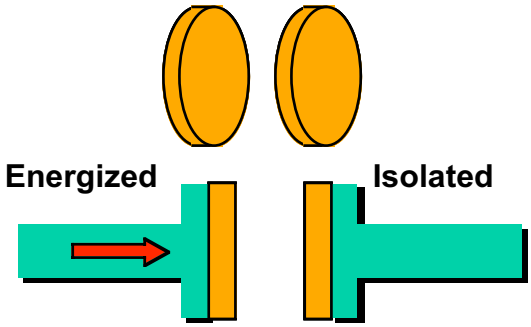


Figure 6.8: Single Blind



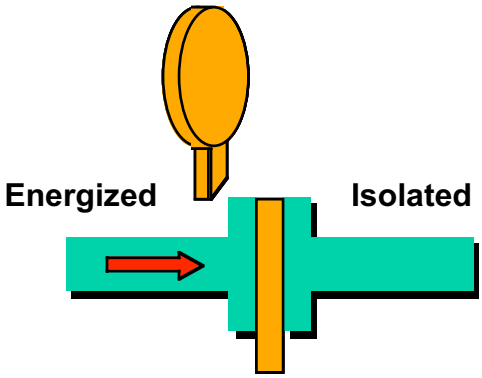
Stand-Off Blind

Figure 6.9: Stand-Off Blind



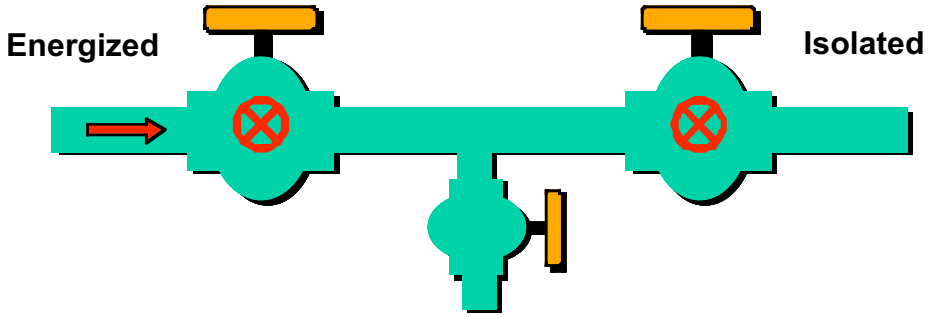
Double Blind

Figure 6.10: Double Blind



Slip Blind

Figure 6.11: Slip Blind



Double Block and Bleed

Figure 6.12: Double Block and Bleed

Examples of Fluid/Gas Isolation Methods that May be Used for Operational Energy Isolation, or Administrative Purposes Only

Note: Locks and/or tags must be applied to each of the valves to meet LOTO program requirements.

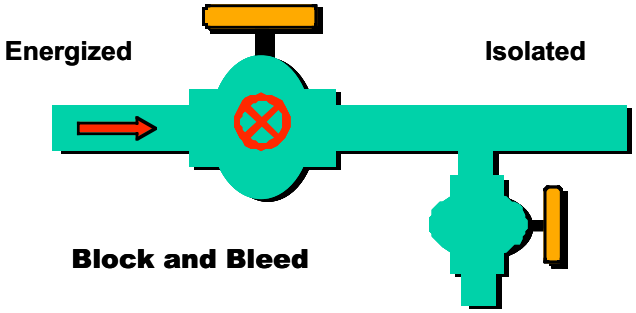


Figure 6.13: Block and Bleed

Double Block

Figure 6.14: Double Block

6.7. Release from Lockout and Tagging

Requirements

The following items are needed to release a machine or system from a locked out and tagged condition:

- Verify that personnel are clear of the potential hazards and notify all affected personnel of the impending removal of lockout devices and tags and equipment reactivation.
- Verify that personnel are clear of the potential hazards and notify all affected personnel of the impending removal of lockout devices and tags and equipment reactivation.
- Remove lockout device(s) and tag(s).
- Reactivate equipment.
- Test and verify that equipment is functioning properly.

6.8. Written Energy Control (Lockout and Tagging) Procedures

Circumstances Requiring Energy Control Procedures

Written lockout procedures shall be developed as needed and retained to support future work activities. Written energy-control procedures shall be developed whenever any of the following conditions exist:

- The maintenance of equipment could create hazards for employees who are not directly involved in maintenance activities.
- There is a single energy source, but it is difficult for the employee to identify and isolate due to its location or configuration.
- There is a potential for injury or damage due to the release of stored energy, residual energy, or the re-accumulation of stored energy after shutdown.
- It is necessary to rely on tags (no locks) as the exclusive means of keeping energy-isolation devices in a safe configuration.
- It is necessary to use more than one lockout device to make a piece of equipment, machine, or system safe to work on.
- There is more than one source of energy (normal and backup electrical, pneumatic, hydraulic, gravity, thermal, chemical, etc.) for the equipment that will be undergoing maintenance.
- There have been past accidents involving the unexpected activation of the equipment or release of stored energy during past maintenance activities.
- Supervisors should document their assessment of whether a specific lock and tag application requires development of written procedures on a Written Hazardous Energy Control Procedure Needs Assessment, FO30.

Worksheet Requirements

When preparing the Hazardous Energy Control Procedure Development Worksheet, form SS14; it is essential that complete information be provided. When completing a worksheet for a specific system or equipment, provide the following information to ensure the final procedure meets all requirements.

- Identify affected employees and provide for their notification prior to energy-isolation activities.
- Identify energy types and amount.
- Identify the hazard associated with each energy type present.
- Identify methods and equipment used to isolate and control energy.
- Identify proper shutdown procedures.
- Specify the type, location, and positioning of all required energy-isolation devices.
- Indicate the correct valve, switch, and breaker positions needed for safe energy isolation.
- Indicate specifically where locks and tags must be placed.
- Indicate, step by step, how to safely relieve, disconnect, or restrain sources of potentially hazardous stored energy.
- Identify any potential for energy to accumulate and, step by step, how to monitor, remove, or verify continued safe working conditions.
- Identify, step by step, method for testing or verifying the proper isolation of hazardous energy.
- Provide steps to ensure maintenance related tools and equipment are removed and equipment is properly reassembled prior to restoring energy sources.
- Provide for the notification of affected employees prior to restoration of energy sources.
- Provide, step by step, method to verify proper operation of equipment following maintenance.

Developing New Written Energy Control Procedures

An individual or group of individuals may develop written energy-control procedures. A group may be required to develop procedures for complex equipment or lockout and tagging situations. At least one authorized employee who is familiar with the equipment being isolated shall participate in procedure development. A draft procedure worksheet, form SS14, shall be peer reviewed and approved by an authorized employee supervisor who is familiar with the equipment being isolated.

Use the following steps to develop a new energy-control procedure:

Developing New Written Energy Control Procedures

Step	Action
1	Obtain a copy of the Hazardous Energy Control Procedure Development Worksheet, form SS14 from the Wind Tunnel Operations Division Document web site or from a supervisor.
2	Using equipment knowledge, manufacturer's instruction manuals, engineering drawings, etc. record the information requested on the worksheet.
3	Provide the completed worksheet to the appropriate supervisor.
4	Designated person(s) perform a review of completed procedure worksheet for completeness, accuracy, and safety.
	NOTE Supervisors who are authorized employees and knowledgeable of the equipment being isolated may perform a peer review of the procedure worksheet. Supervisors may choose to assign the peer review to another authorized employee who is familiar with the equipment being isolated
5	The supervisor signs and dates the completed worksheet and forwards to the Technical Publications Group for assignment of a control number, final procedure formatting, and posting to the appropriate document Web site.
	NOTE Once approved by the supervisor, the worksheet can be used as the procedure until the final formatted version becomes available on the document Web site.

Revising Written Energy Control Procedures

Completed energy-control procedures are controlled documents. The supervisor or authorized employee initiating a change shall follow the document change process contained in the Wind Tunnel Operations Division Configuration Management Procedures, A027-9391-XB4.

6.9. Lockout Device and Tag Monitoring

Description

All energy-isolation activities requiring the application of a master danger tag shall be logged and tracked. Master danger tags shall be applied whenever:

- The hazardous energy-control activity will extend beyond the end of the work shift of the authorized employees who applied the locks and tags.
- The hazardous energy-control activity requires the application of locks or tags to more than one energy-isolation device.
- Multiple work groups will be locking or tagging the same energy-isolation devices simultaneously to support different work activities.

In all other instances, authorized employees may rely solely on the application of personal locks and personal danger tags without the need for logging and tracking.

Tracking is accomplished by removing the stub portion of the master danger tag and recording information about the lockout or tagging activity into the appropriate facility or system Hazardous Energy Control Logbook. An electronic copy of the log sheet, form SS17, is available on the Wind Tunnel Operations Division Document Web site.

Logbook custodians shall be designated and identified in each logbook. The custodians shall periodically inspect their logbooks for accuracy and completeness and shall ensure that pages containing documentation of lockout or tagging activities are retained for a six-month period following completion of the lockout or tagging activities they are associated with.

Applying and Removing Tags

When lockout device and tag monitoring is required, follow these steps for applying or removing lockout devices and tags:

Applying or Removing Lockout Devices and Tags

Step	Action
1	Fill-in the required information on the master danger tag and stub at the time of application.
2	Make an entry for the tag on a Hazardous Energy Control Log Sheet in the appropriate facility or system logbook.
3	Attach the tag stub to the portion of the page where the logbook entry was made.
4	Perform the lockout or tagging activity in accordance with the appropriate procedure.
5	Upon completion of the maintenance activity, remove the lockout devices and tags in accordance with the appropriate procedures.

Applying or Removing Lockout Devices and Tags

Step	Action
6	Complete the master danger tag by entering the required “Reported Clear” and “Put in Service” information and sign the tag.
7	Complete the logbook entry by filling in the “Cleared By” and “Placed in Service By” fields on the Energy Control Log Sheet in the appropriate facility or system logbook.
8	Fasten the removed tag to the corresponding stub and logbook entry for retention.

6.10. Multiple Shift Lockout and Tagout

Description

This section describes the process for ensuring continuity of energy isolation through shift-change periods and allows the energy-isolation configuration to remain in place for extended periods when personnel are not performing maintenance activities. This process does not require shift overlap to ensure continuity of protection; however, departing and arriving supervisors or designated leads shall exchange information about the progress of the work and the status of the equipment.

Follow these steps when energy isolation will remain in place longer than a single shift:

Isolating Energy Through Extended Periods or Shift Changes

Step	Action
1	Follow established lockout or tagging procedure to prepare the equipment for shutdown and energy isolation.
2	Prepare a master danger tag and make a logbook entry for the tag and work activity.
3	Initiate shutdown and isolation in accordance with the established procedure.
4	Apply a group lock hasp to the energy-isolation device.
5	Apply the master danger tag and supervisor lock to the group lock hasp.
6	Apply a personal lock with personal danger tag to the multiple lock hasp then perform the assigned tasks.
7	At the end of the shift, remove the personal lock with personal danger tag from the group lock hasp, leaving the master danger tag and supervisor lock in place to maintain the energy isolation.

Isolating Energy Through Extended Periods or Shift Changes

Step	Action
8	Before beginning work on subsequent shifts while the lockout and tagging activity is still in progress, verify that the master danger tag and supervisor lock are still in place and that the equipment is in the correct energy-isolation configuration.
9	Apply your personal lock with personal danger tag to the multiple lock hasp and continue the work.
10	When work is complete remove your personal lock with personal danger tag and the master danger tag and supervisor lock. Then restore the system to operational status in accordance with the established procedure.
	NOTE If the individual who completed the work did not apply the supervisor lock and master danger tag they shall leave them in place and contact the individual who did apply them. If the individual who applied them is not available, contact Shift Leader or supervisor to have them removed.

6.11. Group Energy Isolation Procedure

Description

Group lockout devices shall be used to allow each member of a group to exercise direct control of an energy-isolation device by applying their own personal lock and personal danger tag to the group lockout device. Master danger tags and supervisor locks shall be used to provide individual work group control when multiple work groups are locking out or tagging the same energy-isolation device to support simultaneous work activities.

When tagging procedures are used because locks cannot be attached to the energy-isolation device, each individual in the group shall apply and remove their personal danger tag in the same manner they would a lock.

Group Energy-Isolation Process

Follow these steps for group energy-isolation situations:

Group Energy-Isolation Process

Step	Action
1	Use the established procedure to prepare for equipment shut down and energy isolation.
2	When the work involves multiple groups performing different functions on the same equipment, the lead or supervisor for each work group prepares their own master danger tag, makes their log entry for the tag, and coordinates with others to initiate isolation and shutdown in accordance with the established procedure.
3	When a single device is used for energy isolation, each lead or supervisor applies a multiple lock hasp to the energy-isolation device for their group then applies a master danger tag and supervisor lock to their hasp.
4	When multiple lock hasps cannot accommodate the number of crews or crew members, or when locks must be applied to multiple energy-isolation devices, use equipment locks and the referral danger tag process to isolate energy sources and log the work activity. The leads or supervisor place the keys for the equipment locks in a group lock box, and secure them by applying master danger tags and supervisor locks for their individual work activities.
5	Crewmembers attach their personal locks and personal danger tags to the appropriate group lockout device containing the master danger tag and supervisor lock for their work group.
6	Crewmembers remove their personal locks and personal danger tags at the end of the shift while leaving the master danger tag and supervisor lock in place.
7	When work is complete, each crewmember removes their personal lock and personal danger tag from the group lockout device.
8	Following the established procedure, the lead or supervisor removes the supervisor lock and master danger tag from the group lockout device and gives direction to restore the equipment to operational status.

6.12. Referral Tags

Description

The referral tag processes simplifies Hazardous Energy Control Logbook (logbook) documentation when it is necessary to lockout or tag multiple pieces of equipment to support a work activity. The process allows for the entry of a single master danger tag in the logbook. The master danger tag is then referred to by referral danger tags that are applied to individual energy-isolation devices that are often remotely located, and support the same hazardous energy-control activity.

Using Referral Tags

When required, follow these steps to use the referral tag process:

Using Referral Tags

Step	Action
1	The authorized employee determines from the written energy-control procedure that the hazardous energy-control activity will involve multiple energy-isolation devices.
2	The authorized employee prepares a master danger tag for application to either a group lockout device or the primary energy-isolation device, and makes a corresponding entry in the appropriate logbook.
3	The authorized employee prepares referral danger tags for application to each of the remaining isolation devices used to support the energy-isolation activity. The serial numbers and locations of each referral tag shall be included in the log entry for the master danger tag prepared in the previous step.
4	The authorized employee follows the written energy-control procedure to apply the master and referral danger tags to each energy-isolation device involved in the hazardous energy-control activity. Referral danger tags shall be applied using equipment locks unless tagging procedures are being followed. The locks and tags remain in place for the duration of the work.

Using Referral Tags

Step	Action
	NOTE When the activity involves a single employee and a single work shift, the master and personal danger tags may be applied with a personal lock. In all other situations, the master danger tag shall be applied with a supervisor lock.
5	Following completion of the task, the authorized employee follows the written energy-control procedure to remove the lockout devices or tags, account for all referral danger tags and equipment locks, complete the logbook entry, and reactivate the equipment.

6.13. Emergency Lockout Device or Tag Removal Procedure

Description

There is an increased risk of personnel injury and equipment or facility damage whenever someone other than the individual who applied them removes lockout devices or tags. Therefore, this special procedure shall only be performed under EXTREME circumstances. There is increased risk of injury because the individual who applied the lockout device or tag may still be exposed to the hazard or may return to the workplace and resume work under the assumption that their device is still in place. There is increased risk of equipment or facility damage because the individual, who applied the device and has the most knowledge of the reasons for the application of the device and the operational status of the equipment, is not available.

This section defines the process for ensuring personnel safety and the safe configuration of equipment prior to authorizing removal of a lockout device or tag applied by an individual who is not present in the workplace when there is a need to remove energy-isolation. This procedure also applies to the removal of locks by their owners when the key has been lost. The need for applying this procedure should be very infrequent since personnel are required to remove their personal locks and personal danger tags from equipment at the end of each shift. The need for applying this procedure should also be reduced by the use of supervisor locks for group, multiple isolation devices, and multiple shift activities.

When the individual who applied a lockout device cannot remove it because they do not have the key with them or because the key is lost, a master or duplicate key shall not be used to remove it. The lock shall be removed using bolt cutters or another method that results in the destruction of the lock. This prevents unauthorized removal of the lock by someone else if they find the key later.

In the case of lost keys, only the individual who applied them or his or her supervisor shall remove the lockout devices and tags. The following Removal Procedure shall be followed when it has been determined that:

- A lockout device or tag applied for hazardous energy-control purposes is impeding progress on some critical activity.
- The authorized employee who applied the lockout device or tag is not available in the workplace to remove it or does not have their key.
- It is not possible to wait for the device owner to obtain their key or return to the workplace due to safety issues or the potential for SIGNIFICANT operational impact.

Removal Procedure

Lockout devices or tags shall not be removed until the requestor obtains the required approvals. The device/tag owner's supervisor/shift leader and manager must sign the Lockout Device and Tag Removal Request.

When the device/tag owner's manager is not available, only the following approval methods are acceptable:

- The manager may approve by telephone. The manager must sign the Lockout Device and Tag Removal Request immediately upon returning to the workplace.
- The person to whom the manager has delegated authority during a planned absence may sign the Lockout Device and Tag Removal Request. The delegate may not approve the removal request if already signing it as the approving supervisor or shift leader.
- The next higher level manager may sign the Lockout Device and Tag Removal Request if other approval methods are unavailable.

Follow these steps to perform the emergency lock removal procedure:

Emergency Lock Removal

Step	Action
1	Fill out a Lockout Device and Tag Removal Request form, FO32.
2	When the form is filled-in and the required approvals have been obtained, proceed with the device removal in accordance with the applicable hazardous energy-control procedure.
3	Following device removal, return the completed form and removed devices to the device owner's supervisor.
4	The supervisor ensures that the device owner is informed of the device removal upon their return to work, before they are allowed to perform their normal work activities.

Emergency Lock Removal

Step	Action
5	The device owner acknowledges the notification buy providing a signature, and the date and time notified they were notified in the spaces provided on the form.
6	The supervisor forwards the completed form to the FO Safety Office for retention.

6.14. Lockout Processes Involving Interlock Keys

Description

The purpose for Interlock Keys is to control equipment configuration, and operation of wind tunnels and wind tunnel support systems. As such, they are part of the normal operating controls for these systems and MAY NOT qualify as energy-isolation devices. Dependence on their exclusive use may not provide positive isolation from energy sources, since the energy paths may not be broken and secured by the Interlock Key.

Lockout procedures involving the use of Interlock Keys shall ensure that energy sources are isolated, locked out, and tagged to prevent unexpected energization or startup of equipment, or the release of stored energy during maintenance activities. If necessary, breakers may have to be racked out and the breaker room locked as well to assure zero energy state to the system, sub-system, or component undergoing maintenance.

Both the Wind Tunnel Operations Division and FO Safety Office personnel shall review lockout procedures involving Interlock Keys

6.15. Locking or Tagging for Administrative Purposes

Description

The purpose of administrative locking or tagging is to secure areas and equipment for operational or general safety and operational purposes. Administrative locks shall be a color other than red or gold. Administrative locks and tags shall not be used in situations where personnel performing maintenance may be exposed to hazards posed by the unexpected energization of startup of equipment or the release of stored energy. Personal danger tags and personal locks shall not be used for administrative locking or tagging purposes. Administrative locks and tags may be used to:

- Secure unsafe equipment to prevent personnel injury, equipment damage, or facility damage.
- Secure equipment to prevent its operation by unqualified or unauthorized personnel.
- Secure equipment in a specific configuration such as locking fire suppression water valves open.

- Secure equipment that is no longer being used or maintained in a de-energized configuration.
- Secure doors and perimeter fences.

Before applying administrative locks or tags, determine whether there is a need for hazardous energy control rather than administrative locking or tagging. The requirements for hazardous energy-control locking and tagging shall be followed whenever there is a potential for the unexpected energization or startup of equipment or the release of stored energy to injure personnel performing maintenance.

Administrative locks and tags shall not be used to permanently secure equipment for which there is no planned use for more than 12 months. Permanently isolate such equipment from energy sources (decommission) to minimize the number of locks and tags present in the workplace for extended periods.

Administrative locks may have multiple keys. For example, multiple personnel may have keys for a lock applied to prevent the unauthorized use of equipment.

Administrative Danger Tags

Danger-Do Not Operate (ARC form 316) tags may be used for administrative tagging purposes. Danger tags shall only be used in situations where equipment must be held in the OFF (de-energized) configuration to eliminate the potential for injury of personnel in the area or damage to the equipment or facility.

Administrative Caution Tags

Caution—Special Conditions (ARC form 317) tags may be applied to equipment to identify operational limits or points of contact that can authorize its use.

Administrative Lock and Tag Monitoring

All Danger tags applied for administrative purposes shall be entered into the appropriate Hazardous Energy-Control logbook in the same manner as a master danger tag. The need to monitor Caution tags is determined for each tag use. Determining factors include the need to document the use restrictions and the need to communicate the restrictions to other prospective users.

6.16. Periodic Energy Control Procedure Inspections

Description

The use of individual written energy-control procedures shall be inspected at least annually to determine:

- Whether the procedures are being followed as prescribed.
- Whether those involved in carrying out a procedure know their responsibilities.
- Whether a procedure continues to provide the necessary protection.
- Whether changes are necessary to increase a procedure's effectiveness or to reflect new equipment conditions.

An authorized employee, who is familiar with, but not participating in, the current energy-control activity, shall perform the inspection. A place is provided at the end of each written procedure for the inspector to record his or her inspection results. Corrective actions shall be initiated for any observation that identifies deviations from or inadequacies in the procedure. The inspector shall verify that the procedure:

- Identifies current affected employees.
- Identifies current energy hazards available to equipment.
- Identifies all current energy-isolating devices.

The inspector shall also verify:

- Authorized employees performed the procedure.
- Authorized employees performed the procedure.
- Proper master and referral tag log entries were made.
- Lockout devices and tags were applied correctly.
- If required, personal protective equipment was properly used.

The final portion of each procedure contains the space for the inspector to record his or her observations and comments. When signed and dated, the completed procedure then becomes the inspection record. Supervisors shall keep a copy of the completed procedures and forward the original to the FO Safety Office for retention. The FO Safety Office will perform semi-annual reviews of the inspection records to identify common written procedure problems and any deficiencies in their proper completion.

6.17. Training

Description

All Wind Tunnel Operations Division employees require some level of hazardous energy-control training since virtually anyone may have occasion to enter an area where lockout devices and tags are in place. The content of the initial training varies for authorized employees, affected employees, and all other employees.

Authorized Employees

Initial classroom training for authorized employees shall include:

- The content of this standard.
- The purpose, function, and restrictions of the energy-control program.
- Recognition of applicable hazardous energy sources.
- Details about the type and magnitude of the hazardous energy sources present in the workplace.
- The methods and means necessary to isolate and control energy source, i.e. the elements of the energy-control procedures.
- Limitations of tags when they are used as the exclusive means of energy isolation.

Affected and Other Employees

Initial training for affected employees and other employees shall include:

- The contents of this standard.
- The purpose, function, and restrictions of the energy-control program and that only authorized employees possess the knowledge and skills necessary for the safe application, use, and removal of energy controls.
- Recognition of situations where energy-control procedures are being used.
- The purpose of written energy-control procedures and the importance of not attempting to start up or use the equipment that has been locked out or tagged.
- Limitations of tags when they are used as the exclusive means of energy isolation.

Refresher Training

Refresher Training shall be provided to authorized employees and affected employees to briefly reacquaint them with the general requirements of the Hazardous Energy-Control Program, to communicate lessons learned, and to ensure that they are provided with the opportunity voice any questions or concerns they have with the Hazardous Energy-Control Program.

Refresher training will also be performed to meet Center Requirements and whenever:

- There is a change in job assignments.
- A change in equipment or processes that present new hazards.

- A change in energy-control procedures.
- A periodic inspection of an energy-control procedure reveals reason to believe that there are deviations from or inadequacies in the employee's knowledge or use of the energy-control procedure.

On the Job Training

Employees shall receive facility-specific training in the safe application, use, and removal of energy controls before being authorized to proceed unsupervised. Supervisors shall document the authorization to perform the application, use and removal of energy controls for individual facilities on an On-the-Job Training (OJT) Record, SS13. Completed forms shall be forwarded to the FO Safety Office for retention.

6.18. Subcontractors and Other Organizations

Description

Employees of subcontractors and other organizations shall be provided with the same level of protection against injury as Wind Tunnel Operations Division, support contractor, and visitor personnel. Personnel who will perform work requiring hazardous energy control must be trained and qualified as authorized workers or be escorted by someone who is. In addition, steps shall be taken to coordinate work activities between subcontractors, representatives of other organizations, and points of contact for the Wind Tunnel Operations Division personnel. This coordination is critical to ensuring the safety of Division personnel, minimizing adverse effects on operations, and ensuring the safety of equipment and facilities. The appropriate points of contact are the Facility Manager, Facility Chief Engineer, or Facility Service Manager as appropriate for the specific work location.

Other Organizations

Other organizations control many of the utilities that support Wind Tunnel Operations Division facilities. Examples of these include electrical power, sanitary and fire suppression water, steam boiler and chiller systems, the sanitary sewer, etc. When these personnel perform maintenance activities in Division facilities, precautions shall be take to prevent the injury of affected personnel or damage to equipment or facilities. When necessary, supervisor locks, master danger tags, personal locks, and/or personal tags shall be applied by Division personnel to energy-isolation devices used by subcontractors or other organizations.

Subcontractors

When subcontractor services are required to support construction or maintenance in Wind Tunnel Operations Division facilities, the contracting organization shall inform the subcontractor of energy-control requirements and procedures. This may be done through appendices to contract documents. The subcontractor shall be required to follow these procedures unless they receive specific written authorization to follow other acceptable procedures. The criteria for determining whether subcontractors may follow other energy-control procedures are:

- Determining that only the subcontractor's personnel will be exposed to, or affected by, hazards posed by the work activity.
- Determining that the subcontractor's energy-control program meets the Ames Research Center hazardous energy-control requirements and applicable regulations.
- Demonstrating that the subcontractor personnel are trained in, and have knowledge of, the application of their energy-control program.
- Making appropriate written procedures available as required.

Subcontractors that do not meet these criteria shall be treated in the same manner as escorted visitors who are exposed to the same hazards.

6.19. Definitions

Affected Employees	Employees whose job requires them to operate or use equipment on which maintenance may be performed using lockout or tagging procedures, or whose job requires them to work in an area where such maintenance is being performed.
All Other Employees	Employees whose job assignments are or may be performed in areas where energy control procedures are utilized.
Authorized Employees	A person who through classroom and on-the-job training is qualified and authorized to lockout or tag equipment in order to protect personnel during maintenance activities.
Capable of being Locked Out	The equipment has an energy-isolating device with a hasp or other means of attachment to which, or through which, a lock can be affixed, or it has a locking mechanism built into it. Other energy-isolating devices are capable of being locked out, if lockout can be achieved through the temporary application of lock hasps or other means of attaching locks, without the need to dismantle, rebuild, or replace the energy-isolating device or permanently alter its energy-control capability.
Danger Zone	A portion of the operating zone of a machine where moving parts or released energy may cause injury to personnel.
Device Owner	The individual who applied the lockout device or tag.

Energized	Connected to an energy source or containing residual or stored energy. Consider electricity, pneumatic and hydraulic pressure, chemical, mechanical, gravity, springs, and etc.
Energy Control	Prevention of the unexpected energizing of equipment and the unexpected release of stored energy in equipment.
Energy-Control Procedure	A written procedure used by an authorized employee to orderly shutdown equipment, safely isolate and lockout or tag the energy sources, render safe all stored or residual energy, and verify the isolation and de-energization of equipment.
Energy-Isolating Device	A mechanical device that physically prevents the transmission or release of energy, such as a manually operated electrical circuit breaker, a disconnect switch, a line valve, a block, blanking plate, and any similar device used to block or isolate energy. Push buttons, selector switches, and other control circuit type devices are not energy isolating devices.
Imminent Danger	Any conditions or practices that pose a danger which could reasonably be expected to cause death or serious physical harm, serious damage to facilities or equipment, or serious damage to the environment, either immediately or before the danger can be eliminated through normal procedures and processes.
Interlock Key	An operational control used to establish and maintain the configuration of wind tunnel equipment, sub-systems, and systems.
Lockout	The placement of a lockout device on an energy-isolating device, in accordance with an established procedure, ensuring that the energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed.
Lockout Device	A device that utilizes a positive means such as a lock to hold an energy-isolating device in the safe position and prevent the energizing of equipment. Blank flanges and bolted slip blinds are considered to be lockout devices for the purpose of this standard.
Maintenance	Workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying, and maintaining or servicing equipment. These activities include lubrication, cleaning or unjamming of equipment and making adjustments or tool changes.
Master Danger Tag	A danger tag that is recorded in a Hazardous Energy Control Logbook. Master danger tags are used in conjunction with all multiple work shifts, multiple groups, and multiple isolation device lockout and tagging activities. They are also used in conjunction with all single group lockout or tagging activities except those involving: a single group and a single isolation device and a single work shift.

Normal Operations	The utilization of equipment to perform its intended function.
Personal Danger Tag	A danger tag that is issued to an authorized employee for their personal protection. The tag contains their photograph, name, and company affiliation. The authorized employee shall apply the tag whenever they are involved in maintenance activities requiring hazardous energy control and they are in a location where the unexpected energization or startup of equipment could injure them, or release of stored energy. Visitor danger tags are temporary personal danger tags issued to wind tunnel visitors. Visitor danger tags retain the user's name and company affiliation but do not contain a photograph.
Point of Operation	The point at which an individual comes into contact with a machine for the purposes of operating the machine for its intended function.
Referral Danger Tag	A danger tag used in conjunction with, and references, a master danger tag and Hazardous Energy Control Logbook entry, in situations where a single hazardous energy-control activity involves multiple energy-isolation devices.
Setting Up	Any work performed to prepare equipment to perform its intended function.
Subcontractors	Individuals or organizations with who contracts are issued for services either directly by the Wind Tunnel Operations Division, or by the Support Contractor on behalf of the Wind Tunnel Operations Division.
Support Contractor	The company holding the Wind Tunnel Operations Division's Aerospace Testing Facility Operation and Maintenance contract.
Tagout	The placement of a tag on an energy-isolating device, in accordance with an established procedure, to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tag is removed.
Verify and Verification	Actuating the controls that are normally used to energize and operate the equipment on which maintenance will be performed to confirm that it has been isolated from the energy sources.

6.20. Locking and Tagging Examples

Description

This section contains examples of the various ways locks and tags shall be used. The examples show most of the locking and tagging situations normally encountered within the Wind Tunnel Operations Division.

Figure 6.15: Single Person—Single Shift—Single Device

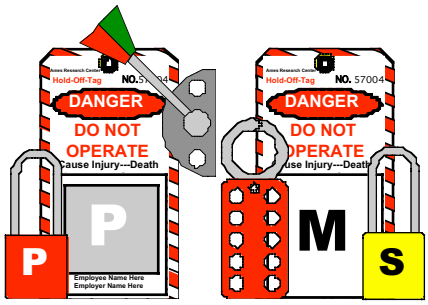


Figure 6.16: Single Person—Multiple Shifts—Single Device

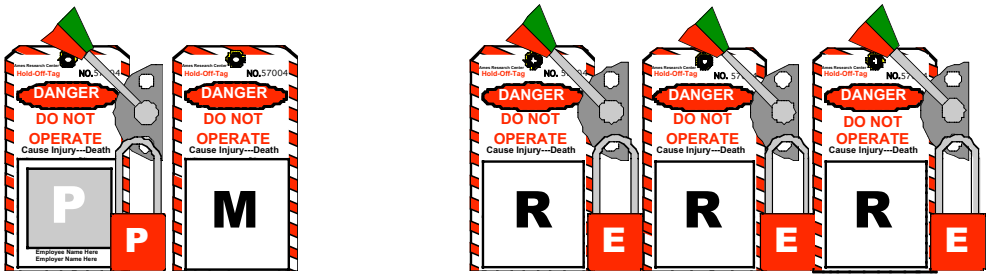


Figure 6.17: Single Person—Single Shift—Multiple Devices

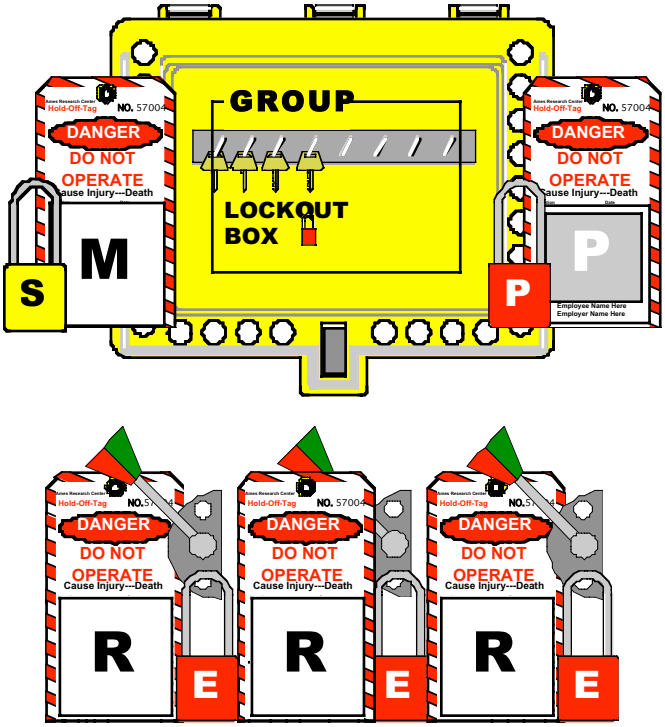


Figure 6.18: Single Person—Multiple Shifts—Multiple Devices

Figure 6.19: Single Group—Single Shift—Single Device

Figure 6.20: Single Group—Multiple Shifts—Single Device

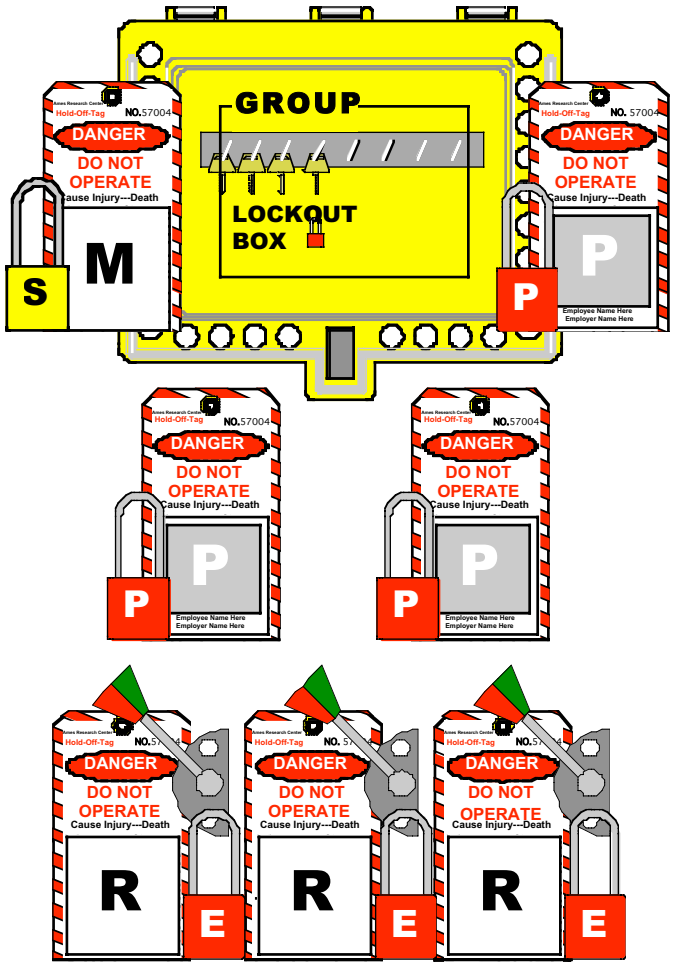


Figure 6.21: Single Group—Single/Multiple Shift—Multiple Devices

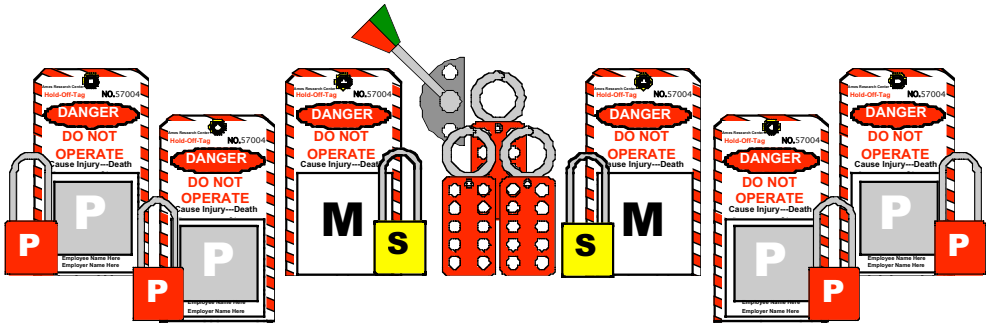


Figure 6.22: Multiple Groups—Single/Multiple Shift—Single Device

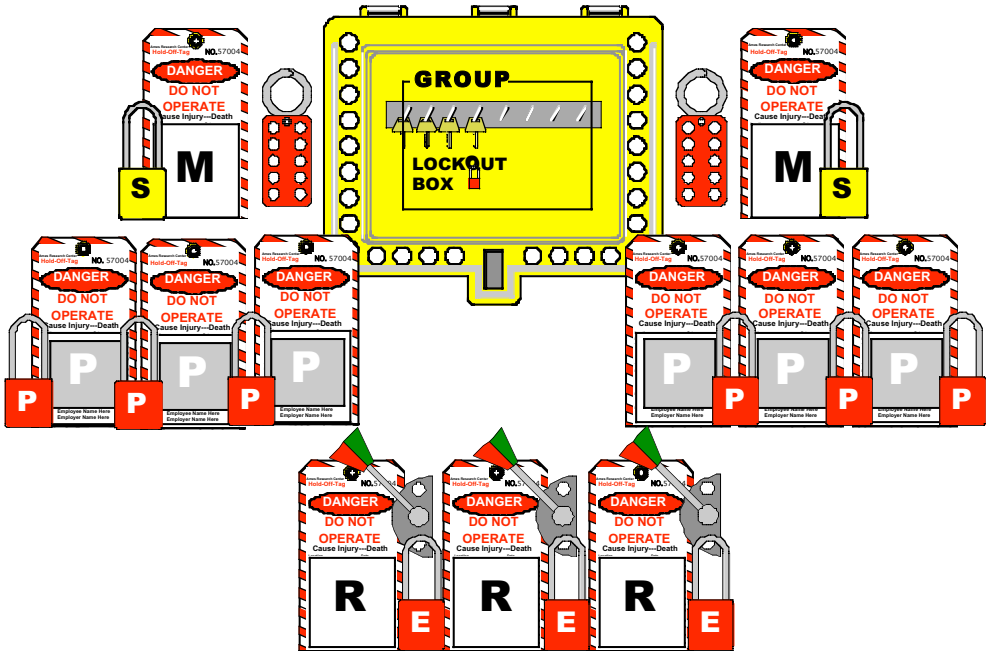


Figure 6.23: Multiple Group—Single/Multiple Shift—Multiple Devices

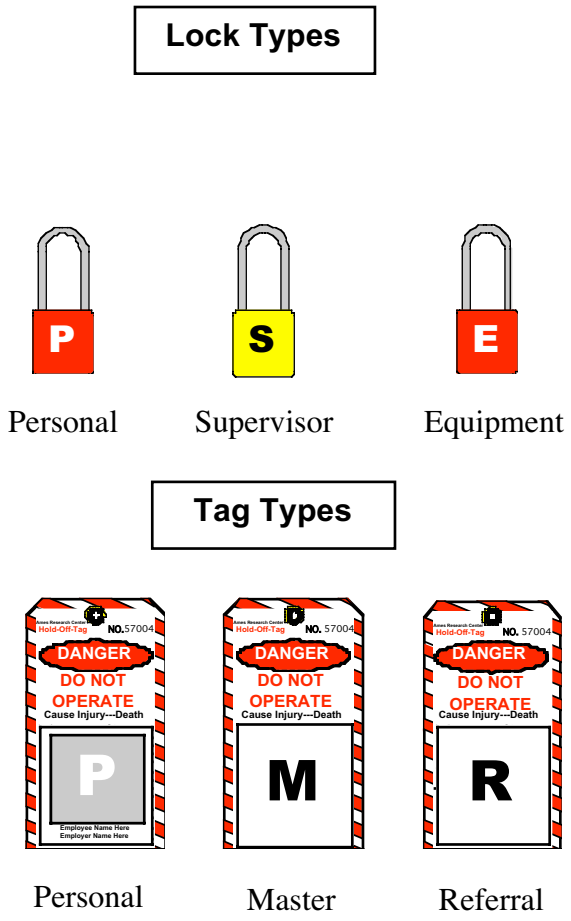


Figure 6.24: Symbol Key

6.21. References

Ames and Division Documents	Ames Health and Safety Manual, APG 1700.1
	Wind Tunnel Operations Division Configuration Management Procedures, A027-9391-XB4
Forms	CAUTION - SPECIAL CONDITIONS Tag, ARC317
	DANGER - DO NOT OPERATE Tag, ARC316
	Energy Control Log Sheets, SS17
	Hazardous Energy Control Procedure Development Worksheet, SS14
	Lockout Device and Tag Removal Request, FO32

On-the-Job Training (OJT) Record, SS13

Written Hazardous Energy Control Procedure Needs Assessment, FO30

End of Chapter

7. Radiography Safety

7.1. Description

Purpose

This purpose of this plan is to assure compliance with the safety provisions of the Health and Safety Manual, Ames Research Center, APG 1700.1, for activities associated with radiography inspection of Wind Tunnel Operations Division facilities and equipment. It is the Division's policy that no one is required to work in an area where exposure at any time could exceed the levels allowable for continuous or instantaneous exposure.

Radiography activities should be performed at times when a minimum number of persons are present (off-shift and weekends). No set-up is allowed before 5:00pm for activities conducted during the week. Radiography requires the following:

- Certification (as part of radiographic safety plan).
- Completion of area control precautions.
- Appropriate personnel notification (to Duty Office, Safety Office, Code JE, Code JEF, Wind Tunnel Operations Division personnel, etc).
- Briefing of radiographic inspectors on fire safety requirements.

Scope

This manual applies to Division civil servant and support contractor personnel, subcontractors, temporary workers, and visitors under the authority of the Wind Tunnel Operations Division.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

7.2. Responsibilities

Single Point of Contact

Radiographic inspections require a Single Point of Contact (SPC) to coordinate radiographic activities within areas under the control of the Division. The Division Chief who serves as the SPC until an SPC is designated, must designate the SPC in writing on a Single Point of Contact form, RSP1. The SPC has the authority to delegate tasks and responsibilities to the Project Manager, and is mainly responsible for the following:

- Preparing a Radiography Procedures and Radiation Safety Plan for each activity to be signed by the Division Chief and maintenance and operations branch chiefs.
- Maintaining familiarity with the provisions of the Ames Radiation Safety Guide in the Ames Health and Safety Manual, APG 1700.1.
- Coordinating with operations branch, support services contractor(s), and other organizations.
- Inspecting area control provisions and ensuring signs identifying activity and times are posted.
- Ensuring that the persons performing the radiographic inspection have been briefed on fire safety requirements.
- Advising line management on the status of the radiographic activity and notifying management in writing of the planned activities including: location, area control provisions, who is performing the work, when the work will be performed, and when areas are to be cleared.
- Notifying the Ames Radiation Safety Officer (RSO) 72 hours before the start of radiographic activities.

Radiation Safety Officer (RSO)

The RSO's responsibilities include the following:

- Reviewing and retaining file copies of the radiography contractor's safety plan, Nuclear Regulatory Commission (NRC) license, and reciprocity agreement.
- Meeting with the Project Manager to evaluate the safety plan, location of radiography, source activity, schedule of operation, and notification plan, and providing guidance to project personnel
- Issuing NASA, Ames radiation film badges to Ames personnel to document any on-site exposure (industry contractors are responsible for providing their own film badges).
- Auditing radiography operations and suspending radiography activities if warranted by safety deficiencies.

- Reviewing and concurring with this Radiography Safety Plan and specific project radiography plans.
- Informing Nuclear Regulatory Commission (NRC) when new radiographers have received contracts to operate at NASA, Ames (within the past year).

Project Managers

Project managers' responsibilities include the following:

- Keeping the RSO informed on radiographic activities. Assuring that the radiography contractor has a safety plan and a license or reciprocity agreement on file with the RSO.
- Notifying NASA facility safety representatives and management in the restricted radiography testing area to assure that any disruptions to their operations are understood.
- Notifying NASA security and the Moffett Fire Department of radiography testing.
- Ensuring daily and nightly radiography compliance with established safety procedures.
- Surveying the restricted area and maintaining documentation on site and available for review at all times.
- Reviewing and maintaining documentation of radiographer, area exposure levels, and radiation badge assignments.
- Attending all radiography operations and assisting the radiography contractor in gaining access to all necessary sites (contact with the radiography contractor is maintained by radio during radiography exposures).

Radiography Contractor

The radiography contractor's responsibilities include the following:

- Clearing the restricted area within the 2mR/hr boundary line.
- Securing the 2mR/hr boundary with ropes, signs, and red flashing lights.
- Surveying the 2mR/hr boundary line.
- Maintaining documentation of the restricted boundary at the on-site office available for review at all times. Copies must be supplied daily to the Project Manager.
- Complying with provisions of this document.
- Complying with all laws governing the use and handling of a radioactive source. Any discrepancies between governing regulations and this document must be immediately brought to the attention of the Project Manager.
- Identifying high-radiation areas (≥ 100mR) with posted signs.

Authorized Personnel

At least one week before the start of radiography operations, all authorized personnel in, or posted around, the perimeter of the radiography testing area must be trained by the radiography project monitor to understand all procedures and requirements written in this document and the project radiography plan. Authorized personnel are:

- Designated SPC
- Radiography contractor
- NASA security personnel
- Project Manager and designees
- NASA RSO
- FOW branch personnel monitoring and allowing access to the facility

7.3. Requirements

Establish Parameters

Prior to exposure, the high-radiation and restricted-area (maximum 2mR/hr) perimeters must be calculated, posted with the required warning signs, and roped off. Warning signs and rope must be of the distinctive magenta and yellow radiation warning material. Flashing red warning lights must be displayed at major entry points and in low-light areas.

Conduct Surveys

Surveys must be done the first night of radiography and continue throughout the project each time the source is moved to verify and document the 2mR/hr safe boundary line. Adjustments to the restricted zone are made based on the initial night's survey and subsequent surveys. The Project Manager and NASA representatives support the radiography contractor during these initial surveys. The radiography contractor must keep survey documentation with survey locations and results noted.

The Project Manager must enter the initial survey results into the project files and immediately provide copies to the NASA RSO. Note that surveys of the 9x7ft SWT and 11ft TWT have been performed during previous years with 200 Curie sources of Iridium 192. The results of those surveys may be applied in establishing the 2mR/hr line for future efforts involving the Unitary tunnels.

During each radiography shift, the radiography contractor to confirm the 2mR/hr safe boundary limit must survey the restricted area. The Project Manager must also perform at least one survey at the beginning of each radiography shift to confirm the 2mR/hr boundary. These surveys are to be graphed on a map that shows the radiography contractor's 2mR/hr line. These survey maps are to be made available for audit by the NASA, Ames RSO at all times. These records become the property of the NASA, Ames Office of Safety at the conclusion of radiography testing.

Secure Buildings

During the period of radiography, any effected Division building must be closed and locked by Division personnel, tagged by the radiography contractor, and kept off limits to personnel. The building must be inspected by NASA security after locking and tagging all doors. Radiography may not begin until NASA security has reported the building clear and initialed the appropriate checklist and all other checklist items have been verified.

Buildings not under FO division cognizance may be in the restricted zone. The Project Manager must notify the Facility Service Manager (FSM). The FSM must notify all personnel that the building is off limits during periods of radiography. These buildings must be closed and locked by NASA security. The buildings must be inspected by NASA security prior to radiography. Radiography will not begin until NASA security has reported that the buildings are clear.

Secure Closures

Where required by calculations and verified by measurement, roads must be barricaded by NASA security and entry blocked to the restricted zone.

Restrict Area

The restricted area must be cleared of all unauthorized personnel and kept under direct surveillance during exposure operations. The "No Entry Area" will be determined after initial surveys are reviewed and an assessment of current operations is conducted. Surveillance must be provided by the radiography contractor and by NASA security. NASA security guards will be posted at key locations, so direct surveillance of the restricted area can be maintained at all times.

Establish Communication

Security guards and radiography contractor personnel must be provided with radios on the same frequency to maintain full communication.

Complete Records

The Project Manager or night monitor assistant must complete the attached preoperation and postoperation checklists each night of radiography. Enter each completed checklist and survey map into the project files at the end of each radiography shift. Enter records of significant events that occur during the radiography shift on the back side of each night's survey map.

Emergency Procedures

The following sections describe actions to be taken in the event of an emergency.

Unauthorized Entry Into the Restricted Area

Any individual entering the restricted area will be stopped and removed from the area immediately by the Project Manager or designee and the posted NASA security guards. The guards shall notify the Project Manager immediately that an individual has crossed the 2mR/hr line entering the restricted zone. The guards shall remain at the perimeter of the restricted zone and verbally stop the individual in the restricted zone. If the individual does not stop, the guard shall instruct the radiography contractor to secure the source immediately. The Project Manager with the aide of NASA security shall remove the individual from the restricted area. Then the radiography contractor, as instructed by the Project Manager, may proceed with radiography.

The Project Manager or assistant shall record the individual's name, branch affiliation, immediate supervisor, branch chief, time of entry, date of entry, whether individual was aware of testing prior to entry, reason for entry, where entry originated, and individual's destination. All information must be documented in the project files. The area of entry and path taken by the unauthorized individual must be surveyed and documented on the survey map. Inform the individual of the radiography testing and to stay clear of the restricted area. The unauthorized entry shall be brought to the attention of the individual's branch chief or higher authority and the NASA RSO the following work day. The Project Manager prepares and submits an incident report.

Stuck or Loose Source Outside Camera

Perform the following steps when the source either gets stuck outside the radiography camera or becomes loose:

Procedure for a Stuck or Loose Source Outside the Camera

Step	Action
1	The radiography contractor notifies the Project Manager or assistant immediately of problems with securing the source.
2	The NASA RSO or alternate must be immediately notified and all activity at project site must be terminated. Security will maintain boundaries and no outside staff will be allowed into the area without approval of the RSO or alternate.
3	The Project Manager or assistant notifies posted NASA security personnel and the NASA Security Office that additional personnel are needed to monitor the area. The Moffett Fire Department must also be notified that the source is not secured.
4	The radiography contractor requires provisions on site to handle such an occurrence and will implement them immediately.
5	Once the source is secured, posted NASA security personnel, the NASA Security Office, and the Moffett Fire Department must be notified that the source has been secured.
6	The radiography contractor immediately files a written report to the Project Manager or assistant of the incident and the remedy.
7	FO division and support services contractor management, the NASA RSO, and the NASA Office of Safety, Health, and Medical Services must be notified immediately if the incident is of major significance. An incident report must be filed with remedy the same day.

7.4. References

Ames and Division Documents	Ames Health and Safety Manual, APG 1700.1

End of Chapter

8. Bloodborne Pathogens

8.1. Description

Purpose

The Wind Tunnel Operations Division personnel shall minimize exposure to bloodborne pathogens during any mishap or accident by avoiding human blood or other potentially infectious materials of human origin. Additionally, Division personnel shall know whom to call for assistance when human blood or body fluids are present in the working environment. This chapter states the basic requirements for protection of employees from the potential hazards of occupational exposure to bloodborne pathogens and addresses the OSHA Bloodborne Pathogen Standard requirements.

Scope

This chapter applies to all employees, temporary workers, support contractor personnel, and subcontractor personnel who are under the authority of the Wind Tunnel Operations Division and may be exposed to human blood or other potentially infectious materials of human origin.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

8.2. Responsibilities

Supervisors

Supervisors' responsibilities include the following:

- Ensure their personnel are aware of the requirements of this chapter.
- Coordinate response to any exposure incident in accordance with the guidelines of the Ames Bloodborne Pathogens Protection Plan in the Ames Health and Safety Manual, APG 1700.1.
- Complete the following forms from the appendix of the Plan: Exposure Incident Checklist for Supervisors, the Exposure Incident Description, and the Exposure Incident Evaluation form.

Employees

Employee's responsibilities include the following:

- Immediately report any mishap where there is a potential for exposure to bloodborne pathogens.
- Minimize risk of exposure to self and others when potential for exposure to bloodborne pathogens exists.

Division Safety Office

The Division Safety Office's responsibilities include the following:

- Ensure this chapter is kept current.
- Assist supervisors in awareness training of their personnel.
- Support mishap-reporting procedures.

8.3. Requirements

Description

Bloodborne pathogens are viruses, bacteria, and other microorganisms that are carried in a person's bloodstream and cause disease. If persons come in contact with blood or bodily fluids infected with a bloodborne pathogen, they may become infected. The most commonly transmitted diseases include hepatitis B virus (HBV), human immunodeficiency virus (HIV), and hepatitis C virus (HCV). An exposure incident is defined as contact of human blood or bodily fluids to non-intact skin such as dermatitis or wound, contact to mucous membranes, or injury by a contaminated object.

Response Procedure

Personnel working within the Wind Tunnel Operations Division are not expected to come into contact with infectious materials such as blood or bodily fluids in the normal working day. Should such an incident arise, or if material suspected of being infectious is discovered, the employee shall not attempt to clean up the material. He or she shall:

- Call 911 and notify the dispatcher of the presence of potentially infectious materials.
- Cordon off the area.
- Notify supervisor.
- Notify the Division Safety Office.

For any emergency involving an injury or illness, immediately call 911 from an Ames site phone. The 911 dispatcher will notify the proper on-call safety personnel to evaluate the situation and arrange cleanup. The Health Unit's role would be caring for individuals exposed to potential bloodborne pathogens. They also can assist employees who have been injured or become ill.

Employees who sustain minor injuries that result in small amounts of blood loss shall clean up any residue on tools, equipment, and work surfaces as soon as possible. All cleaning materials contaminated with blood or other body fluids shall be deposited in a labeled "biohazard" bag. Disinfectants and bags can be obtained from the Division Safety Office.

Controls

Personnel can assist in controlling an exposure to bloodborne pathogens by ensuring that a contaminated area is restricted. The universal precaution is to assume that all human blood and bodily fluids are infectious. All other control actions shall be left to designated Emergency Responders who are prepared with specialized training, PPE, and HBV vaccinations.

Sharps

Transmission of bloodborne pathogens could occur from an accidental injury with a sharp object contaminated with infectious material. Examples of such sharp objects, referred to as “sharps”, include needles, broken glass, knives, blades, or any other object which can pierce, puncture, or cut your skin. Any needle or sharp object which may be contaminated with blood or other potentially infectious material, shall be discarded in a puncture proof container, labeled as “Biohazard” and discarded as medical waste via the Division Safety Office.

Uncontaminated sharp objects shall be disposed of in a closed container that will prevent others from being injured. The container shall be closable, puncture resistant, and labeled with “Sharps Waste” or “Glass Waste”. Bring your “Sharps” container to the Division Safety Office for disposal. If needed, sharps containers or biohazard bags can be obtained from the Division Safety Office.

First-Aid Providers

First Aid and CPR training is provided at Ames to volunteers who are interested in responding as “Good Samaritans” in an emergency at home or elsewhere. All personnel who take this First Aid and CPR training must also be trained in bloodborne pathogen control procedures and methods to minimize exposure during any revival attempt.

8.4. References

Ames and Division Documents

Ames Health and Safety Manual, APG 1700.1

Ames Safety Accountability Program, Bloodborne Pathogens

External Documents

OSHA Standard 29 CFR 1910.1030: Occupational Exposure to Bloodborne Pathogens

California Code of Regulations, Title 8, GISO, § 5193

End of Chapter

9. Confined-Space Entry

9.1. Description

Purpose

This chapter describes the procedures, permits, and authorization forms required to implement Division policy to eliminate or control potential injury or death resulting from confined-space entry.

Scope

This chapter applies to Division civil servants, support contractor personnel, and subcontractor personnel who work in confined spaces.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

General

Confined-space work can present potentially life-threatening safety and health hazards. Individuals who work in confined spaces must understand these hazards and use precautions for protecting themselves and others.

A Safe Plan of Action (SPA), FO13, is a tool for identifying potential hazards. This form should be developed whenever entry into a confined space is anticipated, and may help to determine if a Confined-Space Entry Permit is required. It should also help identify potential hazards associated with both the planned work and the confined space.

At no time are Division employees authorized to enter a permit-required confined space to attempt a rescue. Two out of every three confined-space fatalities result from attempting such a rescue. Rescue operations requiring confined-space entry shall be conducted only by NASA Ames Research Center emergency personnel.

At no time are Division employees authorized to enter a confined space known to contain conditions that are immediately dangerous to life or health (IDLH). Entry into such conditions requires equipment and training beyond the scope provided to Wind Tunnel Operations Division employees.

9.2. Responsibilities

Managers

Managers' responsibilities include the following:

- Ensure implementation of and compliance with the contents of this chapter and associated procedures.
- Ensure that equipment required for safe entry into confined spaces is available.
- Ensure that employees and supervisors are trained in using and maintaining equipment for safe entry into confined spaces before using it.

Division Safety Office

Division Safety Office responsibilities include the following:

- Provide consultation and information essential to protect employees involved in confined-space operations.
- Refer to regulations for assisting management and supervisors in making appropriate decisions about confined spaces.
- Ensure that original entry permits are forwarded to the Ames Office of Safety and Mission Assurance.
- Maintain a filed copy of each entry permit.
- Review each entry permit within one year of its closure date for completeness and appropriateness of precautions taken.
- Annually review the confined-space entry program and procedures to evaluate the program and determine if any revisions are required.

Entry Supervisors

Entry supervisors' responsibilities include the following:

- Participate in developing a Safe Plan of Action (SPA), FO13.
- Verify that permit-required confined-space entry procedures are followed as required.
- Determine if alternate confined-space entry procedures can be used, and if appropriate, authorize using the Alternate Confined-Space Entry Permit, FO11.
- Verify that all required atmospheric testing is performed and documented on the entry permit.
- Verify that the correct procedures and equipment are identified for each confined-space operation.
- Verify that rescue services are notified before anyone enters a confined space requiring an Entry Permit for Permit Required Confined Spaces, ARC 230, and that there is a means of summoning rescue services.

- Ensure that the Entry Permit for Permit-Required Confined Spaces, ARC 230, or the Alternate Entry Permit, FO11, is properly completed and posted at the confined-space entry site.
- Authorize confined-space entry when all requirements are met.
- Terminate confined-space entry if necessary.
- Prevent unauthorized individuals from entering the confined-space work area.
- Ensure that the confined-space entry conditions remain unaltered when operations are transferred from one individual to another.
- Close out and sign the entry permit at the completion of the job or shift.
- Forward each original entry permit and alternate entry permit to the Division Safety Office within ten days.
- Retain a copy of each entry permit and alternate entry permit for a period of at least 12 months.

Attendant

The attendant's responsibilities include the following:

- Participate in developing SPAs and entry permits.
- Remain at the confined-space entry point unless relieved by another attendant.
- Monitor for any changes or conditions inside or outside the space that could adversely affect the entrant.
- Initiate evacuation and emergency procedures if required
- Instruct occupants to exit the confined space when any irregularities are observed.
- Perform non-entry rescues if necessary.
- Provide hazard information about the confined space to rescue and medical personnel.
- Take action as necessary when unauthorized individuals approach or enter a permit-required confined space.
- Know the potential hazards that may be encountered during confined-space entry, and the measures for protecting against them.
- Provide, upon completing the confined-space entry activity, copies of the signed entry permit to all coordinating organizations identified on the permit.

Authorized Entrant

The authorized entrant's responsibilities include the following:

- Follow all procedures and precautions specified on the entry permit.
- Participate in the developing SPAs and entry permits.

- Use all provided equipment properly.
- Maintain communication with the attendant.
- Alert the attendant upon recognizing a dangerous situation or prohibited condition.
- Exit as quickly as possible when any of the following occur:
  - The attendant or entry supervisor orders an evacuation
  - There are warning signs of a dangerous situation.
  - A prohibited condition is detected.
  - An evacuation alarm is activated.
- Know the potential hazards that may be encountered during confined-space entry, and the measures for protecting against them.
- Know the signs, symptoms, and consequences of exposure to potential health hazards that may be encountered during confined-space entry.

Other Employees

Other employees' responsibilities include the following:

- Refrain from entering the confined-space work area or crossing barriers established to isolate the confined-space entry area.
- Refrain from handling, moving or modifying confined-space entry equipment unless directed to do so by the confined-space entry supervisor or attendant.
- Promptly follow instructions from entry supervisors, attendants, emergency rescue team members, or Division management.

Contractors and Sub-Contractors

Contractors and subcontractors, and any entity serving as a Division contractor or sub-contractor, have responsibilities including the following:

- Comply with the requirements of this chapter and associated procedures.
- Provide the Division Safety Office with a copy of their company's confined-space entry program or procedures.
- Provide the Division Safety Office with a list of all individuals who are authorized permit-required confined-space entrants, attendants, or entry supervisors.
- Provide the Division Safety Office with copies of each authorized employee's permit-required confined-space certification.
- Notify the Moffett Dispatch prior to each permit-required confined-space entry. (Telephone notification is acceptable.)

- Allow the Division Safety Office and management-authorized personnel to inspect their work site, equipment and entry permits.
- Require entry team members to comply with Division management or their qualified representatives' instructions to evacuate a confined-space. (A qualified representative may be any Division employee who is trained and certified as an entrant, attendant, or entry supervisor.)

9.3. Identifying Confined Spaces and Required Entry Procedures

Confined Spaces

A confined space has all the following characteristics:

- The space is large enough for an individual to bodily enter it.
- The means for entry or exit are limited or restricted by size or configuration, such as spaces inside tanks, vessels, silos, storage bins, hoppers, vaults, and pits.
- The space is not intended for continuous human occupancy.

Permit-Required Confined Spaces

All confined spaces shall be considered permit-required confined spaces until it's determined that no hazards are associated with entering the space. Any confined space not requiring an entry permit shall be reevaluated at the time of entry.

Permit-required confined spaces are confined spaces that may subject an entrant to one or more potential hazards, such as the following:

- An atmosphere made hazardous by contaminants, or one with oxygen levels below 19% or above 23.5%.
- Engulfment by a material such as sand, dirt, or fluids.
- Physical hazards, such as moving or rotating equipment, objects that could impale a person, and extreme temperatures.
- Electrical or other energy hazards, such as radiation, lasers, or sudden pressure releases.
- A confined space with an internal configuration from which extraction may be difficult, or in which an entrant could become trapped.
- An internal configuration that could restrict normal breathing, such as a space with inwardly converging walls, or a floor that slopes downward and tapers to a smaller cross-section.
- Any other recognized serious safety or health hazard.

Wind Tunnels

A wind tunnel circuit may or may not be a confined space. This depends on how, where, and when it is entered, and on the hazards posed by the specific location or activity to be performed. It's important, however, to always follow the appropriate wind tunnel standard operating procedures and test-specific procedures.

Although there may be other safety hazards, the NFAC, Unitary and 12-Foot wind tunnel test sections are not confined spaces because the means of entry into the test sections are large enough not to limit or restrict egress.

Determining Confined-Space Entry Procedures

There are standard procedures and alternate procedures for permit-required confined-space entry. For details, refer to the Standard Procedures for Permit-Required Confined-Space Entry and the Alternate Procedures for Permit-Required Confined-Space Entry sections in this chapter.

Use the following flowchart, Determining Confined-Space Entry Procedures, to determine which confined-space entry procedure is required:

10. Hearing Conservation

10.1. Description

Purpose

This chapter describes the procedures for implementing the Wind Tunnel Operations Division policy to protect and preserve employees' and contractors' hearing. These procedures comply with Federal Occupational Safety and Health Administration (OSHA) and NASA standards, and provide methods for identifying and controlling excessive noise that may be harmful. These procedures are also intended to minimize the incidence of occupational-related hearing loss, and to help ensure that employees are informed about noise in the workplace and protection measures they can use at work and at home.

This chapter fulfills Federal OSHA requirements for a written hearing conservation program.

Scope

This chapter applies to all employees, temporary workers, support contractor personnel, and subcontractor personnel who are under the authority of the Wind Tunnel Operations Division and who work near noise.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

General Information

Hearing conservation is an important aspect of the safety and health program. Workplace noise can cause hearing loss, create physical or psychological stress, and contribute to accidents by making it difficult to communicate.

Noise exposure can be controlled. Every effort is to be made to use quieter processes, machinery, and equipment. When feasible engineering controls cannot reduce noise levels to or below the exposure limit, proper hearing protection shall be used. In addition, all employees exposed to noise levels of a time-weighted average (TWA) above 80 dBA shall participate in the hearing conservation program.

There are many reasons for providing an effective hearing conservation program, including the following:

- Protecting the organization's most important resource—employees.
- Providing a safe and healthful workplace.
- Complying with governmental regulations.

Management, supervisory, and employee commitment to hearing conservation, and a positive attitude are important aspects of the overall hearing conservation program.

The key elements of the division hearing program are the following:

- Noise evaluation and surveillance procedures.
- Engineering and administrative noise exposure control.
- Personal hearing protection.
- Audiometric testing and follow-up.
- Training and education.

10.2. Responsibilities

Managers

Managers' responsibilities include the following:

- Ensure that feasible engineering and administrative controls are implemented to reduce noise exposures in their area of responsibility.
- Ensure that employees comply with all requirements of this chapter.
- Ensure that employees attend Hearing Conservation Training as specified.
- Ensure that employees are provided with appropriate hearing-protection devices (HPD).
- Advise the Division Safety Office of any changes of operations or installations of new equipment that may alter noise levels.

Supervisors

Supervisors' responsibilities include the following:

- Inform affected employees about noise sources in their work areas, and provide this information to the Division Safety Office.
- Ensure that appropriate caution signs are posted in high noise areas and on noisy tools and equipment.
- Recommend, if possible, feasible engineering and administrative controls to reduce noise exposure in work areas.
- Ensure the following for employees who work near noise:
  - Hearing Conservation Training is completed annually.
  - Hearing-protection devices (HPD) are available, and that employees understand when to wear them.
  - Initial baseline and annual audiometric testing is completed annually.

- Enforce the requirement that employees wear HPDs when exposed to short or long-term continuous noise in excess of 85 dBA, or exposed to impulse noise in excess of 140 dB.
- Consider noise reduction when purchasing equipment and tools.
- Properly maintain equipment and tools.
- Refer employees who suspect they're developing hearing problems to the Ames Health Unit or the Contract Health Unit, as appropriate.

Employees

Employees' responsibilities include the following:

- Be aware of potential division noise-hazards.
- Successfully complete Hearing Conservation Training, which includes understanding noise sources and their controls, before working near noise, and annually thereafter.
- Follow all safe work practices and requirements described in this chapter.
- Use appropriate hearing protection in noisy work areas and wherever there are signs requiring that hearing protection be used.
- Demonstrate understanding of hearing protection limitations, and how to properly use, fit, and maintain hearing-protection devices (HPD).
- Complete a baseline audiogram at initial employment, followed by annual audiometric exams.
- Participate in noise evaluation surveys when required.

Division Safety Office

Division Safety Office responsibilities include the following:

- Oversee and annually review and update the Hearing Conservation chapter to ensure compliance with OSHA and NASA standards.
- Assist managers and employees with hearing conservation compliance.
- Assist with tracking and maintaining employee Hearing Conservation Training documentation.
- Conduct Code Q-approved Hearing Conservation training for Division employees.
- Schedule noise surveys and noise dosimetry with ARC Safety, Health, and Medical Services as needed.
- Schedule annual audiometric testing for all ATOM contract employees.

- Ensure all ATOM contract employees receive advanced written notification to avoid high levels of noise at least 14 hours preceding an audiometric test.
- Communicate audiogram test results to each contract employee.
- Meet with any employee who may have questions about audiogram results.
- Schedule repeat audiometric exams with the contract health clinic if a contract employee's results indicate a possible standard threshold shift.
- Enter all ATOM employee threshold shifts on the OSHA Log as required by this chapter and OSHA regulations.
- Maintain hearing records and noise surveys for 30 years beyond the duration of employment.

Ames Health Unit

Ames Health Unit responsibilities include the following:

- Perform baseline, annual, and termination (or job change) audiometric exams for civil servants who work near noise at or above 80 dBA, time-weighted average (TWA).
- Notify civil servants when their annual audiometric exams are due.
- Provide employees with their audiometric results, and schedule further testing or referrals if needed.
- Maintain employee-hearing records for 30 years beyond the duration of employment.

Facility Chief Engineer

The facility chief engineer's responsibilities include the following:

- Review new or modernization facility and operational plans to ensure that adequate attention is given to noise exposure controls.
- Select for lowest-possible noise emission levels when purchasing new equipment or installing new processes.

Project Managers for Subcontractor Activities

Project managers for subcontractor activities have responsibilities that include the following:

- Ensure that contract employees working on-site comply with the hearing conservation requirements described in this chapter.
- Provide information to subcontract workers about division noise hazards.
- Assist in selecting for lowest-possible noise emission levels when purchasing new equipment or installing new processes.

Subcontractors

Subcontractors' responsibilities include the following:

- Demonstrate that subcontractor employees who work near noise comply with hearing conservation requirements as prescribed by OSHA, NASA, and the Wind Tunnel Operations Division.

10.3. The Written Hearing Conservation Program

Written Hearing Conservation Program

The Written Hearing Conservation Program is a comprehensive program that is reviewed and updated under the direction of the Division Safety Office. This program fulfills Federal OSHA requirements and describes the processes for identifying, monitoring and controlling noise, performing audiometric testing and medical monitoring, providing hearing-protection devices, and employee training. Also, the Division Safety Office maintains, and makes available to employees, copies of this chapter and regulatory documents.

If work-area noise levels are reduced to within accepted guidelines, the Wind Tunnel Operations Division Safety Office and upper management reserve the right to terminate any or all phases of the Hearing Conservation Program.

10.4. Noise Identification, Evaluation, and Surveillance

General

The hearing conservation program's success depends on an accurate knowledge of the existing noise environment. Accurate surveys identify and define areas where potentially harmful noise exposures exist. Follow-up noise measurements are made and recorded whenever there are changes in work practices or methods that may change noise exposures. Noise exposure measurements are available upon request.

Effective noise exposure measurements help prevent hearing loss by identifying employees who work in noisy areas. These employees shall participate in the Hearing Conservation Program, which includes exposure monitoring, audiometric testing, medical monitoring, and training. Hearing protection is recommended for exposures of 80 dBA to 84 dBA, and enforced at 85 dBA or above. Affected employees are notified if their noise-exposure level reaches 80 dBA TWA or above.

Noise-induced hearing loss is a function of the following three factors:

- Exposure time
- Average noise level
- Peak level of very loud sounds

The table below identifies measured noise levels for various activities:

Table 10.1: Noise Levels for Various Activities

(Measurements are immediate readings rather than time-weighted averages.)

Decibels	Noise Sources From the Highest Decibel Rating To the Lowest
180	Rocket Launching Pad
140-150	Jet Plane
140-150	Firearms
130	Riveting on Steel
110-120	Automobile Horn
112	Sandblasting
105	Concert
* 105	Diesel Motor House, N-227 Yard
100	Pneumatic Drill
100	Hydraulic Press
* 99	N-227A Hydraulic Pump Operating, 1st Floor
* 97	N-227D Mezzanine, West Stairs
* 95-113	N-227D Yard Equipment Between the Switch Gear Room and N-227D
95	Lawn Mower
* 91-99	N-227A First Floor Hatch
90	Subway

90	Spray Painting
85	Kitchen Blender
* 82	N-227C, Front of North Door
* 82-86	Forklift at N-227C
80	Noisy Restaurant
80	Office Calculator
75	Busy Traffic
66	Conversational speech
50	Average Home
40	Quiet Office
20-30	Whispered Speech

* During wind tunnel operation.

Permissible Exposure Level (PEL) and Action Level (AL)

The PEL and AL are based on sound pressure and duration of exposure, and represent conditions to which nearly all workers may be repeatedly exposed without adverse effects on their ability to hear and understand normal speech. Noise-exposure limits, however, may not protect all workers from the adverse effects of noise exposure.

The Wind Tunnel Operations Division uses the noise-exposure limits recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) and the National Institute for Occupational Health and Safety (NIOSH), which are more conservative than the noise-exposure limits OSHA recommends. (OSHA defines the PEL as an 8-hour TWA of 90 dBA, and the AL as an 8-hour TWA of 85 dBA.)

The noise-exposure limits used by ARC and the Wind Tunnel Operations Division are the following:

- Ames PEL—An 8-hour TWA of 85 dBA, at a slow-response setting.
- Ames AL—An 8-hour TWA of 80 dBA, which is a level that requires employees to participate in the hearing conservation program.

Based on conservative assumptions about noise-attenuation when hearing protection devices are properly used, the following table uses the ARC and Wind Tunnel Operations Division's exposure limits to indicate allowable safe noise-exposure at 80 dBA or more, and with varying levels of hearing protection:

Table 10.2: Permissible Duration for Noise Exposure at ARC

Sound Levels	Permissible Hours of Exposure Per Day			
	No Hearing Protection*	10 dB Hearing-Protection	15 dB Hearing-Protection	20 dB Hearing-Protection
80 dBA (ARC AL)	16	More than16	More than 16	More than 16
85 dBA (ARC	8	More than16	More than 16	More than 16
90 dBA	4	16	More than 16	More than 16
95 dBA	2	8	16	More than 16
100 dBA	1	4	8	16
105 dBA	1/2 (30 minutes)	2	4	8
110 dBA	1/4 (15 minutes)	1	2	4
115 dBA	1/8 (71/2 minutes)	1/2 (30 minutes)	1	2

* The permissible exposure indicated in this table does not alter the division's policy that any employee exposed to 85 dBA or more must wear proper hearing protection.

If engineering or administrative controls cannot reduce exposure to an acceptable sound level as indicated in the No Hearing Protection column of the table above, employees shall be provided hearing-protection devices and required to use them.

Identifying Hazardous Noise Areas

The Office of Safety Environment and Mission Assurance (SEMA) assists the Wind Tunnel Operations Division in identifying and routinely monitoring noise in work areas. The Division Safety Office shall maintain and periodically review records in order to identify changes.

The following areas shall be routinely monitored:

- Areas where noise levels are suspected to be in excess of a TWA of 80 dBA.
- Areas where changes to facilities, equipment, procedures, or processes that may increase the potential for noise shall be monitored.

When Is Noise Too Loud?

The following describes conditions that may indicate that noise should be monitored and that controls should be implemented:

- When noisy conditions make normal conversation difficult, or if you can't hear another person talking in a normal voice from three feet away.
- When conditions cause employees to complain about the loudness of noise.
- When there are indications that employees are losing their hearing.
- When there is high-frequency noise. High-frequency noise at lower decibels (e.g. 85 dBA) can cause more damage to the inner ear than low-frequency noise at higher decibels (e.g. 95 dBA).

Caution and Warning Signs or Labels

The area supervisor is responsible for ensuring that personnel observe all caution and warning signs or labels, and that they take appropriate precautions regarding noise and hearing protection.

Equipment, power tools, and machines that produce hazardous noise shall be appropriately labeled in accordance with the Ames Health and Safety Manual, APG 1700.1.

Caution signs shall be posted at the entrance to any work area where noise levels exceed 85 dBA. Signs shall state that persons entering the area must wear proper hearing protection. The required hearing-protection devices, and instruction on using them properly, shall be provided to personnel. Anyone entering or working in the identified areas is required to wear hearing-protection equipment.

Signs and labels shall be yellow and black, such as the following examples:

Figure 10.1: Black and Yellow Caution Signs

The following caution sign shall be posted in areas where noise from wind tunnel operations is loud, but intermittent:

Figure 10.2: Caution Sign for Loud, But Intermittent Noise

The following warning sign shall be posted in areas where there are elevated rupture discs for relieving high pressure within a wind tunnel:

Figure 10.3: Warning Sign for Areas With Elevated Rupture Discs

Noise Measurements and Exposure Assessments

To effectively control noise, it must be accurately measured according to standard procedures, and the measurements must be properly evaluated against accepted criteria. All noise monitoring shall be conducted in accordance with the Ames Health and Safety Manual, APG 1700.1, and with OSHA CFR 1910.95.

Noise surveys shall be conducted using sound level meters and noise dosimeters that meet the appropriate American National Standards Institute (ANSI) standards and ARC requirements. The equipment shall be calibrated acoustically before and after each survey.

Noise exposure monitoring includes both area monitoring and personal monitoring, as described below:

Area Monitoring

Area monitoring is performed using a calibrated instrument set to the A-scale, slow response. It measures environmental noise in decibels to identify areas where employees' exposure to noise may be above acceptable levels, and where more thorough monitoring may be needed.

Measurements shall be documented on a sketch of the area, indicating where each reading was obtained.

Typical area-measurement locations include:

- The hearing zone at the employee's normal work location.
- Adjacent to the noise source(s).
- At the entrance(s) to the work area.
- At other locations within the area where the employee might spend time working.

If area noise levels are below 80 dBA TWA, no further routine monitoring in that area is required. Periodic reviews, however, shall be made to determine if there are any changes that warrant additional area monitoring.

If any area measurements equal or exceed 80 dBA, personal monitoring shall be performed for representative employees who work in or near the high noise area or equipment.

Personal Monitoring

Personal noise measurements are generally obtained after area monitoring identifies noise levels at 80 dBA TWA or higher. Representative employees from these areas shall be monitored for their personal noise exposure.

Personal monitoring shall be performed using a calibrated noise dosimeter. Each monitored employee shall wear the dosimeter with the microphone placed in the employee's hearing zone. The dosimeter shall be worn for the full duration of a normal work shift while the employee performs a normal work routine. As soon as possible after the end of the work shift, the dosimeter shall be removed, and the data it recorded shall be printed.

Each monitored employee shall be required to maintain a detailed description of the work performed and any unusual activities or noises during the monitored work shift.

Monitoring results shall be made available to the employee, and if exposure equals or exceeds 80 dBA TWA, the employee shall participate in the Hearing Conservation Program.

Periodic Monitoring

Representative employees who work for periods of more than 2 consecutive hours in a high noise area, and whose 8-hour TWA equals or exceeds 80 dBA, shall be monitored periodically to determine their personal noise exposure

All areas where noise levels equal or exceed 80 dBA shall be monitored periodically.

Work areas shall be monitored whenever a change in production process, equipment, or controls increases the noise exposure such that additional employees are exposed to noise levels at or above 80 dBA on a time-weighted average basis (TWA).

Areas where noise levels drop below 80 dBA due to changes in equipment, controls or processes shall be eliminated from the monitoring program.

10.5. Hazardous-Noise Controls

Engineering and Administrative Noise Controls

Whenever possible, the engineering staff and project managers shall consider possible engineering controls, implementing them if technologically and economically feasible, and managers and supervisors shall use administrative controls to reduce employees' exposure-time.

Engineering controls include the following:

- Redesigning noisy equipment.
- Isolating noisy equipment in sound-absorbing rooms.
- Using carpet and baffles.
- Using deflectors or barriers of wood or metal panels lined with acoustic material in front of or around noisy machinery.
- Replacing noisy metal parts with plastic or rubber components.
- Eliminating vibration noise by placing heavy equipment on resilient pads.
- Tightening or adjusting large vibrating surfaces such as panels, covers, or guards.
- Regularly lubricating and aligning equipment in order to reduce friction between rotating, sliding or moving parts.
- Running equipment at lower speeds.
- Balancing rotating parts.

Administrative controls include the following:

- Adjusting work schedules to minimize noise exposure.
- Using job rotation to prevent prolonged uninterrupted noise exposure.

Due to the complexity and size of some division equipment, and due to economic and physical limitations, some noise levels cannot currently be reduced below acceptable limits. If engineering and administrative controls cannot reduce the amount of noise exposure to or below the allowed limits, appropriate personal hearing protective devices shall be made available and issued to noise-exposed employees.

Hearing Protection Devices (HPD)

An HPD is any device that can be worn to reduce the level of sound entering the ear. HPDs include insert-type earplugs, which are inserted into the ear and worn exclusively by the owner, and earmuffs.

HPDs shall be worn by all personnel whenever entering an area where operations generate the following noise:

- At or greater than 85 dBA sound level.
- At or greater than 140 dB peak sound pressure level.

Noise-Reduction Rating (NRR) for HPDs

The division hearing conservation objective is to reduce noise at the ear drum to less than 80 dBA TWA, therefore, all hearing protection devices (HPD) purchased by the Division Safety Office shall have the highest possible noise reduction ratio (NRR).

NRRs are derived from ideal laboratory tests, therefore, some caution must be observed in determining HPD effectiveness based on NRR. The real world value may be as little as 50% of the published NRR value.

The recommended method for obtaining an estimate on the level of noise reduction provided by an HPD is to subtract 7 from the NRR (OSHA recommends further reducing the NRR value by a safety factor of 50%), and then subtract the remainder from the TWA dBA the employee is exposed to. The result is the approximate level of noise the worker will be exposed to when wearing that HPD.

When wearing a combination of two types of HPD, such as earplugs and earmuffs (required when noise levels reach 110 dBA), it's misleading to refer to this as "double hearing protection". The total attenuation is not equal to the sum of their individual attenuation values. To estimate the combined value, OSHA recommends reducing the published NRR for the highest rated HPD, as described above, then adding 5 dBA.

HPD sound attenuation is limited by human body and bone conduction mechanisms. Even though an HPD may have high noise attenuation values, the actual noise reduction may be less. This is because noise surrounding the head and body bypasses the hearing protector and is transmitted through tissue and bone pathways to the inner ear.

Selecting Hearing Protective Devices (HPD)

When noise levels are below 110 dBA, employees may select their own HPD from a variety of suitable ones provided by the Division Safety Office, including insert-type earplugs and earmuffs.

When noise levels are 110 dBA or higher, personnel shall select earplugs and earmuffs to wear in combination. Referring to this as “double hearing protection” is misleading, however. For estimating the total attenuation when combining HPDs, refer to the OSHA-recommended method as described above in the section on Noise-Reduction Rating for HPDs.

Insert-Type Earplugs

Insert-type earplugs are HPDs designed to provide an airtight seal within the ear canal. The following are insert-type earplugs:

- **Pre-molded Earplugs**—Pre-molded earplugs are readily available to employees. They are pliable with fixed proportions. Two standard styles—single flange and triple flange—come in various sizes and fit most people. While these earplugs are reusable, they may deteriorate and should be replaced periodically. The Hearing Conservation class provides employees with instruction on proper insertion, wear, and care (e.g., daily cleaning) for pre-molded earplugs.
- **Formable Earplugs**—Formable earplugs are readily available to employees. They come in just one size, and are made of material which, after being compressed and inserted into the ear, expands to form a seal in the ear canal. For proper insertion that provides noise attenuation values similar to those from correctly fitted pre-molded earplugs, each earplug must be held in place while it expands enough to remain firmly seated. Some may be washed and are reusable, but need to be replaced after two or three weeks, or when they no longer form an airtight seal. Supervisors must ensure employees understand how to properly use formable earplugs.
- **Custom-Molded Earplugs**—Custom-molded earplugs are used by a small percentage of the population who cannot be fitted with standard pre-molded or formable earplugs. Custom earplugs can be made to fit the exact size and shape of the individual’s ear canal. Individuals needing custom earplugs shall be referred to an audiologist.

Earmuffs

Earmuffs are devices that cover the ears with cushioned domes. Their effectiveness in reducing the level of noise that reaches the ear depends on an airtight seal between the cushion and the wearer’s head. If noise exposure is relatively frequent or intermittent over long periods, earmuffs are probably the best choice for hearing protection. For noise levels at or above 110 dBA, personnel are required to use earmuffs in combination with earplugs, and may choose to do so even at lower noise levels.

In choosing earmuffs, consider the following:

- When wearing earmuffs near electrical hazards, it is desirable to use nonconductive suspension systems.
- Since ill-fitting earmuffs can cause painful pressure on earlobes, it's important to select earmuffs with sufficiently large domes.
- Stereo headphones are not considered earmuffs or a substitute for HPDs.

Using Hearing Protective Devices (HPD)

Always use and maintain HPDs as originally intended and in accordance with instructions, and inspect them periodically to verify that they continue to provide adequate protection. Use only devices that are intended to protect hearing. Neither cotton nor stereo headphones are acceptable HPD substitutes.

When using earmuffs, anything that compromises the seal between the cushion and circumaural flesh (the flesh around the ear) may degrade hearing-protection performance. For example, earmuff efficiency is reduced when the frames of eye protective devices or long hair interfere with the seal.

Before using earplugs, inspect them to make sure they are in good condition and not deteriorating, just as you would inspect any other personal protective equipment (PPE). Be aware that earplugs tend to work loose as a result of talking or chewing, and they must be re-seated from time to time during the working day.

Be aware that HPD sound attenuation is limited by human body and bone conduction mechanisms. Noise can bypass an HPD and be transmitted through tissue and bone pathways to the inner ear.

In posted areas, wearing hearing protection is mandatory, and shall be enforced by management. Continuing failure to properly wear provided hearing protection could result in termination of employment.

Maintaining Hearing Protective Devices (HPD)

It's important to keep HPDs clean and in good condition. Consider the following for maintaining reusable earplugs and earmuffs:

Reusable Earplugs (e.g. Triple Flange and Formable)

- Wash as needed in lukewarm water with hand soap, rinse in clean water, and dry thoroughly before use.
- Dirty earplugs could cause an ear infection.
- Alcohol and harsh detergents can harden and degrade some earplugs.
- Wet or damp earplugs should not be placed in their containers.

Earmuffs

- Earmuff plastic or foam cushions should be kept clean in the same way as earplugs, but the inside of the cushioned domes should not get wet.
- When not used, earmuffs should be stored where air can circulate to allow any moisture absorbed into the domes to evaporate.
- Human perspiration tends to stiffen earmuff cushions, reducing their ability to form a seal around the ear. For this reason, earmuff cushions require periodic replacement.

10.6. Medical Monitoring

Audiometric Testing Program

The Division Safety Office's Audiometric Testing Program was implemented in order to meet the Hearing Conservation Program goal to preserve employees' hearing. This program includes baseline audiograms at the time of, or soon after, an employee's hire-date, and annual audiograms for all ATOM contract and civil service employees who work in noisy areas at or above 80 dBA TWA.

Employees who participate in the Hearing Conservation Medical Monitoring Program shall receive a final audiometric examination before termination of employment, retirement, or change of job classification with less noise exposure.

Employees shall be instructed to avoid noise for at least 14 hours before taking an audiogram.

Health Clinic and Industrial Audiometric Testing Vans

The Ames Health Clinic is responsible for baseline, annual, and termination (or job change) audiometric exams for civil servants who work near noise at or above 80 dBA, time-weighted average (TWA). The clinic notifies civil servant employees when their annual audio exam is due.

All ATOM contract employees complete their annual audiograms when the Industrial Audiometric Testing Van is scheduled to be on site once per year. If employees miss their annual audiogram when the van is on site, they shall complete it at the contract health clinic. Baseline and termination audiograms shall also be taken at the contract health clinic.

Audiograms are reviewed by an audiologist or physician and compared to the employees' baseline reports. Recommendations are made when indicated, and each employee shall receive his or her report from the Division Safety Office or the Ames Health Unit as soon as it is received from the audiologist review.

All audiometric testing shall conform to the following requirements and criteria described in the Ames Health & Safety Manual, APG 1700.1, and OSHA Standard 29 CFR 1910.95, "Occupational Noise Exposure":

- Qualification requirements for personnel performing and reviewing audiometric testing.
- Calibration requirements for audiometers.
- Specifications for audiometric test equipment, and rooms or booths.
- Audiogram procedures.
- Medical criteria for further testing, referrals, and follow-up.

Audiometric Records

Audiometric records are maintained as described in the Record-Keeping section of this chapter.

Standard Threshold Shift (STS)

An STS is an average 10 dB or more decrease in an employee's hearing sensitivity at 2000, 3000, and 4000 Hz in either ear, relative to the employee's baseline audiogram. Allowances are made for presbycusis (gradual age-related hearing loss) in accordance with the procedure described in OSHA1910.95, Appendix F, "Calculation and Application of Age Correction to Audiograms".

When audiometric testing indicates that an employee exhibits an STS, the following applies:

- The employer shall notify the employee within 21 days after receiving a report indicating that the employee exhibits an STS.
- The employee's workplace shall be reviewed to identify and evaluate any changes in noise level, and to consider whether additional controls may be necessary.
- The Ames Health Unit (for civil servants) or the Safety Office (for ATOM contract employees) shall meet with the employee to explain the STS test results and what STS means, to ensure that the employee's Hearing Conservation Training is up-to-date, and that the employee knows how to correctly wear hearing protection. A repeat audiogram may be recommended at that time.

- Meetings for discussing the STS with the employee shall be documented, and records shall be maintained in the employee's file. Refer to the form Standard Threshold Shift (STS) Review, FO20 for documenting such meetings.
- The employee shall be tested again within 30 days. If the second test does not confirm a STS, then the previously demonstrated hearing change is considered only temporary.

The Office of Safety and Mission Assurance (for civil servants) or the Division Safety Office (for ATOM contract employees) shall make an entry on the OSHA Log to identify any employee who demonstrates a work-related shift in hearing averaging 25 dB or more in either ear at 2000, 3000, and 4000 Hz.

10.7. Training

Employee Training and Education

All new employees and employees with a time-weighted average exposure level of 80 dBA and above shall successfully complete the Hearing Conservation class offered by the Office of Safety and Mission Assurance or the Division Safety Office. Supervisors ensure that all employees exposed to noise shall participate in the Hearing Conservation Program, and shall complete annual Hearing Conservation Training.

The Hearing Conservation class shall include the following minimum topics:

- Noise-induced hearing loss
- Hazardous noise recognition
  - A definition of elevated noise
  - Typical noise levels at work and at home
  - Noise that can cause harm (over 85 dB) and pain (over 140 dB)
- Symptoms of over-exposure to hazardous noise
- Advantages and limitations of hearing protection devices (HPD)
- HPD selection, fit, and use
- Noise-measurement procedures
- Audiometric testing procedures and purpose
- Hearing Conservation Program requirements

By posting signs in areas where hearing protection devices are required, by posting educational materials at appropriate locations, and by publishing articles in the EHS Newsletter "Safety Lines," management shall regularly remind employees of the necessity for preserving hearing.

Because hearing loss can occur from many causes other than industrial noise exposure, all employees can benefit from hearing conservation education. Employees who are not exposed to high noise levels are also encouraged to participate in Hearing Conservation Training.

10.8. Records

Training Records

Training databases, including a division database that's maintained by the Division Safety Office, and an ARC database, provide tracking to assist management in scheduling Hearing Conservation Training for employees. The Division Safety Office also offers assistance in tracking Hearing Conservation Training.

Personal Monitoring Records

The Ames Health Unit (for civil servants) or the Division Safety Office (for ATOM contract employees) shall maintain personal monitoring records for 30 years beyond the duration of each affected employee's employment.

Area-Monitoring Records

Area-monitoring records for employees' work areas shall be maintained for 30 years beyond the duration of each affected employee's employment.

The Division Safety Office and Ames Safety Environment and Mission Assurance (SEMA) shall maintain records to document the results of all area monitoring.

If area measurements equal or exceed 80 dBA TWA, these records shall provide the following:

- The measurements
- A sketch identifying the locations where measurements were taken
- The noise sources

Audiometric Records

Audiometric records shall be maintained for 30 years beyond the duration of each affected employee's employment.

The Ames Health Unit retains results in employees' medical files of audiograms they perform.

The Division Safety Office retains results of audiograms performed by the contract industrial audio testing van, and by the contract health clinic.

All employee medical records are confidential and are maintained, transferred, and made available in accordance to NASA Ames policies and OSHA 29CFR 1910. 20: Access to Employee Exposure and Medical Records.

10.9. Definitions

A-Weighted Decibel (dBA)	A sound level reading in decibels made on the A-weighting network of a sound-level meter or dosimeter set at slow response. A-weight more closely typifies the human ear response to sound.
Action Level (AL)	An OSHA-published 8-hour time-weighted average of 85 dBA measured on the A-scale at a slow-response setting; or a 50% dose of the permissible exposure limit (PEL). The ARC AL is 80 dBA and is more conservative than OSHA's.
Audiogram	A chart, table, or graph showing an individual's hearing threshold level, in decibels, as a function of frequency.
Audiologist	A professional, specializing in the study of hearing, who is certified by the American Speech, Hearing, and Language Association and licensed by a state board of examiners.
Audiometer	An instrument for measuring the threshold or sensitivity of hearing.
Audiometry	The measurement of hearing.
Background Noise	The total of all noise in a situation, independent of the presence of the sound being measured.
Baseline Audiogram	An audiogram obtained from testing after a 14-hour period of quiet. This is the audiogram against which future audiograms are compared.
Bone Conduction	The process by which sound is transmitted to the inner ear through the bones of the skull.
Decibel	A unit for measuring the loudness of sound or sound-pressure level. The decibel level of a sound is related to the logarithm of the ratio of sound pressure to a reference pressure. The dB has meaning only when the reference pressure is known. The internationally accepted reference pressure used in acoustics is 20 micropascals.
Dose	The cumulative sum of discrete sound pressure levels workers are exposed to over a sample period, expressed as a percentage of the permissible exposure limit (PEL). A 100% dose is equal to the PEL, and a 50% dose is equal to the action level (AL).

Dosimeter	An instrument that registers occurrence and cumulative duration of noise exceeding a level at a chosen point in the environment or on a person. Results are reported in a time-weighted average (TWA) over 8 hours and the percent of the permissible dose. Also called a noise dosimeter.
Ear Protection	A device inserted into or placed over the ear in order to weaken air-conducted sounds.
Earmuff	A type of ear protector that encloses the entire outer ear.
Earplug	A type of ear protector that is inserted into the ear.
Frequency	The rate at which pressure oscillations are produced. One hertz is equivalent to one cycle per second. A subjective characteristic of sound related to frequency is pitch.
Hearing Conservation	Measures to reduce the risk of noise-induced hearing loss.
Hearing Loss	Impairment of auditory sensitivity.
Hearing Threshold Level	The amount in decibels by which an ear's threshold of hearing exceeds a standard audiometric reference zero.
Hertz	A unit of frequency that equals one cycle per second. An audiogram measures hearing sensitivity at 500, 1000, 2000, 4000, 6000, and sometimes 8000 hertz.
Noise	Disturbing, harmful, or unwanted sound.
Noise Reduction Rating (NRR)	Manufacturers of hearing protection assign an NRR to each type of hearing protector. NRR indicates the relative level of protection provided by the earplug or earmuff. The higher the NRR, the more protection the equipment provides.
Occupational Hearing Loss	A permanent hearing loss sustained in the course of an occupation or employment.
Permanent Hearing Loss	Hearing loss deemed to be irrecoverable.
Permanent Threshold Shift	A threshold shift that shows no progressive reduction after the presumed cause is removed.
Permissible Exposure Limit (PEL)	The OSHA-published noise-exposure equivalent to an 8-hour, time weighted average (TWA) of 90 dBA. The Ames PEL is set at 85 dBA TWA.

Representative Exposure	Measurements of the noise to which an employee, deemed representative of the employees in a particular workplace, is exposed, or an 8-hour time-weighted, average sound level that an employer deems representative of noise exposure in that workplace.
Reportable (Recordable) Hearing Loss	An average decrease in either ear, relative to an employee's baseline audiogram, of 25 dB or more at 2000, 30000, and 4000 Hz. Such hearing loss is to be recorded on the OSHA 200 Log. After January 1st, 2002, reportable hearing loss will be any standard threshold shift (STS), and such hearing loss is to be recorded on the OSHA 300 Log.
Revised Baseline Audiogram	An annual audiogram designated to be utilized in lieu of an employee's original baseline audiogram in measuring changes in hearing sensitivity. The baseline audiogram is revised when a reportable threshold shift has taken place.
Standard Threshold Shift	An average decrease in either ear, relative to an employee's baseline audiogram, of 10 dB or more at 2000, 30000, and 4000 Hz.
Temporary Threshold Shift	That component of threshold shift which shows a progressive reduction with the passage of time after the apparent cause has been removed.
Threshold Shift	An elevation of the threshold of hearing for an ear.
Time-Weighted Average (TWA) Sound Level	A measured sound level, which if constant over an 8-hour exposure, would result in the same noise dose as is measured. TWA is a measure of total noise exposure that takes into account the variations in sound level at different times of day and for different periods of time. The TWA essentially adds up all the noise exposure over the 8-hour period and averages it out.

10.10. References

Ames and Division Documents	Ames Health & Safety Manual, APG 1700.1
Forms	Standard Threshold Shift (STS) Review, FO20

External Documents	OSHA Standard 29 CFR 1910.95: Occupational Noise Exposure
	OSHA Standard 29 CFR 1904.10: Recording Criteria for Cases Involving Occupational Hearing Loss
	OSHA Standard 29CFR 1910.1020: Access to Employee Exposure and Medical Records
	American Conference of Governmental Industrial Hygienists (ACGIH), 2000 TLVs® and BEIs®, Threshold Limit Values for Chemical Substances and Physical Agents

End of Chapter

11. Safe Plan of Action (SPA)

11.1. Description

Purpose

Wind Tunnel Operations Division policy is that all assigned work be evaluated to identify associated hazards, and that these hazards be effectively eliminated or controlled. This chapter establishes the requirements and processes for developing written Safe Plans of Action (SPA) and conducting Task Safety Awareness (TSA) meetings as one method for implementing this policy.

Scope

This chapter applies to all employees, temporary workers, and support contractor personnel who are under the authority of the Wind Tunnel Operations Division, including sub-contractors when they are performing a Division task in cooperation with Division personnel.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

General

An SPA is a written safety plan, oriented towards a specific work task, and developed by the team members assigned to perform that task. Its purpose is to identify and document potential hazards and hazard control methods.

TSA meetings are for reviewing SPAs and familiarizing the task team daily with the hazards and controls associated with a task, briefing new members of the task team, and addressing new hazards occurring after the original SPA was written.

11.2. Responsibilities

Managers

Managers' responsibilities include the following:

- Ensure the requirements described in this chapter are met.
- Provide employees with required SPA and TSA training.
- Provide employees with training and equipment to accomplish their tasks safely.

Supervisors

Supervisors' responsibilities include the following:

- Ensure that personnel are aware of the requirements of this chapter.
- Ensure that personnel are trained in the SPA and TSA processes.
- Identify the work area and task to be performed, and identify these on an SPA.
- Ascertain training requirements for specific tasks.
- Assign only appropriately trained employees to the task.
- Provide task team members with safety information specific to the job site, such as other work in progress.
- Encourage personnel to use the SPA and TSA processes in accordance with this chapter.
- Solicit task team participation in identifying hazards and hazard control measures, including personal protective equipment (PPE), required permits, and procedures.
- Maintain records of SPAs completed for their areas of responsibility.

Employees

Employees' responsibilities include the following:

- Learn, understand, and apply the contents of this chapter.
- Participate with the entire task team in identifying hazards and hazard control measures, such as PPE, procedures, training, permits, and any other equipment required to mitigate hazards.
- Sign any SPA developed for an assigned task, indicating participation in developing the plan, understanding of the plan, and agreement to follow the plan.
- Advise the supervisor and task team members of any changes in the task or environment that introduce new hazards or render existing hazard controls ineffective.
- Participate in TSA meetings before beginning a task, each day before continuing a task, whenever there is a change in existing or potential hazards, and whenever a new team member is assigned to a task.

Division Safety Office

Division Safety Office responsibilities include the following:

- Review this chapter and ensure it is updated as necessary.
- Assist supervisors in providing personnel with SPA and TSA training.
- Assist supervisors in providing personnel with training in recognizing hazards.
- Assist supervisors in identifying, controlling, or eliminating hazards when requested.

- Assist supervisors in identifying selecting, and procuring PPE.
- Assist supervisors in training personnel on how to properly use PPE and other safety equipment.

11.3. Requirements

Safe Plan of Action (SPA) Form, FO13

Safe Plan of Action (SPA), FO13, is the form that supervisors and team members use to document an SPA.

A completed SPA form serves as a reference for safely planning a task, and as the basis for Task Safety Awareness (TSA) meetings.

When to Develop an SPA

Whether or not an SPA is required, all tasks shall be evaluated before performing them. Individuals and task teams shall conduct a work area survey and a task composition review to identify existing and potential hazards, and to determine appropriate hazard elimination and control methods.

An SPA is required before performing a task if one or more of the following criteria apply:

- An Ames Research Center permit is required, such as a permit for hot work or confined-space entry.
- Special safety protection is required, such as fall-protection equipment.
- This or similar tasks resulted in past injury, illness, or a close call.
- Multiple organizations or different groups of employees are required to perform the task.
- The task is technically detailed or complex.
- The task is unique or non-recurring.
- The task involves a lead change.
- The task extends over more than one shift.
- The task takes four hours or more to complete.

SPA Development Process

The supervisor and team members assigned to perform a task that requires an SPA shall complete a Safe Plan of Action (SPA), FO13, in accordance with the following steps:

Completing an SPA

Step	Action
1	The supervisor shall identify the work area and task to be performed, including any special or unique conditions.
2	The supervisor (or lead) and team members shall determine if an SPA is required for performing the task. (Use the criteria in the section When to Develop an SPA.)
3	If an SPA is required, the supervisor (or lead) and team members shall survey the work area and review the task to identify existing and potential hazards.
4	The supervisor (or lead) and team members shall record all identified existing and potential hazards on the SPA form.
5	The supervisor (or lead) and team members shall determine and record a safe plan on the SPA form for controlling or eliminating the identified existing and potential hazards.
6	The supervisor (or lead) and team members shall each sign the SPA to indicate their participation in developing the plan, that they understand it, and that they agree to follow it.
7	The task team shall post the SPA at the job site for the duration of the task.
8	The supervisor (or lead) and team members shall update the SPA whenever one or more of the following occurs: • There are changes in the task or environment that introduce new hazards or render existing hazard controls ineffective. • A new person is assigned to the task team.
9	Upon completing the task, the supervisor shall file the SPA for future reference.

When to Conduct TSA Meetings

The supervisor (or lead) and team members shall conduct brief, two to five minute-long TSA meetings as follows:

- At the beginning of each shift before continuing a task.
- Whenever there is a change in existing or potential hazards associated with a task.
- Whenever a new person is assigned to a task team.

Hazard Changes

Whenever there are changes in existing or potential hazards associated with a task, a TSA meeting shall be held, and the changes and measures for controlling or eliminating the hazards shall be documented on the SPA.

New Task Team Members

When new members are assigned to a task team, a TSA meeting shall be held in order to review the SPA with the new members. Following the review, new members shall sign the SPA.

11.4. Training

General

Management shall ensure that Division personnel shall receive training on the SPA and TSA processes as follows:

- All Division personnel shall receive initial training.
- Division personnel shall receive additional training when there are significant SPA or TSA process changes.
- Division personnel shall receive refresher training upon demonstrating an inadequate understanding of the SPA or TSA processes.

11.5. Records

General

SPA and TSA records shall be maintained as follows:

- Supervisors shall retain completed SPAs in their records.
- The Division Safety Office shall maintain SPA and TSA training records.

11.6. References

Forms

Safe Plan of Action (SPA), FO13

End of Chapter

12. Lifts and Cranes

12.1 Description

Purpose

This chapter describes the procedures, certification requirements, and personnel training required for implementing Division policy to safely perform lifts.

Scope

This chapter applies to Division civil servants, support contractor personnel, and subcontractor personnel who perform lifts with Division overhead cranes. Only requirements associated with lifts that are within crane and rigging rated capacity are addressed.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

General Information

All lifts using overhead cranes must be done in a safe manner. The precautions to be taken, and the level of review depend on how the lift is classified. This chapter defines lift classifications of engineered, critical, and normal lifts, and describes the measures Division personnel and contractors are to take to ensure that all lifts can be accomplished safely.

12.2 Responsibilities

Managers

Managers' responsibilities include the following:

- Ensure implementation of and compliance with the contents of this chapter and associated procedures.
- Ensure that the equipment required for lift and crane operations is available.
- Ensure that employees and supervisors are trained in using and maintaining equipment for critical lifts before performing the lift.

Test Engineers or Project Engineers

The responsibilities of test engineers or project engineers who request that a lift be performed, include the following:

- Classify the lift as engineered, critical, or normal, based on the criteria detailed in this chapter.
- For a critical lift, prepare a critical lift plan.
- For a normal lift, prepare a Safe Plan of Action (SPA) for Normal Lifts, FO21.

Supervisors or Site Leaders

The responsibilities of supervisors or site leaders include the following:

- Review lift plans, either a critical lift plan or a SPA for normal lifts, and ensure that they are completed, approved, and reviewed before the lift is performed. Refer to Lift Plans (Critical Lift Plan and SPAs for Normal Lifts) in this chapter.
- Verify that rigging and lifting equipment is in good working order, appropriate for the application, and is properly certified.
- Ensure that personnel involved in lifts are trained and certified for their assigned tasks during a lift.

Facility Engineers

Facility engineers' responsibilities include the following:

- Ensure overhead cranes for critical lifts are certified.
- Ensure that overhead cranes for normal lifts are inspected as required.
- Ensure that crane load-testing is performed as required.
- Ensure that special rigging and lifting fixtures are built and inspected.
- Ensure that rigging rated-load tests are performed.

Crane Operators and Riggers

Crane operators and riggers' responsibilities include the following:

- Perform their work in accordance with the requirements of this chapter and all other applicable NASA and regulatory requirements for lifts.
- Inspect rigging and lifting equipment prior to each lift to ensure equipment is in good working order, appropriate for the application, and is properly certified.

FO Division Safety Office

Division Safety Office responsibilities include the following:

- Provide consultation, hazard analyses, and information essential to protect employees involved in critical lift operations.
- Refer to regulations for assisting management and supervisors in making appropriate decisions about critical lifts.
- Review critical lift plans, and ensure that they are completed, approved, and reviewed by all team members before the lift is performed. Refer to Lift Plans (Critical Lift Plan and SPAs for Normal Lifts) in this chapter.
- Assist in personnel training on specific hazards and specific procedures required for a given critical lift.

Division Certified Instructors

Division certified instructors' responsibilities include the following:

- Provide training to crane operators and riggers in safe crane operation for any type of lift as defined in this chapter.

12.3 Rights

Requesting a Lift Review

In all cases, lifts must be performed in a safe manner. Any person involved in a lift may stop the lifting operation and request that management perform a lift review, or that additional measures be taken to ensure that the lift can be done safely.

12.4 Types of Lifts

Lift Categories

Lift requirements depend on the type of lift to be performed. A lift can be engineered, critical, or normal. These lift classifications are defined in the following sections.

Classifying Lifts Flowchart

The following flowchart outlines the steps for classifying a lift:

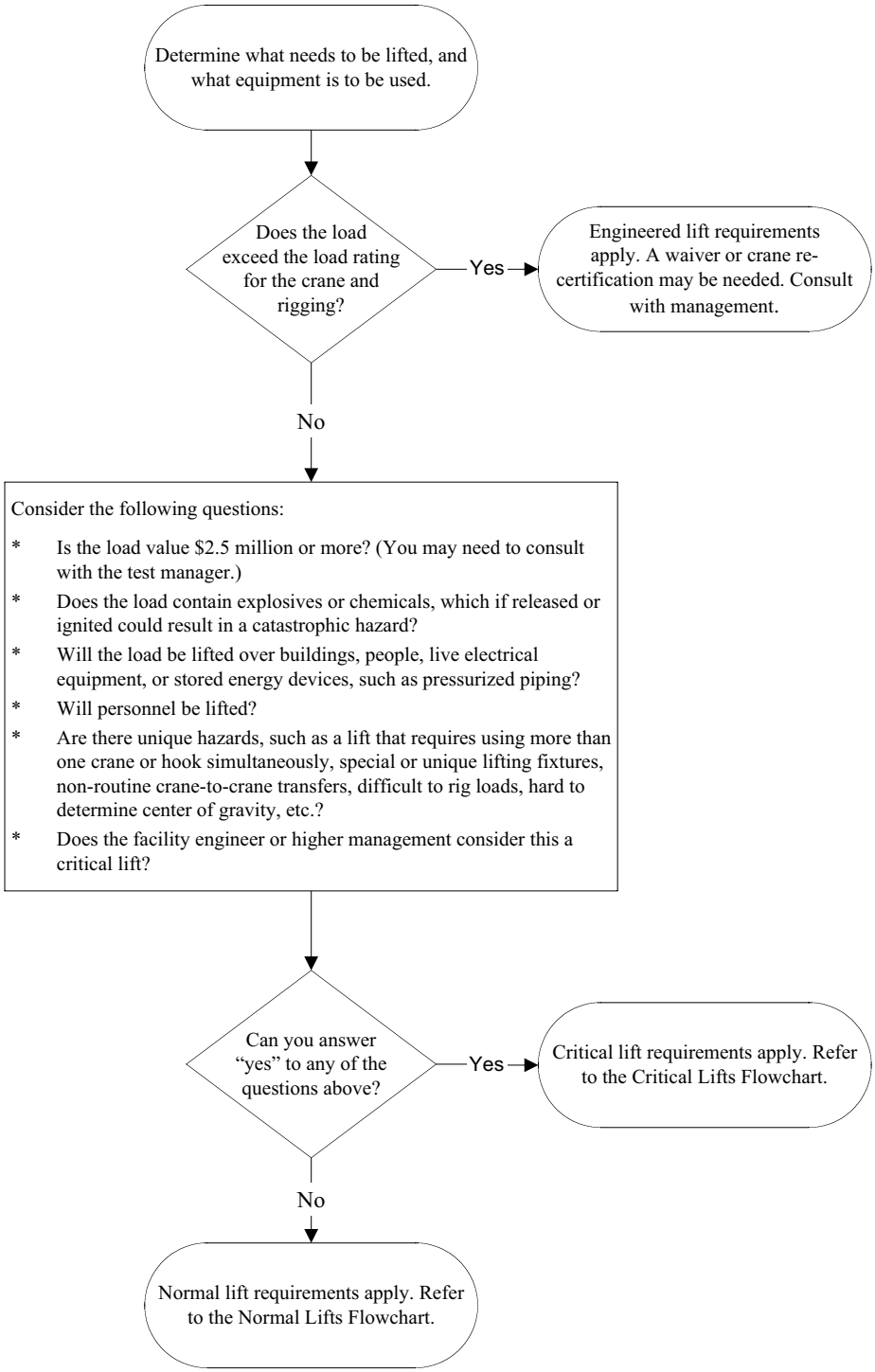


Figure 12.1: Classifying Lifts Flowchart

Engineered Lifts

Engineered lifts involve loads that exceed the rated load of the crane or rigging. These lifts may require waivers or that the crane be rated again before performing the lift. These procedures are beyond the scope of this chapter and require engineering evaluation and Division approval. Consult with Division management regarding engineered lifts.

Critical Lifts

Critical lifts have the potential of causing loss of life, severe injury, or major property damage.

In addition to normal training, examination, licensing, and renewal requirements, operators who perform critical lifts must be trained in the specific procedures associated with critical lifts. For more information, refer to the Training section in this chapter.

Extensive requirements must be met to certify a crane for critical lifts and for individual critical lifts to be performed. For more information, refer to Critical Lift Requirements in this chapter.

The FO Division classifies a lift as critical if any of the following criteria apply:

- There is a monetary value of $2.5 million or more. If the value is unknown, consult with the test manager.
- The lift involves explosives or chemicals that if ignited or released could result in a catastrophic hazard.
- The lift must be performed over buildings or people, or over live electrical equipment or stored energy devices, such as pressurized piping.
- The lift requires lifting personnel.
- The lift involves unique hazards, such as requiring more than one simultaneous crane or hook, special or unique lifting fixtures, a non-routine crane-to-crane transfer, or involves a load with a geometrical shape that is hard to rig, or for which it is hard to determine the center of gravity (CG), etc.
- The facility manager or higher management considers the lift critical.

Normal Lifts

If a lift is not a critical lift, and if the article to be lifted weighs less than the crane's rated load, then the lift is normal.

A normal lift typically involves routine, minimal-hazard lifting operations. Normal lifts are governed by standard industry rules and practices, except as supplemented with unique NASA testing, operations, maintenance, inspection, and personnel licensing requirements, as described in this chapter. For more information, refer to Normal Lift Requirements and Training sections in this chapter.

If the calculated combined weight of the article being lifted, and the rigging for lifting it, exceeds 85% of the crane's rated load, a load cell must be used to determine the weight of the actual load.

12.5 Critical Lift Requirements

Requirement Categories

This section describes the requirements for performing critical lifts. It includes a flowchart, detailed descriptions, and a checklist.

Critical lift requirements are divided into the following categories which also correspond with the three different paths on the flowchart:

- Crane and Rigging
  (A facility engineer responsibility.)
- Documentation and Critical Lift Plan
  (A test manager or project engineer responsibility.)
- Personnel Training and Certification
  (A site leader responsibility.)

Critical Lifts Flowchart

Critical lift requirements are outlined in the following flowchart. Each of the three paths must be completed before performing a critical lift.

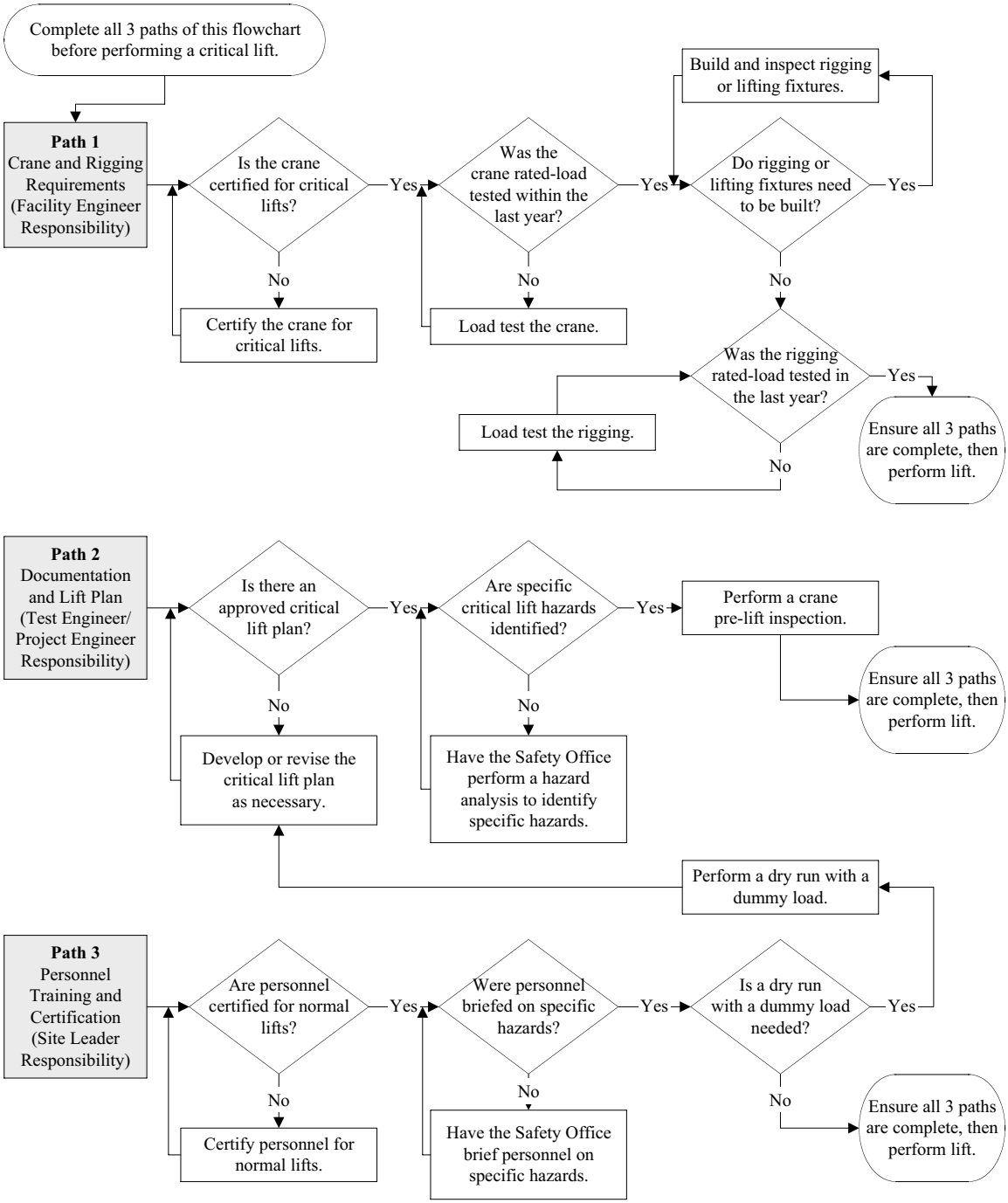


Figure 12.2: Critical Lifts Flowchart

Critical Lift Crane and Rigging

This section includes the following crane and rigging requirements which are the responsibility of the facility engineer:

- Certification for Overhead Cranes
- Crane Load-Testing
- Special Rigging and Lifting Fixtures
- Rigging Rated-Load Test

Certification for Overhead Cranes

The following cranes are certified for critical lifts:

- NFAC 40x80 35 ton and 5 ton cranes
- NFAC 80x120 70 ton and 10 ton cranes
- N246 25 ton crane
- N227D 10 ton crane

The following cranes are **not** certified for critical lifts:

- Unitary Plan 11 x 11 ft five-ton crane
- Unitary Plan 9 x 7 ft five-tone crane
- 12 ft Pressure Wind Tunnel cranes

A copy of the crane certification should be kept near the crane controls, with the original on file with the site leader.

Detailed requirements on design, testing, inspection, and maintenance of overhead cranes used for critical lifts are described in the Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9B, Chapter 2. The specific requirements that apply to critical lifts performed with Division cranes, and the paragraphs where these requirements may be found, are the following:

- A hazard analysis shall be performed on all cranes used for critical lifts. Refer to paragraph 201.c.
- Each hoisting unit shall have at least two means of braking: a holding brake and a control brake. Worm gears shall not be used as a means of braking unless the lead angle is sufficient to prevent back driving. Refer to paragraphs 201.f(2)(f) and 201.f(2)(g).
- The electrical system will have a fail-safe design to ensure that if any component fails, it will not cause the crane to operate in a speed range faster than commanded. Refer to paragraph 201.g(6).
- An assessment for remote emergency stops independent from the operator controlled emergency stop shall be performed. Refer to paragraph 201.g(8).

- Dual upper limit switches are required. Refer to paragraph 201.g(9).
- Lower limit switches are required to prevent reverse winding of the wire rope. Refer to paragraph 201.g(10).

Crane Load-Testing

Ensure that the crane was subjected to a rated-load test within the last year.

If a rated-load test report has not been done within a year of the planned lift, arrange for a crane load test to be performed.

Special Rigging and Lifting Fixtures

If special rigging or lifting fixtures need to be built, review rigging and fixture designs in accordance with Division design review processes.

After special rigging or lifting fixtures are built and inspected, the as-built design drawings and inspection records are to be attached to the Change Request (CR) Form, CR-1, and submitted to Configuration Management (CM) for filing.

Rigging Rated-Load Test

For slings and other rigging, annual rated-load tests, or a rated-load test just prior to performing the critical lift, is required. Refer to the Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9B (Paragraph 802b).

The date of the last rigging load test should be recorded on a tag attached to the rigging. If the rigging has not been certified within one year of the planned lift, arrange to perform a rigging load test.

Critical Lift Documentation and Critical Lift Plan

All critical lift documentation and records are to be attached to the Change Request (CR) Form, CR-1, that identifies all information associated with this particular lift. The CR Form and attached documents are to be submitted to Configuration Management (CM) for filing.

This section includes the following documentation and critical lift plan requirements which are the responsibility of the test engineer or project engineer:

- Critical Lift Plan
- Hazard Analysis
- Crane Pre-Lift Inspection

Critical Lift Plan

Write a critical lift plan for the lift. Ensure that the critical lift plan is reviewed and approved in accordance with the Division design review processes, then attached to the CR.

Hazard Analysis

Division Safety Office personnel is to perform a hazard analysis to identify critical lift-specific hazards. The completed hazard analysis is to be submitted to CM for filing.

Crane Pre-Lift Inspection

The site leader ensures that a crane pre-lift inspection is performed, and maintains completed inspection documentation.

Critical Lift Personnel Training and Certification

This section includes the following personnel training and certification requirements which are the responsibility of the site leader:

- Personnel Certification
- Personnel Briefing
- Dry Run with Dummy Load

Personnel Certification

The crane operator and rigger(s) involved in the critical lift should have a current Crane Class Training Card. If not, they must be certified to perform normal lifts before proceeding.

Hazard analysis documentation is to be completed by the Safety Office and attached to the Change Request (CR) Form, CR-1, and submitted to Configuration Management (CM) for filing.

Personnel Briefing

After the hazard analysis is developed, the Division Safety Office personnel are to brief the lift personnel on the identified hazards.

Dry Runs

If a dry run with a dummy load needs to be performed, perform the dry run. Update the critical lift plan and the hazard analysis based on this experience.

Critical Lift Requirements Checklist

The following is a critical lift requirements checklist. Ensure that the checklist is complete before performing the lift.

Critical Lift Requirements Checklist

Step	Action	√
1.	Ensure that the crane is certified for critical lifts.	
2.	Ensure that the crane was subjected to a rated-load test within the last year.	
3.	If necessary, ensure that any special rigging or lifting fixtures are built.	
4.	Ensure that the rigging was subjected to a rated-load test within the last year.	
5.	Ensure that a critical lift plan is developed.	
6.	Ensure that specific critical lift hazards are identified.	
7.	Ensure that the pre-lift inspection of the crane and rigging are complete.	
8.	Ensure that the crane operator and riggers have current crane class training cards, and are certified for normal lifts.	
9.	Ensure that Division Safety Office personnel brief the lift personnel in the specific critical lift hazards identified by the hazard analysis.	
10.	If necessary, perform a dry run with a dummy load, and update the critical lift plan and hazard analysis as appropriate.	

12.6 Normal Lift Requirements

Requirement Categories

This section describes the requirements for performing normal lifts. It includes a flowchart, detailed descriptions, and a checklist.

Normal lift requirements are divided into the following categories which also correspond with the three different paths on the flowchart:

- Crane and Rigging
  (A facility engineer responsibility.)
- Documentation and SPA
  (A shift engineer responsibility.)
- Personnel Training and Certification
  (A site leader responsibility.)

Normal Lifts Flowchart

Normal lift requirements are outlined in the following flowchart. Each of the three paths must be completed before performing a normal lift.

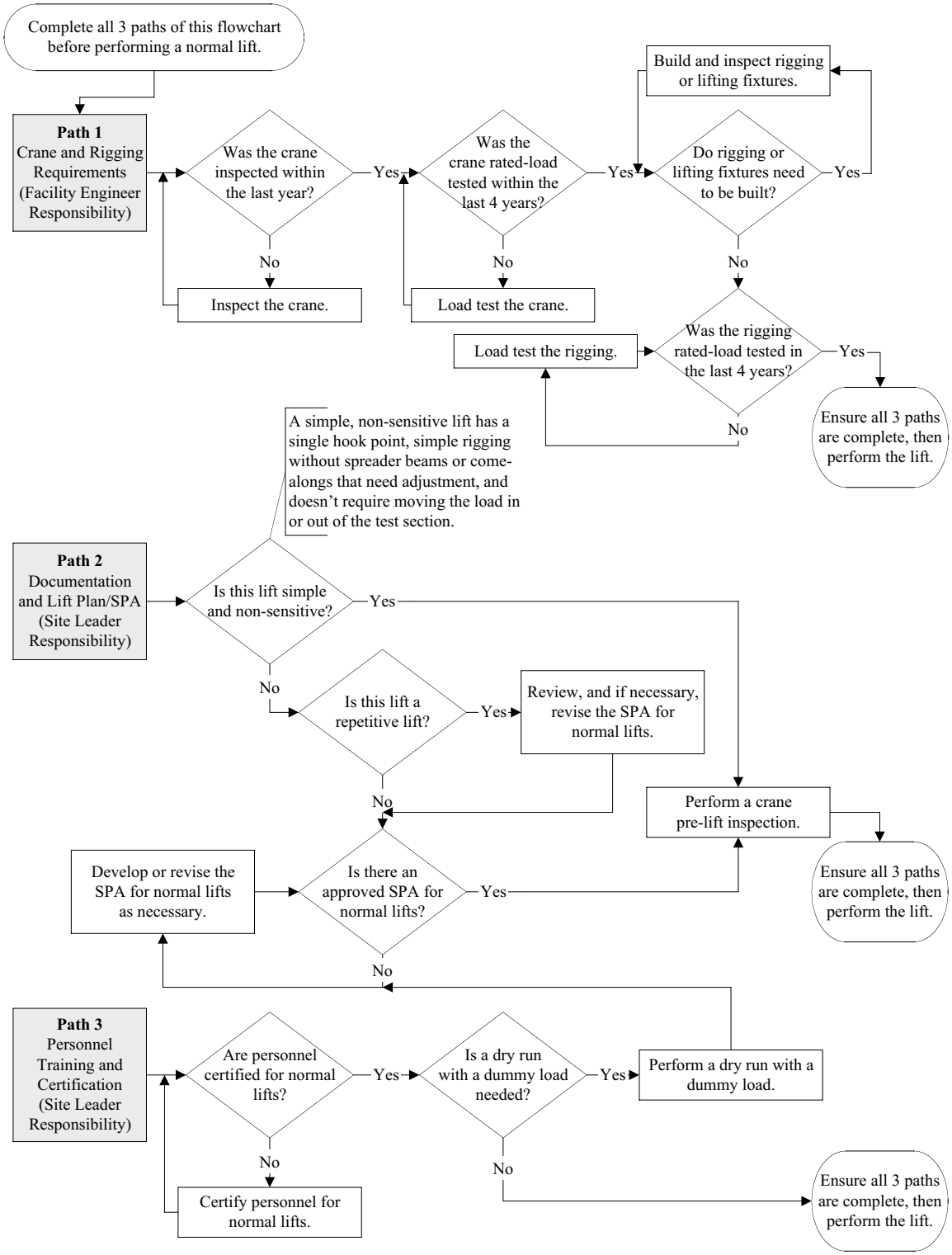


Figure 12.3: Normal Lifts Flowchart

Normal Lift Crane and Rigging

This section includes the following crane and rigging requirements which are the responsibility of the facility engineer:

- Overhead Crane Inspection
- Crane Load-Testing
- Special Rigging and Lifting Fixtures
- Rigging Rated-Load Test

Overhead Crane Inspection

If the crane has not been certified within a year of the planned lift, arrange for a crane load test to be performed.

Crane Load-Testing

Ensure that the crane was subjected to a rated-load test within the last four years.

If a rated-load test report has not been done within 4 years of the planned lift, arrange for a crane load test to be performed.

Special Rigging and Lifting Fixtures

If special rigging or lifting fixtures need to be built, review rigging and fixture designs in accordance with Division design review processes.

After special rigging or lifting fixtures are built and inspected, the as-built design drawings and inspection records are to be attached to the Change Request (CR) Form, CR-1, and submitted to Configuration Management (CM) for filing.

Rigging Rated-Load Test

The date of the last rigging load test should be recorded on a tag attached to the rigging. If the rigging has not been certified within the last four years, arrange to perform a rigging load test.

Normal Lift Documentation and Lift Plan/SPA

This section includes the following documentation and SPA requirements which are the responsibility of the site leader:

- Simple Non-Sensitive Lifts
- Repetitive Lifts
- Lift Plan/SPA
- Crane Pre-Lift Inspection

Simple Non-Sensitive Lifts

Lift plan and SPA documentation are not required for simple, non-sensitive lifts.

A simple, non-sensitive lift has a single hook point, simple rigging without spreader beams or come-alongs that need adjustment, and doesn't require moving the load in or out of the test section.

Repetitive Lifts

If this lift has been done before, then a SPA for normal lifts should already exist. Review the existing SPA, and if necessary, revise it.

Lift Plan/SPA

For all normal lifts that are not simple and non-sensitive, the test engineer or the project engineer is to ensure that an approved Safe Plan of Action (SPA) for Normal Lifts, FO21, is completed before performing the lift.

SPA documentation is maintained by the site leader.

If there is no completed and approved SPA for normal lifts, prepare one. Ensure that the SPA is reviewed and approved by all team members in accordance with the Division design review processes.

For details on how to prepare a SPA, refer to Lift Plans (Critical Lift Plans and SPAs for Normal Lifts) in this chapter.

Crane Pre-Lift Inspection

The site leader ensures that a crane pre-lift inspection is performed, and maintains completed inspection documentation.

Normal Lift Personnel Training and Certification

This section includes the following personnel training and certification requirements which are the responsibility of the site leader:

- Personnel Certification
- Dry Run with Dummy Load

Personnel Certification

The crane operator and rigger(s) involved in a normal lift should have a current Crane Class Training Card. If not, they must be certified to perform normal lifts before proceeding.

Dry Runs

If a dry run with a dummy load needs to be performed, perform the dry run. Update the existing SPA based on this experience.

Normal Lift Requirements Checklist

The following is a normal lift requirements checklist. Ensure that the checklist is complete before performing the lift.

Normal Lift Requirements Checklist

Step	Action	√
1	Ensure that the crane was inspected within the last year.	
2	Ensure that the crane was certified and rated-load tested within the last four years for normal lifts.	
3	If necessary, ensure that any special rigging or lifting fixtures are built.	
4	Ensure that the rigging was subjected to a rated-load test within the last four years.	
5	Determine if this lift is this a simple, non-sensitive lift, with only a single hook point that requires no spreader beams or a come-along to adjust it. Do the following: • If this is a simple, non-sensitive lift, perform a crane pre-lift inspection. • If this is not a simple, non-sensitive lift, prepare a SPA, ensure that it's reviewed and approved, and provide it to the site leader to keep on file.	

Normal Lift Requirements Checklist

Step	Action	√
6	Determine if this is a repetitive lift. • If this is a repetitive lift, review, and if necessary, revise the existing SPA. • If this is not a repetitive lift, prepare a SPA, ensure that it's reviewed and approved by all team members, and provide it to the site leader to keep on file.	
7	Ensure that the pre-lift inspection of the crane and rigging are complete.	
8	Ensure that the crane operator and riggers have current crane class training cards, and are certified for normal lifts.	
9	If necessary, perform a dry run with a dummy load, and update the SPA as appropriate.	

12.7 Lift Plans (Critical Lift Plans and SPAs for Normal Lifts)

Critical Lift Plans

A critical lift plan is intended to help ensure that all safety considerations in performing a critical lift are observed. There is no specific form for preparing a critical lift plan, however, this section provides critical lift plan requirements that are in accordance with the Ames Health and Safety Manual, APG 1700.1.

A critical lift plan should include all information relevant to performing a specific critical lift safely, including the following:

- The names of the qualified lift operator and riggers.
- The date and time the lift is to be performed.
- The crane type and capacity, and a copy of the latest daily crane inspection.
- A list of serial numbers and certification expiration dates for all lift equipment, including slings, shackles, spreader bars, come-alongs, etc.
- A description of the load, including how many built-in lift points there are.
- A copy of the engineer's free body diagram.
- Special rigging procedures, including sketches that indicate how rigging is to be done.

- Details about any special conditions or restrictions, such as the wind speed restriction of 15 mph or less for using the crane pad at the 80 x 120 ft wind tunnel.
- Instructions for inspecting all lifting devices prior to performing the lift.
- Instructions for ensuring the load path is clear.

Critical Lift Plan Signature Requirements

At a minimum, a critical lift plan is to be reviewed and signed by the critical lift plan originator, the facility engineer, the Safety Office, and the crane operators and riggers involved in the lift.

SPA for Normal Lifts

A Safe Plan of Action (SPA) for Normal Lifts, FO21, should be completed and signed by the team members performing the normal lift. Its purpose is to help ensure that all safety considerations in performing a normal lift are observed. This form was developed in accordance with the Ames Health and Safety Manual, APG 1700.1.

12.8 Training

Requirements for personnel training and certification are described in NSS/GO-1740.9B, Safety Standard for Lifting Devices and Equipment.

12.9 Records

Critical Lift-Specific Documents

While the lift is being performed, critical lift-specific documents are to be available from the person directing the lift. Once completed, they should be kept on file with the Division Safety Office. These documents include the following:

- Critical Lift Plan
- Hazard Analysis

Critical Lift Crane and Rigging Certification Documents

The responsible facility engineer shall maintain files for the following certification documentation for cranes and rigging used for critical lifts:

- Crane hazard analysis records for critical lifts, required by NSS/GO-1740.9B, Safety Standard for Lifting Devices and Equipment, paragraph 201.c.
- Crane certification records for critical lifts, such as operational test results for the two means of hoist braking, and annual rated-load test documentation.
- Sling and rigging certification records for critical lifts, such as annual rated-load test documentation.

Crane Operator and Rigger Certification Documents

The responsible facility site leader shall maintain originals, and the Division Safety Office shall maintain copies, of the following operator and rigger certification documents:

- Crane operator and rigger training records
- Critical lift training records

12.10 Definitions

The following definitions are taken from NSS/GO-1740.9B, Safety Standard for Lifting Devices and Equipment.

Crane	A machine for lifting and lowering a load and moving it horizontally, with the hoisting mechanism an integral part of the machine.
Load	The actual object being raised or moved, plus all rigging.
Rated Load	Or safe working load or rated capacity—An assigned weight that is the maximum load the device or equipment shall operationally handle and maintain. This value is marked on the device indicating maximum working capacity. This is also the load referred to as “safe working load.” If the device has never been down-rated or up-rated, this also is the “manufacturer’s rated load.”
Rated-Load Test	A load test performed at predetermined intervals with a load equal to the rated load.
Sling	A lifting assembly and associated hardware used between the load and hoisting device hook.

12.11 References

Ames and Division Document	Ames Health and Safety Manual, APG 1700.1
Forms	Change Request Form, CR-1 Safe Plan of Action (SPA) for Normal Lifts, FO21
External Document	Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9B

End of Chapter

13. Working Alone

13.1 Description

Purpose

Wind Tunnel Operations Division policy is to ensure the safety of personnel who are working under conditions where they are away from others who could render assistance if they become ill or injured. The purpose of this chapter is to establish requirements and guidelines for implementing this policy.

Scope

This chapter applies to civil servant and support contractor personnel, temporary workers, visitors, subcontractors, and others under the jurisdiction of the Wind Tunnel Operations Division who work alone or supervise personnel who work alone.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

General

The term "working alone" means that an individual is in a work location, environment, or situation that will prevent others from observing and communicating verbally with them unless steps are taken to establish a means of remote communication.

The primary risk of concern for those working alone is that they will become injured or ill and will not be able to perform a self-rescue, or be able to summon required assistance.

It is not practical or desirable to eliminate all instances of working alone. For example, single individuals on flexible schedules often work alone in offices before or after regular business hours, and craftsmen conduct rounds while alone on swing or grave shifts. However, steps must be taken in all instances to ensure that supervisors and workers identify the risks posed by working alone, and manage them to an acceptable level.

This chapter identifies some activities that pose higher than normal risks that cannot be performed while alone. Representative examples of these activities are provided in the Requirements Section.

13.2 Responsibilities

Managers

Managers' responsibilities include the following:

- Ensuring that supervisors are aware of and follow the requirements of this chapter.
- Ensuring the availability of the equipment and personnel required to implement this policy.
- Periodically monitoring the work activities of their subordinates for compliance with this policy.

Supervisors

Supervisors' responsibilities include the following:

- Ensuring that their personnel are aware of the requirements of this chapter.
- Ensuring the evaluation of work assignments to identify situations where personnel will be working alone.
- Evaluating situations where personnel will be working alone to ensure that the associated risks are identified, evaluated, and adequately controlled.
- Ensuring that personnel who work alone do not perform activities that pose higher than normal risks.
- Ensuring that appropriate information regarding working alone and communication requirements are incorporated into Safe Plans of Action (SPA), work plans, procedures, and work orders.

Safety and Quality Assurance (S&QA) Office

Safety and Quality Assurance (S&QA) Office responsibilities include the following:

- Periodically reviewing and maintaining this policy.
- Assisting supervisors and management in the training of their personnel regarding the contents of this policy.
- Conducting periodic audits of work activities to evaluate the level of understanding of these requirements and the Division's compliance with them.

Employees and Temporary Workers

Employees' and temporary workers' responsibilities include the following:

- Complying with the requirements of this chapter.
- Evaluating work activities before starting to perform them to determine if they will be required to work alone.

- Notifying supervisors when they will be placed in situations where they will be working alone, and taking steps to eliminate the risks or control them to an acceptable level.
- Refraining from performing activities that pose higher than normal risks while working alone.

Project Managers and Hosts/Escorts

Project managers' and hosts'/escorts' responsibilities include the following:

- Evaluating planned customer, subcontractor, and visitor activities to identify if there is a potential that they will be working alone.
- Taking steps to prevent customers, subcontractors, and guests from working alone, or ensuring that they are aware of and follow the requirements contained within this chapter.

13.3 Requirements

Task Evaluation

Supervisors and employees shall evaluate all work assignments to determine whether personnel will be required to work alone. When instances are identified where personnel will be working alone, steps shall be taken, as appropriate for the potential risks, to establish a means of remote verbal or visual communication with them. A means of communication shall be implemented whenever personnel will be performing tasks that pose higher than normal risks. The evaluation activity may be included as part of the Safe Plan of Action process, and the resulting preventive measures recorded on the SPA form.

Some risks may be high enough to preclude personnel from working alone unless continuous verbal and/or visual communication with the worker can be established and maintained.

Risk Decision Process

Use the following decision tree to identify communication requirements for those working alone:

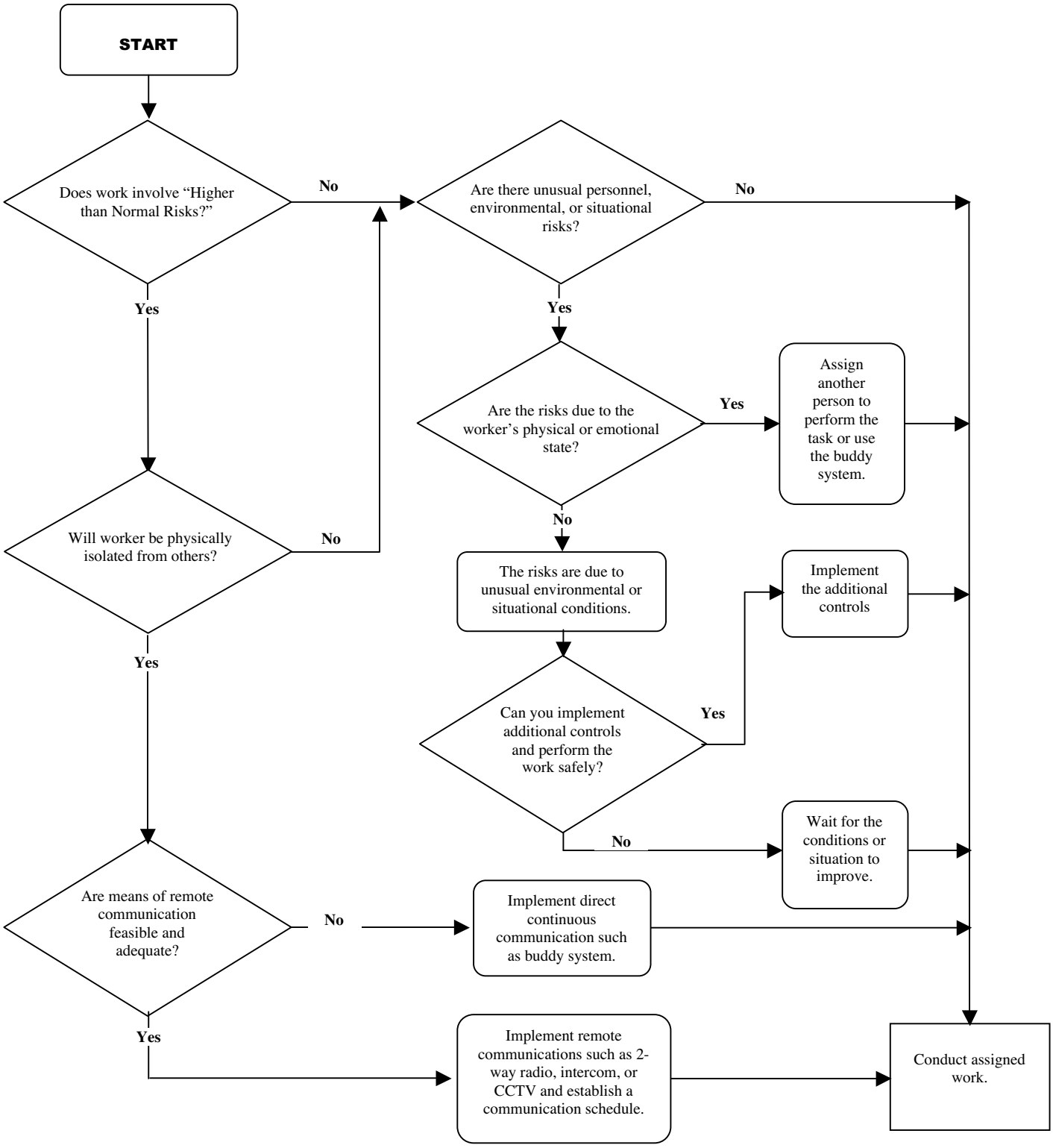


Figure 13.1: Lone Worker Communication Decision Tree

Activities Posing Normal Risks

Activities posing risks similar to those that people routinely encounter at home or as members of the general public are considered to pose normal risks. Examples of activities posing normal risks include:

- Working in offices and control rooms.
- Working in shop areas performing setup activities and operating properly guarded machines.
- Ascending and descending stairs and elevators.
- Walking between work locations.
- Conducting maintenance rounds, such as verifying fluid levels, taking oil samples, and monitoring gauges or displays.

Activities Posing Higher than Normal Risks

Activities pose higher than normal risks when they have a credible potential for exposing individuals to risks of severe occupational injury or illness. In general, the probability of sustaining a specified injury or illness will be substantially higher for the workers performing the activity than for the general site population. Most higher than normal risks will involve high energy sources, such as corrosive or flammable chemicals, electricity, heights, ionizing radiation, hazardous or moving equipment/machinery, non-ionizing radiation, pressures, and rotating equipment. They may also involve inert or acutely toxic materials.

The following is a representative list of activities involving higher than normal risks:

- Entering the Unitary Plan and 12 ft wind tunnel circuits.
- Entering the Unitary Plan and 12 ft wind tunnel plenums.
- Working in any wind tunnel test section.
- Working in the NFAC balance houses.
- Operating aerial lifts, such as scissors lifts and boom lifts.
- Actuating high-voltage switchgear, i.e. greater than 600 V.
- Breaking connections on, or pressure testing hydraulic or pneumatic systems with operational pressures exceeding 15 psig, excluding shop air and instrument air up to 140 psig in lines not exceeding 1 inch in diameter.
- Conducting work where an individual may come in contact with uninsulated, energized electrical equipment or components having a potential greater than 50 V. Examples include activities, such as making or breaking energized connections, troubleshooting, and diagnostic or functional testing.

- Operating or conducting maintenance on unguarded equipment that poses mechanical, point of operation, or mechanical power transmission hazards, such as adjusting or performing functional tests. Examples of such equipment include woodworking and machine tools, pumps, fans, compressors, etc.
- Entering a permit-required confined space. Refer to "Confined-Space Entry," Wind Tunnel Operations Division and Support Contractors Safety Manual, A027-9991-XS1.
- Conducting work requiring the use of life-saving safety equipment, such as personal fall-arrest or restraint equipment.
- Using or working around unenclosed Class IV lasers.
- Working with dangerous quantities of hazardous materials.

Unusual Personnel, Environmental, and Situational Risks

Supervisors or managers must consider the presence of unusual working conditions and the physical and psychological state of the worker when executing the risk decision process and making work assignments. For example, unusually wet, cold, hot, or noisy ambient conditions may increase the level of risk to a worker from what is usually considered to be normal, to higher than normal.

The physical condition and psychological state of the employee may also affect the level of risk a worker is exposed to when in isolation. For example, performing some specified activity while alone may be considered to pose a normal risk to the general population, however, it may not be prudent to allow personnel who have just returned from medical leave, have high cardiac risks, or have medical conditions, such as diabetes or epilepsy, to perform these tasks under the same working conditions.

Communication Means

The means that can be used to establish communication with lone personnel include two-way radio, wired or wireless headsets, closed-circuit TV (CCTV), and in some instances, telephone. The method to be used for a specific activity must be selected based on its effectiveness related to the location and activity, and hazards and risks posed by the work activity. For example, two-way radio communication may not be effective for personnel located within the shielded confines of a wind tunnel circuit. In instances such as this, it may be necessary to implement the buddy system to preclude personnel from working alone rather than depending on an unreliable communication method.

Communication means that rely on some action by the worker, such as keying a radio or dialing a phone, are not appropriate as a sole means of communication in instances where the lone worker can be suddenly and unexpectedly incapacitated. This is a credible scenario in instances where there is a risk of electric shock or a sudden release of inert or toxic gases into an occupied space, such as carbon dioxide, nitrogen, carbon monoxide, and hydrogen sulfide.

Communication Schedule

Those who will be working alone should advise a lead or supervisor where they are going and how long they expect to be gone, and establish a communication schedule that is appropriate for the hazards and risks presented. When personnel are performing higher risk activities, communications should be more frequent or continuous, such as monitoring on CCTV.

13.4 Training

Initial Training

All Division personnel shall receive training on the contents of this chapter upon its initial release, and as part of new-hire orientation briefings.

Retraining

Personnel shall be retrained on the contents of this chapter:

- Following revisions to this chapter that incorporate substantial changes in the requirements it identifies.
- Upon demonstrating inadequate knowledge or understanding of the information contained within this chapter.

13.5 Records

Training Rosters

Rosters documenting attendance at training sessions, as specified by this chapter, shall be forwarded to the Division Safety Office for record-keeping purposes.

13.6 Definitions

Buddy System

The use of a second worker who is in continuous verbal and/or visual communication with another worker for the purpose of monitoring their work activities and/or physical condition, and providing or summoning emergency assistance if required. Buddies should not be conducting activities or be in positions where they are likely be incapacitated by the same events or conditions as the workers they are monitoring.

Dangerous Quantities	The presence of hazardous materials in amounts which, if released, pose a serious hazard of personal injury or illness, or serious damage to property or the environment.
Hazardous Chemicals	Chemicals with physical properties, such as corrosiveness, stability, temperature, reactivity, toxicity, flammability, etc., that pose a threat of harm to personnel, property, or the environment.
Ionizing Radiation	Forms of particulate radiation, such as alpha, beta, and neutron; and electromagnetic radiation, such as gamma, and x-ray, that possess enough energy to ionize cell tissues upon exposure.
Non-Ionizing Radiation	Forms of electromagnetic radiation, such as radio frequency, microwave, infrared, ultraviolet, and laser, which may injure tissues through mechanisms other than ionization, such as heating.
Safe Plan of Action (SPA)	A written safety plan, oriented towards a specific work task and developed by the team members assigned to perform the task. Refer to "Safe Plan of Action (SPA)," Wind Tunnel Operations Division and Support Contractors Safety Manual, A027-9991-XS1.

13.7 References

Ames and Division Documents	Ames Health and Safety Manual, APG 1700.1 Wind Tunnel Operations Division and Support Contractors Safety Manual, A027-9991-XS1
Forms	Safe Plan of Action (SPA), F013

End of Chapter

14. Disaster Prevention

14.1 Description

Purpose

Wind Tunnel Operations Division policy is to plan and prepare in advance for situations that could threaten life and property such as: fire, earthquake, and hazardous material spills, and to take actions to reduce their potential adverse effects on personnel, facilities and equipment, and the environment. The purpose of this chapter is to establish requirements and guidelines that implement this policy.

Scope

This chapter applies to civil servant and support contractor personnel, temporary workers, visitors, subcontractors, and others under the jurisdiction of the Wind Tunnel Operations Division.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

General

Building Emergency Action Plans (BEAPs) establish basic emergency planning and response information for individual buildings at Ames Research Center. BEAPs are developed by the Ames Environmental Services Office, and issued to the facility service managers (FSMs). Additional copies of the BEAPs are positioned in building lobbies, or adjacent to the primary building entrance/exit, and on the ARC Intranet to make them accessible to Division personnel and emergency responders. To access the BEAPs on the Intranet, type "BEAP" in the address, location, or URL field of your web browser and press enter, or use the link on the FO Division Safety Documents Web page at http://pubsgroup.arc.nasa.gov/FO_Dcs/Safety.html.

This chapter establishes division-specific responsibilities, requirements, and processes that implement and supplement the BEAP requirements within the Division.

Delegation of Roles, Responsibilities, and Authority

Given time, conditions requiring immediate actions to prevent a disaster will arise and evacuations will be initiated when some of the Division's designated emergency responders are not available to assist. They may be ill, on leave, temporarily assigned to another shift, in another building, etc. Because of this it is important to identify delegates or alternates for critical positions. The following provides basic guidance for accomplishing this.

Facility Service Manager (FSM)

- When the FSM is not available during regular hours, the designated alternate FSM shall assume the role, responsibility, and authority of the FSM.
- During off-shift periods when personnel are present to support wind tunnel test operations, the test engineer shall assume the role, responsibility, and authority of the FSM for the test facility. The shift supervisor (or craft lead) shall assume the role, responsibility, and authority of the FSM for the remote support areas.

Chiefs, Managers, Group Leaders, and Supervisors

- During planned absences, when the chief, manager, group leader, or supervisor has issued a delegation of authority, the individual receiving the delegation shall assume the emergency response role, responsibilities, and authority of the person who issued it.
- During brief, unanticipated absences, the absent individual's superior will assume their emergency response role, responsibilities, and authority, or assign them to an alternate.
- If there is not a designated supervisor or group leader, the applicable Branch chief or manager shall assume the supervisory responsibilities.

Building Emergency Response Team (ERT) Members

- There are multiple building ERT members assigned to a facility. They are trained to watch out and cover for each other.

14.2 Responsibilities

All Personnel

All personnel have the following emergency preparedness and life safety responsibilities:

- Learning, understanding, and applying the contents of this chapter.
- Reviewing the content of the BEAP(s) appropriate to the area(s) in which they will work.
- Participating in evacuation and emergency drills.
- Reporting emergency situations immediately upon discovery by dialing 911 on any center phone (including Ames pay phones), dialing (650) 604-5555 on a cellular phone, or depressing the red emergency button and calling for emergency assistance on any channel of an Ames two-way radio.

- Evacuating the building or work area expeditiously in accordance with the Building Evacuation Section of this chapter.
- Planning and executing their work in a manner that minimizes the potential for creating an emergency situation. Examples include obtaining appropriate reviews and permits for higher risk activities, minimizing the quantities of hazardous materials stored and used, using the appropriate PPE for the task, etc.

Division Office

Division Office responsibilities include the following:

- Appointing the Division emergency preparedness coordinator.
- Establishing priorities and providing the resources required to develop, implement, and maintain the Division's emergency response plan.
- Approving tour requests for the wind tunnel facilities.

Branch Chiefs and Managers

Branch chief and manager responsibilities include the following:

- Implementing the requirements described in this chapter within their organizations.
- Working with the FSMs and Division Safety Office to designate personnel to carry out site-specific emergency and evacuation duties as outlined in this chapter.
- Ensuring that employees having assigned emergency response duties receive the training and equipment that is required to perform them safely.
- Minimizing the risks emergency evacuations pose to disabled employees by considering employee's disabilities when making office assignments.
- Ensuring that supervisors assign "buddies" to disabled personnel to assist them in exiting the building under emergency conditions.
- Advising the FSM about the locations of disabled personnel and the names of those assigned as buddies to assist them during evacuations.

Supervisors

Supervisors' responsibilities include the following:

- Ensuring that personnel are aware of the requirements of this chapter.
- Ensuring that employees receive the required BEAP, evacuation, and emergency response training for each facility they work in.

- Working with their managers to ensure that buddies are assigned to assist disabled employees during evacuations.
- Taking steps to minimize the potential for creating emergency situations by ensuring that potentially hazardous activities are appropriately planned and controlled. Refer to the Safe Plan of Action Chapter in this manual.
- Evaluating work to identify potential hazards and incorporating hazardous situation response actions into procedures (as appropriate for the hazards) to prevent anomalies from escalating into emergencies This may be accomplished through the Safe Plan of Action process. Refer to the Safe Plan of Action Chapter in this manual.
- Accounting for their subordinates during and following building evacuations.
- Monitoring evacuation and assembly activities to identify issues that could adversely affect personnel safety and taking actions within their authority to correct them. In some instances, a supervisor's action may be to identify the problem to higher management for resolution.

Division Safety Office

Division Safety Office responsibilities include the following

- Assisting the Division emergency preparedness coordinator with the annual review and update of this chapter.
- Providing assistance to the FSMs in developing the BEAPs, and in conducting periodic reviews to ensure that they are up to date and appropriate for the activities performed within each facility. This review shall be accomplished at least once every two years.
- Assisting and advising Division Management, the Division emergency preparedness coordinator, and FSMs in the completion their duties under this chapter.
- Assisting the FSMs with monitoring and evaluating facility evacuations.
- Assisting managers and supervisors in training their personnel to carry out their emergency responsibilities.
- Maintaining training records associated with fire and emergency plans.
- Maintaining copies of MSDSs in facility lobbies to support emergency responders.

Division Emergency Preparedness Coordinator

Division emergency preparedness coordinator responsibilities include the following:

- Representing the Division for Directorate and Center emergency preparedness activities.
- Coordinating development and implementation of the Division's emergency preparedness and response activities.
- Coordinating annual fire/evacuation drills for Division facilities with the Moffett Fire Department.
- Ensuring that FSMs conduct evaluations of each fire drill and emergency evacuation, and that the FSMs initiate appropriate corrective actions for identified deficiencies.
- Maintaining records of fire drill and emergency evacuation evaluations.
- Initiating and tracking corrective actions for deficiencies or problems identified on completed Building Evacuation and Emergency Response Evaluation forms. (Note: This can be done using the Division Action Tracking Database.)
- Coordinating with FSMs to develop and implement training for the FSMs and building ERT members.
- Coordinating with the FSMs and Center emergency responders to conduct facility and operations familiarization tours.
- Conducting a review at least annually of this chapter and initiating revisions as necessary.

Facility Service Managers (FSMs)

FSMs' responsibilities include the following:

- Acting as the lead for the building ERTs for each assigned facility.
- Maintaining a list of building ERT members for each assigned facility.
- Coordinating support for Center emergency responders when they arrive on the scene.
- Acting as the focal point for all critical communications while an emergency condition exists.
- Monitoring progress of building evacuations and documenting areas verified as cleared.
- Coordinating with supervisors and building ERT members to account for all building occupants.
- Completing documented evaluations of each evacuation and providing them to the Division emergency preparedness coordinator.
- Maintaining current personal copies of the BEAPs for each assigned facility.

- Maintaining current copies of BEAPs in the building lobbies, or other suitable locations, for each assigned facility for ready reference by emergency responders.
- Informing the Environmental Services Office BEAP manager when changes in facility use, conditions, or operations warrant modification of the building's BEAP. Refer to Section 5.1 of the applicable BEAP.
- Reviewing their BEAP(s) at least once every two years and recommending appropriate revisions to the Environmental Services Office BEAP managers.
- Reviewing periodically the preventive maintenance (PM) work orders for fire extinguisher inspections to ensure timely completion.
- Reviewing periodically the PM work orders for emergency lighting and exit sign testing to ensure timely completion.

Building Emergency Response Team (ERT) Members

Building ERT member responsibilities include the following:

- Sweeping through buildings upon evacuation to ensure that all personnel are aware that an evacuation was initiated and are evacuating as required.
- Reporting the areas verified clear to the FSM upon exiting the building.
- Maintaining awareness of conditions around them as they exit the facility and reporting observed conditions to the FSM immediately upon exiting.
- Providing assistance to the FSM or Division emergency response coordinator as requested following an evacuation.
- Conducting monthly fire extinguisher inspections as assigned by the FSM.
- Looking while exiting the building to see if the lobby/primary exit BEAP and MSDS binders are still present in their wall holders, and taking those that are to the FSM at the assembly area.

Facility Managers

Facility manager responsibilities include the following:

- Working with the facility chief engineers to ensure the development of procedures to address predictable failures and anomalous situations, and their incorporation into SOPs and maintenance procedures as appropriate for each facility and/or system. The purpose of these procedures shall be to provide direction on how to control or minimize the adverse effects that may result when specified failures or anomalous conditions arise.
- Ensuring that test engineers evaluate proposed tests to identify the associated hazards, and when appropriate, develop test-specific emergency procedures to provide direction on how to control or minimize the adverse effects that may result when specified failures or anomalous conditions arise.

Facility Chief Engineers

Facility chief engineer responsibilities include working with the test engineer and maintenance personnel to ensure the development of procedures to address predictable failures and anomalous situations, and their incorporation into SOPs and maintenance procedures as appropriate for each facility and/or system. The purpose of these procedures shall be to provide direction on how to control or minimize the adverse effects that may result when specified failures or anomalous conditions arise.

Test Engineers

Test engineer responsibilities include the following:

- Evaluating proposed tests to identify the associated hazards, and when appropriate, developing test-specific procedures to provide direction on how to control or minimize the adverse effects that may result when specified failures or anomalous conditions arise.
- Briefing all test customers in the emergency response, evacuation routes, and procedures for their facility.
- Notifying the appropriate Branch chief or manager of any serious event that occurs outside normal business hours.

Visitor Hosts

Visitor host responsibilities include the following:

- Briefing all unescorted visitors in the emergency evacuation procedures for their facility.
- Briefing visitors they are hosting in Division conference rooms, before beginning their scheduled discussions, regarding the primary emergency evacuation route from the conference room to the designated assembly area.
- Taking responsibility for the safety of their guests in the event of a building evacuation, and leading them out of the building and to the designated assembly area.

Facility Engineering Project Coordinators and Managers

Project coordinator and manager responsibilities include the following:

- Evaluating projects early in the conceptual and planning phases to identify those that have safety, health, and environmental implications.
- Working with Division Safety Office personnel to fully evaluate project environmental, safety, and health (ES&H) hazards and develop appropriate hazard abatement or control strategies.
- Communicating Division ES&H requirements and procedures to those who will conduct the work.
- Communicating facility hazards and emergency evacuation routes and procedures to those who will conduct the work.
- Ensuring that required permits, such as permits for hot work, confined-space entry, etc., are obtained before work commences.

14.3 Requirements

Disaster Prevention

The most effective way to prevent serious and unexpected situations from escalating beyond our control and having disastrous effects, is to take actions in advance to prevent them from occurring, or to reduce the severity of adverse effects to an acceptable level if they do occur. Therefore, Division personnel shall place a strong emphasis on evaluating work activities and workplace conditions to identify potential hazards, evaluating risks posed by the hazards, and implementing controls or mitigations to minimize the potential for these events to occur.

Examples of advance preventive actions include: practicing building evacuations, maintaining unobstructed emergency egress routes, performing comprehensive job planning and implementing appropriate hazard mitigations or controls, using and storing hazardous materials properly, and obtaining appropriate permits, such as permits for hot work and confined space entry, before beginning work.

Preventive measures are also effective in reducing the potential impact of natural disasters such as earthquake or flood. Such measures may include: securing equipment and furniture to prevent movement during a seismic event, or placing critical or sensitive equipment in areas that are not prone to flooding or vulnerable to falling debris. Another example is copying or backing-up critical documents and data, and storing them in a location that is physically separated (preferably in a different building) from the working copies.

Disabled Employees

Managers and supervisors must maintain cognizance of subordinates' physical disabilities such as those affecting vision, hearing, or mobility. These disabilities should be considered when making office and work assignments. Consideration should be given to providing first floor offices to those personnel whose disabilities may significantly impair or prevent their ability to exit from upper floors without assistance.

Managers or supervisors should inform the appropriate FSMs of the names and normal work locations of personnel who will require evacuation assistance, and work with them to designate co-workers to assist in the worker's evacuation.

Facility Tours

Division Office approval must be obtained before conducting tours of the Division's wind tunnel facilities. Tour approvals will be based on their purpose, their operational impact, the potential risks posed to the tourists, and the availability of a qualified docent and escorts.

Wind Tunnel Tour Safety Rules are available on the FO Division Safety Documents Web page at http://pubsgroup.arc.nasa.gov/FO_Docs/Safety.html.

Personnel having physical limitations that would prevent them from descending multiple flights of stairs while under emergency conditions and without assistance may not be permitted to tour operations areas. Division Office review and approval of accommodations being implemented to ensure the safety of these personnel will be required before allowing them to participate in the tour.

The maximum ratio of tourists to docents/escorts shall be as follows:

Table 14.1: Maximum Tourists per Docent/Escort and Group

Tour Facility/Location	Maximum Number of Tourists per Docent/Escort	Maximum Number of Tourists Per Group
All Locations, when a single docent is available	12/1	12
N-221B - 80x120 Test Section	15/1	75
N-221B - 80x120 Inlet	10/1	10
N-221 - 40x80 Test Section	12/1	24
N-221 - Upstream side of the Fans	6/1	18
N-221 - Downstream side of the fans	12/1	48
N-227A and 227B	15/1	30
NOTE: Tours of the 12’ PWT are available upon special request only. The number of docents, escorts, and tourists will be determined at the time of approval.		

The docents and escorts shall wear high-visibility clothing provided by the Division Office during the tour to ensure that the tourists can easily identify them. They shall also carry illuminated wand-type flashlights to assist them in directing the tourists safely out of the facility in the event of a power failure or an emergency.

Before starting tours, docents shall introduce themselves and the escorts, and brief the tourists on the basic tour rules and emergency exit procedures.

Building Evacuation

Building evacuations may be initiated through verbal direction, by manually activating an alarm such as by using a fire alarm pull box, or through automatic sensors such as building smoke, heat, or ultraviolet detectors.

If time allows, occupants should turn off computers and equipment, pick up their personal belongings, turn off office lights, and close office doors as they leave.

- Turning off computers, lights, and equipment helps minimize damage if a fire sprinkler activates, or if responding firemen use water or other media to extinguish a fire, and reduces the number of energy sources in the room.
- Occupants who are in their offices, or in very close proximity to their offices, should take personal items such as car keys, coats, purses, etc. with them in case circumstances prevent building reoccupation.
- Closing the door can reduce the potential for fire or smoke incursion into the room from adjacent areas.

While evacuating, personnel should maintain awareness of the conditions and other people around them, and offer assistance to those who appear to need it. Once at the assembly area, personnel should report to their supervisor or manager, or to the building ERT member assigned to their work area to be accounted for. Personnel should also report any unusual conditions observed or missing personnel. Personnel shall remain at the assembly area until they are informed that it is safe to re-enter the building, are directed to another location, or sent home.

Communication

Good communication is an essential element in successful emergency management. Therefore, steps shall be taken to establish clear lines of communication among the FSM, the Center's emergency responders, the building ERT members; Division support personnel, and Division management.

During emergencies, the FSM shall be the focal point for all essential communications. Reports of unusual conditions or missing personnel, requests for the support of Division personnel, instructions from the Center's emergency responders to Division personnel, and communications with other Division facilities to advise them of the emergency condition shall all be directed through the FSM.

Each FSM should be assigned a two-way radio t to have whenever an evacuation occurs. This will allow them to communicate with the Division's facility engineers and craft personnel to coordinate emergency response support.

Fire and Evacuation Drills

Fire/evacuation drills shall be conducted at least annually for each Division facility. The Division emergency preparedness coordinator shall schedule the drills with the Moffett Fire Department, and when possible, with the appropriate FSM. Care should be taken to schedule drills to minimize impact on tests that are in progress.

FSMs shall conduct evaluations of all building evacuations to identify problems requiring correction. The evaluations shall be documented on the Building Evacuation and Emergency Response Evaluation, FO29. Completed evaluations shall be provided to the Division emergency preparedness coordinator. The FSM and Division emergency preparedness coordinator shall discuss identified deficiencies, determine appropriate corrective measures, and initiate corrections.

False Alarms and other evacuations that are evaluated and documented on the Evacuation and Emergency Response Evaluation can be used to satisfy the annual drill requirement.

Emergency Equipment

Emergency equipment, including fire extinguishers, emergency showers or eyewashes, and chemical spill response kits, shall be inspected monthly. The FSMs, in consultation with the Branch chiefs and managers shall designate individuals within each building to conduct these inspections.

Monthly inspections of emergency equipment shall be documented either by entries in an inspection log, the Maximo System, and/or by inspector sign-off on tags or labels on the equipment.

Ames Research Center and Division policy is that only personnel who have been trained in their proper use may use fire extinguishers.

Center personnel, rather than Division personnel, conduct required annual fire extinguisher servicing; inspect and maintain building fire detection, alarm, and suppression systems; and inspect and maintain the safety shower and eyewash units.

Building Emergency Response Teams (ERTs)

The Division emergency response coordinator, in consultation with the FSMs and the Division Chief, shall determine which facilities and shifts require building emergency response teams (ERTs).

The primary functions of the ERT members are to facilitate the safe and efficient evacuation of a facility by sweeping their assigned areas, to report on conditions observed within the facility during the evacuation process, and to assist in accounting for facility personnel at the assembly areas. Depending on the facility, the ERT's composition, and the circumstances, team members may also assist by securing facility systems or equipment.

Typical ERTs shall consist of the building's FSM, an appropriate number of building occupants, and when necessary, specialized support personnel, such as engineers, electricians, mechanics, technicians, etc. Membership may vary somewhat by shift since there are fewer personnel available to support off-shift activities/operations.

The emergency response coordinator and the FSM will determine the size and composition of the teams based on the work shift and the size, complexity, contents, and function of the facility.

The FSM shall maintain a list of ERT member names for each facility and shift. The FSM shall provide copies of the lists to the Division emergency response coordinator for reference and posting on the FO Division Safety Documents Web page.

14.4 Training

All Personnel

All Division personnel shall receive training on the contents and procedures contained in the BEAP, and general emergency response training for each building they work in as follows:

- When first reporting for work or when assigned duties in a new facility.
- When the BEAP or its contents are significantly changed.
- At least once every 12 months.

Division Emergency Responders

Personnel with specific emergency response duties, such as the FSMs and building ERT members shall receive training as to ensure that they can perform those functions safely and efficiently. Training shall be conducted as follows:

- Emergency responders shall receive initial training when first assigned these responsibilities.
- Emergency responders shall receive refresher training annually or when observations or evaluations indicate that an individual or individuals do not have sufficient knowledge or skill to carry out their assignments.
- Division management will encourage emergency responders obtain basic first aid and fire extinguisher training.

14.5 Records

Evacuation Evaluation Records	The Division emergency response coordinator shall maintain records of evacuation drills evaluations and corrective action taken to correct identified deficiencies for a minimum period of 2-years.
Inspection Records	Records of inspections for fire extinguishers, emergency egress lighting, etc. shall be retained for a minimum of 12 months.
Training Records	The Division Safety Office shall maintain records of all training required under this chapter.

14.6 Definitions

Disaster	An occurrence causing widespread destruction and distress, or a grave misfortune; a grave occurrence having ruinous results.
Docent	Lecturer or tour guide.
Emergency	An unexpected, serious occurrence or situation urgently requiring prompt action.
Escort	Division personnel assigned to assist a docent in ensuring the safety of visitors, equipment, and the facility during guided tours.

14.7 References

Ames and Division Documents	Ames Health and Safety Manual, APG 1700.1 Building and Emergency Action Plans (BEAPs)
Forms	Building Evacuation and Emergency Response Evaluation, FO29
External Documents	OSHA Standard 29 CFR 1910, Subpart E: Means of Egress OSHA Standard 29 CFR 1910.157: Portable Fire Extinguishers

End of Chapter

15. Mishap Response and Reporting

15.1 Description

Purpose

Ames Research Center and Wind Tunnel Operations Division (Division) policy is to ensure that mishaps involving personnel, property, vehicles, and the environment are properly reported and investigated, and that appropriate actions are taken to prevent recurrence. The purpose of this chapter is to establish requirements and guidelines that implement this policy within the Division.

Scope

This chapter applies to civil servant and support contractor personnel, temporary workers, visitors, subcontractors, and others under the jurisdiction of the Wind Tunnel Operations Division.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

General

It is always most desirable to take actions which prevent mishaps from occurring, however, once a mishap does occur the initial response can greatly reduce the potential for resulting injuries and illnesses, and the magnitude of property losses and damage to the environment. NASA and the Federal Occupational Safety and Health Administration (OSHA) establish requirements and regulations that hold civil servant and contractor managers accountable for mishap recording and reporting. Regardless of the regulations, however, mishap investigation is an important tool for identifying flaws in the management system, test and maintenance processes, training, and equipment that may not be easy to identify. Once identified, actions can be taken to correct or eliminate the flaws, and thereby either prevent the mishap's recurrence, or reduce the consequences of recurrence.

15.2 Responsibilities

Division Chief

The Division chief is responsible for the following:

- Assigning personnel to serve as an investigator or member of an investigation board for those events that fall within the Division's authority and responsibility.
- Providing the resources required to implement the corrective and preventive measures recommended by the investigator or board.

Managers

Managers are responsible for the following:

- Ensuring that supervisors who report to them are aware of, understand, and comply with the requirements of this chapter.
- Ensuring that supervisors make verbal notifications to the Division Safety Office as soon as possible following the occurrence of mishaps, mission failures, incidents, hazardous material discharges, etc.
- Ensuring that supervisors provide completed NASA Mishap Report Forms, NF 1627) to the Division Safety Office within 24 hours of mishaps, mission failures, incidents, hazardous material discharges, etc.
- Providing technical resources, as requested, to participate in investigations.
- Providing technical support, as requested, to respond to mishaps and emergency situations.
- Taking action within their authority and resources to implement recommended corrective/preventive measures.

Supervisors

Supervisors are responsible for the following:

- Ensuring that their subordinates know and understand their mishap response and reporting responsibilities.
- Reporting mishaps, hazardous material spills, incidents, close calls, etc. to their managers and the Division Safety Office as soon as possible following their occurrence.
- Completing NASA Mishap Report Forms, NF 1627, for each reported event and providing them to the Division Safety Office within 24 hours (1 business day) of the time that the event occurred.
- Working with investigators to determine the mishap's impact, sequence of events, mechanisms and causes, and to develop corrective/preventive measures.
- Implementing corrective/preventive actions that are assigned to them.

Division Safety Office

The Division Safety Office is responsible for the following:

- Coordinating NASA reporting within the Division.
- Coordinating and/or participating in investigations as requested or directed by the Center or Division.
- Providing assistance to supervisors in completing NASA Mishap Report forms.
- Coordinating OSHA record-keeping and reporting for the support contractor as directed by the general manager.
- Providing periodic briefings and educational material to management and employees to ensure that they understand their mishap response and reporting responsibilities.
- Advising management on NASA and OSHA record-keeping and reporting requirements.

All Personnel

All personnel to which this chapter applies are responsible for the following:

- Promptly reporting any mishaps, incidents, close calls, hazardous material releases, etc. to their supervisor and if appropriate, to Moffett Dispatch (911 on any Center phone, or 650-604-5555 when using a cell phone).
- Providing assistance to injured or ill personnel within the limits of their knowledge and abilities until other assistance arrives.
- Initiating an area or building evacuation if warranted to reduce the potential for personnel injury or illness.
- Taking action, within the limits of their knowledge and abilities, to stabilize the situation to minimize the potential for additional property or equipment damage, personnel injury or illness, or contamination.
- Cooperating with investigators as requested to help determine the mishap's impact, sequence of events, mechanisms, and causes; and to develop corrective/preventive measures.

15.3 Requirements

Making An Initial Mishap Response

The initial response to a mishap should be directed at the following:

- Determining its scope and severity so the appropriate response actions can be taken.
- Calling for emergency assistance.
- Stabilizing the situation to reduce the potential for further injury or damage.

- Treating injured or ill personnel.
- Evacuating others from the area to minimize the potential of additional injuries or illnesses.
- Isolating sources of hazardous materials or hazardous energy.
- Securing the area and mishap scene to prevent others from becoming injured or ill, and/or to preserve evidence.
- Containing spills of hazardous materials.

These steps may be followed in a different sequence depending on the circumstances of the mishap. For example, if an individual misjudges a step and falls, the responders need not be concerned with the presence of other physical hazards or hazardous environmental conditions that could jeopardize their safety or that of others. They can immediately begin evaluation and treatment of the injured individual.

This would not be the case if a worker suddenly became unresponsive while working within a permit-required confined space. Confined spaces can pose a very high risk of severe injury or death. Therefore, the initial response in this instance would be to prevent the entry of others into the confined space until the determination is made that environmental conditions are safe for entry, or to limit entry to only those personnel who are trained and equipped to do so safely. Once this is accomplished, steps could be taken to rescue and treat the unresponsive worker.

Determining the Investigation Type

The actual or potential severity of a mishap determines the mishap type, the formality and comprehensiveness of the investigation, and the level of the NASA organization will have the responsibility and authority to appoint investigators.

NASA Headquarters has authority for investigating all Type A and B mishaps; however, they may delegate authority and responsibility for Type B mishaps to Ames Research Center (ARC).

ARC has authority and responsibility for investigating Type C mishaps, incidents, and close calls. The authority and responsibility for many of these are delegated to the individual ARC organizations or contractors.

Normally notifications will be made as identified in the various "Notification" sections of this chapter after determining the investigation type. An exception to this may occur when it is necessary to call "911" to obtain emergency assistance. Moffett Dispatch normally advises the ARC Safety, Health, and Medical Services Division (ARC SHMS) whenever they respond to a 911 emergency call.

Notifying Supervision and Management

Managers and supervisors must be notified of ALL work-related injuries and illnesses, property or equipment damage, and releases of hazardous materials to the environment as soon as possible following their occurrence.

Managers and supervisors, in conjunction with the Division Safety Office, will determine whether non-emergency events must be reported to NASA and/or OSHA, and the timeframe for the notification.

Managers and supervisors, in conjunction with the Division Safety Office, will also determine whether minor events, such as those not requiring NASA or OSHA recording or notification, must be investigated and documented. This determination will be made based on the event's actual or potential severity, the likelihood of recurrence, and its relevance to other Division or Center equipment, processes, and activities.

Notifying NASA and OSHA

NASA and the Occupational Safety and Health Administration (OSHA) require immediate reporting of mishaps having significant actual or potential severity. This allows them to determine whether they must take action to form an accident investigation team/board to conduct their own investigation.

The table that follows summarizes the NASA and OSHA notification requirements. Civil servants generally make the notifications to the ARC SHMS for events involving civil servant employees. Contractors make the notifications for events involving contractor employees. The employer(s) of the injured individual(s) will make the notifications to OSHA.

In the "Who Does The Notification?" column in the following table, "Division" denotes an individual designated by the NASA Division chief; "Contractor" denotes an individual designated by the contractor's general manager; "ARC SHMS" denotes a member of the ARC Safety, Health, and Medical Services organization designated by its Division chief; and "Branch" denotes an individual designated by the chief of the branch whose worker sustained the injury or whose property was damaged.

Table 15.1: Summary of Notification Requirements

Mishap Type	Who Gets Notified?	How Are They Notified?	Who Does The Notification?	Time-frame (Hours)
Type A	ARC SHMS	Telephone and Form NF 1627	Division/ Contractor	1
Fatality that occurs within 30 days of the date of the mishap	ARC SHMS	Telephone and Form NF 1627	Division/ Contractor	1
	OSHA	Telephone/ Fax	ARC SHMS/ Contractor	8
Type B	ARC SHMS	Telephone and Form NF 1627	Division/ Contractor	1
Hospitalization of 3 or more workers within 30 days of the date of the mishap	ARC SHMS	Telephone and Form NF 1627	Division/ Contractor	1
	OSHA	Telephone/ Fax	ARC SHMS/ Contractor	8
High-visibility mission failure	ARC SHMS	Telephone and Form NF 1627	Division/ Contractor	1
Other high-visibility mishaps and close calls	ARC SHMS	Telephone and Form NF 1627	Division/ Contractor	1
Mishaps suspected of resulting from criminal activity	ARC SHMS	Telephone and Form NF 1627	Division/ Contractor	1
	ARC Security Mgmt Branch	Telephone	Division/ Contractor	1
Type C	ARC SHMS	Form NF 1627	Division/ Branch/ Contractor	24

Mishap Type	Who Gets Notified?	How Are They Notified?	Who Does The Notification?	Time-frame (Hours)
Incident	ARC SHMS	Form NF 1627	Division/ Branch/ Contractor	24
Close Call	ARC SHMS	Form NF 1627	Division/ Branch/ Contractor	24

Notifying Family Members

Each civil servant and contractor organization shall follow their internal policies for notifying the next-of-kin when one of their employees sustains a severe workplace injury or dies while at work.

Investigating the Mishap

The investigator or investigation team shall determine the mishap's actual and potential severity and impact, the sequence of events, the mishap mechanism (how it happened), and ALL of the mishap's causes (direct cause, root cause, and contributing causes). This information will be used to identify corrective and preventive actions that will reduce the probability of recurrence and/or the severity of the outcomes if a similar event does occur.

Within the Division, all mishaps involving occupational injury or illness; property, equipment, tests failure; or mission failure shall be recorded on a NASA Mishap Report Form, NF 1627, to ensure consistent data collection. Only those 1627 forms for mishaps, incidents, test failures, or mission failures that require NASA reporting will be forwarded to ARC SHMS.

Mishaps involving actual or potential releases of hazardous material to the environment shall be documented and reported in accordance with Section 4 of the individual Building Emergency Action Plans.

Developing and Recommending Corrective Actions and Lessons Learned

The investigator or investigation team should recommend one or more corrective actions, as appropriate, for each identified mishap cause. Corrective actions that will take one or more months to implement shall be entered into the Division's Action Tracking database. The investigator or investigation team should evaluate whether the lessons learned from the mishap have broader application across the Center, or across NASA. Those that do should be forwarded to the ARC Lessons Learned Coordinator. The process for submitting Lessons Learned, and the identity of the ARC Lessons Learned Coordinator are available through the NASA Lessons Learned Information System web page at: http://llis.gsfc.nasa.gov/.

15.4 Training

Managers and Supervisors

All managers and supervisors shall receive mishap reporting training to familiarize them with the reasons for reporting, their responsibilities for reporting, the NASA and OSHA record-keeping and recording requirements, and the NASA Mishap Report Form, NF 1627. They shall be retrained when there are significant changes in the NASA or OSHA reporting and recording requirements.

Employees

Employees shall be instructed in their mishap reporting responsibilities upon issuance of this chapter, during new-hire briefings, and when there are significant revisions in mishap reporting requirements.

15.5 Records

Corrective Action Records

Records of corrective actions taken in response to mishaps, mission failures, incidents, close calls, and environmental releases shall be retained for at least 5 years following the year in which they occurred.

NASA Records

The Safety, Health, and Medical Services Division has the responsibility for retaining all of the Center's mishap, mission failure, incident, and close call records.

Service contractors shall retain NASA mishap records for the duration of their contracts.

OSHA Records

Each employer shall retain and maintain OSHA occupational injury and illness records for a minimum period of 5-years following the calendar year that the records cover.

When support contractors are replaced through a contract competition or other contract action, they shall transfer their OSHA records to their successors in accordance with the requirements of OSHA regulation 29 CFR 1904.34 – Change of Business Ownership.

15.6 Definitions

Close Call

An occurrence in which there is no injury or an injury of first-aid severity, no significant equipment property damage (less than $1000), and no significant interruption of productive work, but which possesses a high potential for a more significant injury or property damage.

Emergency

An unusual event or situation involving personnel, equipment, facilities or the environment that requires immediate action to control and/or abate.

Event

A term used to refer collectively to mishaps, mission failures, close calls, environmental releases, etc.

First Aid Injury

For the purpose of mishap and OSHA reporting the term "first aid" means the following:

- Using a non-prescription medication at nonprescription strength (for medications available in both prescription and non-prescription form, a recommendation by a physician or other licensed health care professional to use a non-prescription medication at prescription strength is considered medical treatment for record-keeping purposes).
- Administering tetanus immunizations (other immunizations, such as Hepatitis B vaccine or rabies vaccine, are considered medical treatment).
- Cleaning, flushing or soaking wounds on the surface of the skin.
- Using wound coverings such as bandages, Band-Aids™, gauze pads, etc.; or using butterfly bandages or Steri-Strips™ (other wound closing devices such as sutures, staples, etc., are considered medical treatment).
- Using hot or cold therapy.
- Using any non-rigid means of support, such as elastic bandages, wraps, non-rigid back belts, etc. (devices with rigid stays or other systems designed to immobilize parts of the body are considered medical treatment for record-keeping purposes).
- Using temporary immobilization devices while transporting an accident victim (e.g., splints, slings, neck collars, back boards, etc.).
- Drilling of a fingernail or toenail to relieve pressure, or draining fluid from a blister.
- Using eye patches.
- Removing foreign bodies from the eye using only irrigation or a cotton swab.
- Removing splinters or foreign material from areas other than the eye by irrigation, tweezers, cotton swabs or other simple means.
- Using finger guards.

- Using massages (physical therapy or chiropractic treatment are considered medical treatment for record-keeping purposes).
- Drinking fluids for relief of heat stress.

Incident

A mishap consisting of personal injury of less than Type C Mishap severity but more than first-aid severity, and/or property damage equal to or greater than $1,000, but less than $25,000.

Management

A generic reference to those individuals who hold supervisory or management positions within the Wind Tunnel Operations.

Manager

A generic reference to those individuals within the Division who hold Division or Branch chief or deputy chief positions, and those who hold general manager, Branch manager, and contract principle positions.

Medical Treatment Injury

OSHA recordable cases involving:

- Death.
- Days away from work.
- Restricted work or transfer to another job.
- Medical treatment beyond first aid (see "First Aid" in the definitions section).
- Loss of consciousness.
- Cases involving significant injury or illness diagnosed by a physician or other licensed health care professional, even if it does not result in death, days away from work, restricted work or job transfer, medical treatment beyond first aid, or loss of consciousness.
- Work-related needle stick injuries and cuts from sharp objects that are contaminated with another person's blood, human bodily fluids, tissues and organs, and other materials infected with the HIV or hepatitis B (HBV) virus such as laboratory cultures or tissues from experimental animals.
- Medical removal under the medical surveillance requirements of an OSHA standard (such as the Lead Standard).
- An employee’s hearing test (audiogram) reveals that the employee has experienced a work-related Standard Threshold Shift in hearing in one or both ears, and the employee’s total hearing level is 25 decibels (dB) or more above audiometric zero (averaged at 2000, 3000, and 4000 Hz) in the same ear(s) as the Standard Threshold Shift.
- An occupational exposure of an employee to anyone with a known case of active tuberculosis (TB), who subsequently develops a tuberculosis infection, as evidenced by a positive skin test or diagnosis by a physician or other licensed health care professional.

Mishap	An unplanned event that results in injury to non-NASA personnel caused by NASA operations; damage to public or private property (including foreign property) caused by NASA operations; occupational injury or occupational illness to NASA personnel; damage to NASA property caused by NASA operations; or mission failure. (NASA mishaps are categorized as Type A Mishaps, Type B Mishaps, Type C Mishaps, Mission Failures, or Incidents.)
Mishap—Type A	A mishap causing death and/or damage to equipment or property equal to or greater than $1 million. Mishaps resulting in damage to aircraft, space hardware, or ground support equipment that meet these criteria are included, as are test failures in which the damage was unexpected or unanticipated.
Mishap—Type B	A mishap resulting in permanent disability to one or more persons, hospitalization (within a 30-day period from the same mishap) of three or more persons, and/or damage to equipment, or property equal to or greater than $250,000, but less than $1 million. Mishaps resulting in damage to aircraft, space hardware, or ground support equipment that meet these criteria are included, as are test failures in which the damage was unexpected or unanticipated.
Mishap—Type C	Type C Mishap - A mishap resulting in damage to equipment or property equal to or greater than $25,000, but less than $250,000, and/or causing occupational injury or illness that results in a lost workday case. Mishaps resulting in damage to aircraft, space hardware, or ground support equipment that meet these criteria are included, as are test failures in which the damage was unexpected or unanticipated.
Mission Failure	A mishap of whatever intrinsic severity that, in the judgment of the Enterprise Associate Administrator/Institutional Program Officer, in coordination with the Associate Administrator for Safety and Mission Assurance, prevents the achievement of primary NASA mission objectives as described in the Mission Operations Report or equivalent document.
Standard Threshold Shift	A change in hearing threshold, relative to the most recent audiogram for that employee, of an average of 10 decibels (dB) or more at 2000, 3000, and 4000 Hertz in one or both ears.
Supervisor	A generic reference to those personnel within the Division who hold group leader, supervisor and shift lead and facility manager positions.

15.7 References

NASA/HQ	NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Recordkeeping, NASA NPG 8621.1.
Ames and Division Documents	Ames Health and Safety Manual, APG 1700.1
Forms	NASA Mishap Report, NF 1627
External Documents	OSHA Standard 29 CFR 1904: Recording and Reporting Occupational Injuries and Illnesses

End of Chapter

16. Safety Observations

16.1 Description

Purpose

The purpose of this chapter is to establish requirements and guidelines for a safety observation program that implements the Wind Tunnel Operations Division policy to eliminate workplace hazards.

The safety observation program does the following:

- Involves all personnel in the continuous processes of hazard identification and correction.
- Identifies and promotes safe conditions and practices throughout the workplace.

Scope

This chapter applies to civil servant personnel, support contractor personnel, temporary workers, visitors, subcontractors, and others under the jurisdiction of the Wind Tunnel Operations Division.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

16.2 Responsibilities

Managers and Supervisors

Managers and supervisors are responsible for the following:

- Taking actions within their authority to correct unsafe workplace conditions and practices.
- Establishing goals for subordinates regarding the implementation and application of this policy.
- Providing subordinates with the time required to conduct or participate in safety observations.
- Reviewing each Safety Observation Report (SOR), FO25, completed by their subordinates.
- Providing the resources to control or correct identified hazards within their authority, and seeking higher-level management support for controlling and correcting identified hazards that are outside their authority.
- Reviewing compiled data periodically to maintain cognizance of identified positive and/or negative trends.

- Periodically performing and documenting safety observations per the process described in the "Requirements" section.
- Retaining copies of all SORs completed by their subordinates.

Employees

Employees are responsible for the following:

- Taking actions within their authority to correct unsafe workplace conditions and practices.
- Completing a Safety Observation Report (SOR), FO25 to document commendable or unsafe workplace conditions and practices, and the actions taken or recommended for correcting them.
- Requesting observations of work locations or activities that they feel pose unacceptable hazards and risks to personnel.

Division Safety Office

The Division Safety Office is responsible for the following:

- Maintaining and updating this policy to ensure it remains current with corporate policy and contract needs.
- Compiling and analyzing completed SORs to ensure that appropriate corrective actions have been taken or are initiated.
- Conducting training to ensure that Division personnel understand the safety observation process, its purpose, and their responsibilities for the process, and techniques to be used for conducting formal observations.
- Periodically performing and documenting safety observations as described in the "Requirements" section.
- Retaining copies of all SORs.
- Retaining copies of all SOR data analysis reports.

16.3 Requirements

General

Observations of work activities offer a means of providing immediate positive and corrective feedback to those performing the activity, and the observation record provides documentation that can be analyzed over time to identify positive and negative trends, and issues that cannot be recognized easily through observation of a single location or activity.

Observations should be considered to be learning and training tools rather than a means of conducting organized "spying." The observer can provide different perspectives of the activity or location based on their unique knowledge and experiences.

The observers should seek to identify, document, and communicate positive conditions and actions as well as those that should be improved.

Observers should avoid interrupting critical activities that are in progress, unless they pose an imminent danger to personnel or equipment.

Supervisors and work crewmembers are expected to concur with a request to conduct an observation unless there is sound safety, operational, or procedural grounds for denying the request.

Safety Observation Reports should NOT identify the names of the individuals who were observed.

Formal Observations

Formal observations are those that are planned and coordinated in advance with the individuals to be observed and their supervisors or managers. Formal observations provide a method for conducting systematic reviews of our work activities. These observations identify best practices that can be shared with others, and areas needing improvement. They also provide a method for reviewing activities identified by management or employees as a source of safety or operational concern. Formal observations should be conducted as specified in the "Basic Observation Process" section.

Informal Observations

Informal observations are "observations of opportunity." They are not planned for or scheduled in advance. They involve conditions and activities that occur around an individual while they are performing their daily activities. Examples are an individual observing burned-out exit signs or emergency egress lighting while walking between work locations, or observing another worker’s exemplary or unsafe work practices while they are conducting other work in, or passing through, the same or an adjacent area. These things are just as important to take action on and document as those that are planned, since the objective of this program is to reduce workplace hazards. With most informal observations there will not be an opportunity to ask for the supervisor or work crew’s permission before proceeding, however, the observer should provide positive and corrective feedback to those who were observed when it is appropriate and possible to do so. The observation should be documented on a Safety Observation Report form as described in the "Basic Observation Process" section.

Basic Observation Process

The basic safety observation process is as follows:

Basic Observation Process

Step	Action
1	Select an activity to observe. This may be done at the direction of a manager, supervisor, or request of an employee.
2	The observer obtains permission from the supervisor and work crew to conduct the observation.
3	The observer conducts the observation.
4	The observer provides positive and corrective feedback to those who were observed.
5	The observer completes a Safety Observation Report, FO25, to document the findings from the observation, the causes of unsafe conditions or actions, corrective actions taken, and corrective actions recommended.
6	The observer retains the original SOR and provides copies to the following: • The observer's supervisor or manager, as appropriate. • The Division Safety Office.
7	The supervisor or manager reviews the submitted SOR form, and does one or both of the following, as appropriate: • Provides the resources required to control or correct identified hazards within their authority. • Seeks higher-level management support for controlling and correcting identified hazards that are outside their authority.
	NOTE Actions for controlling or correcting identified hazards may be initiated and tracked using the Division Action Item Database.

16.4 Training

Initial Training

Division personnel shall receive training upon publication of this document to prepare them for participation in the safety observation process.

Newly hired personnel shall receive safety observation training as part of their orientation process.

Refresher Training

Division personnel shall receive periodic re-training following significant changes in the safety observation process.

16.5 Records

SOR Copies	Copies of completed SORs shall be maintained by the following: • Supervisors or managers • The Division Safety Office
SOR Data Analysis Reports	SOR data analysis reports shall be maintained by the Division Safety Office.

16.6 References

Forms	Safety Observation Report (SOR), FO25

End of Chapter

17 Energized Electrical Work

17.1 Description

Purpose

The Wind Tunnel Operations Division's policy is to eliminate or control the potential for injury, facility, or equipment damage that could result from work on energized, or potentially energized electrical equipment, wiring, distribution systems, circuits, etc., by requiring their de-energization; or under special circumstances, the use of appropriate protective equipment and development and implementation of special work practices before the work begins. This standard establishes requirements and processes to implement that policy.

Scope

This standard applies to all employees, temporary workers, support contractor personnel, and subcontractor personnel working under the authority of the Wind Tunnel Operations Division. It applies to all servicing and maintenance activities where there is a potential for exposure to energized or potentially energized electrical equipment, wiring, distribution systems, circuits, etc., operating at greater than 50 volts to ground and those involving less than 50 volts to ground if there is an increased potential for exposure to electrical burns or explosion due to electric arc.

Any deviations from, or exception to these requirements must be approved in writing by the Wind Tunnel Operations Division Chief and the Support Contractor General Manager, or their designees, as appropriate.

Document Control

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Authority

All personnel are authorized to refuse to perform work without repercussion when conditions or practices associated with an energy-control activity pose an imminent danger of injury or harm to personnel, facilities, equipment, or the environment.

Penalties

The deliberate failure to follow the requirements of this document is grounds for disciplinary action up to and including discharge from employment.

17.2 Responsibilities

Managers

Managers have the following responsibilities regarding energized electrical work:

- Provide overall guidance for the energized work control program.
- Ensure that supervisors are aware of and follow the requirements of this standard.
- Ensure the availability of the equipment and personnel required to implement this standard.
- Take all necessary steps to enforce the requirements found herein.
- Periodically monitor the work activities of subordinates for compliance with this standard.

Electrical Supervisors

Electrical Supervisors have the following responsibilities regarding energized electrical work:

- Designate/authorize Qualified Electricians.
- Ensure each of the Qualified Electricians is trained in this standard.
- Ensure that work assignments are evaluated to identify situations where personnel will be performing energized electrical work.
- Evaluate situations where personnel are performing energized electrical work and ensure that associated risks are identified, evaluated, and adequately controlled.
- Ensure that appropriate information regarding energized electrical work and requirements are incorporated into Safe Plans of Action (SPA), work plans, procedures, and work orders.
- Review and sign all SPAs for work on energized electrical equipment. (See Sec. 17.6 Work Practices, General.)
- Monitor work to ensure each Qualified Electrician complies with this standard.
- Conduct and document the results of visual observations of energized electrical work procedures using the Safety Observation Process contained in Chapter 16 of the Wind Tunnel Operations Division and Support Contractor Safety Manual, AO27-9991-XS1.

Continued on the next page

Electrical Supervisors (cont.)

- Take actions to correct errors in procedures and failures of personnel to follow established procedures.
- Maintain records of inspections and tests for voltmeters and electrical testers.
- Maintain records of inspections, repairs, and tests done on personal protective equipment such as gloves and hot line sticks.

Supervisors

Supervisors have the following responsibilities regarding energized electrical work:

- Review the requirements of this chapter for applicability to their employee's work activities.
- Evaluate employee work assignments to identify when their employees may be working in situations that are covered by the scope of this chapter.
- Designate and authorize personnel who are not "Qualified Electricians," such as Electrical Engineers, Electrical Technicians, Instrument Engineers, and Instrument Technicians, in accordance with section 17.3 of this Chapter to work on non-insulated, energized circuits and apparatus over 50 volts.
- Ensure that employees who may come in contact with non-insulated, energized circuits and apparatus over 50 volts are familiar with the construction and operation of the equipment, understand the hazards involved, and are trained to recognize and avoid them through the use of procedures and personal protective equipment.
- Conduct and document the results of visual observations of energized work procedures using the Safety Observation process contained in Chapter 16 of this manual.
- Maintain records of inspections and tests for voltmeters and electrical testers.
- Maintain records of inspections, repairs, and tests done on personal protective equipment such as gloves and hot line sticks.

Facility Managers, Chief Engineers, and Service Managers

Facility Managers, Chief Engineers, and Facility Service Managers (FSM) responsibilities regarding energized electrical work include coordinating with representatives of subcontractors or other NASA organizations to:

- Ensure the safety of Wind Tunnel Operations Division personnel.
- Minimize the potential for adverse effects on operations.
- Ensure the safety of equipment and facilities.

Competent Person

Competent person responsibilities are as follows:

- Inspect insulating blankets to ensure that they are in good condition and to ensure that they have the correct Type and Class ratings for their intended uses.
- Inspect voltmeter, electrical testers, and leads to ensure that they are in good condition and that their calibrations are current.

Employees

Employees who will perform work on energized, or potentially energized electrical equipment have the following responsibilities:

- Comply with the requirements of this standard.
- Perform their assigned work in accordance with their training and specific energized electrical work procedures.
- Avoid performing electrical work until they are designated and authorized by their Supervisor or the Electrical Supervisor, as appropriate, to perform such work.
- Evaluate work activities before starting them to determine if they involve energized electrical work.
- Assist supervision with the development and validation of procedures for energized electrical work.
- Report identified errors or omissions in procedures to supervision so that appropriate corrective actions can be taken.
- Inspect electrical personal protective and test equipment as specified in this chapter before and after each use.
- Remove any damaged personal protective and test equipment from use and report it to their supervisor, Tool Crib Attendant, or Safety Office as appropriate to prevent further use and to identify the cause of the damage.

Division Safety Office

The Division Safety Office responsibilities include the following:

- Periodically review, revise, and maintain this standard.
- Assist supervisors and managers performing inspections as requested.
- Conduct periodic audits of work activities to evaluate the level of understanding and compliance with these requirements.

Subcontractors

Subcontractors shall demonstrate that they have trained their employees in requirements and procedures for energized electrical work, and comply with the direction provided by Wind Tunnel Operation Division or Support Contractor when they participate in activities addressed within the scope of these requirements.

Project Managers and Hosts/Escorts

Project managers and 'hosts/escorts' responsibilities include the following:

- Evaluate planned customer, subcontractor, and guest activities to identify potential energized electrical work.
- Ensure customers, subcontractors and guests are aware of and conform to this standard.

17.3 Requirements

Lockout Tagout

Prior to working on or around electrical equipment, determine the equipment's energy state. In all situations where exposure to energized or potentially energized equipment could occur, make every effort to de-energize the equipment (and other equipment in the area which might effect the work) prior to beginning the work. Lock and tag equipment in accordance with the Lockout and Tagout Chapter of this manual (Chapter 6).

Qualified Electricians

Only Qualified Electricians designated and authorized by the Electrical Supervisor to perform electrical work according to the requirements of this Standard (Chapter 17) may work on and/or test energized or potentially energized electrical equipment, wiring, distribution systems, circuits, etc.

Work Functions Restricted to Qualified Electricians/ Qualified Energized Electrical Workers

The following duties/functions may only be performed by Qualified Electricians:

- Operate any circuit switching device 480 volts or above, except motor starters and valve operators from push button stations.
- Test or troubleshoot electrical equipment.
- Repair, alter, or otherwise work on electrical equipment.
- Remove or install fuses.
- Perform work on non-insulated energized circuits and apparatus over 50 volts.
- Perform work within 10 feet of non-insulated energized circuits and apparatus that are not barricaded or covered or otherwise guarded to prevent electrical shock hazards and contact by tools, equipment, or personnel.

Notes: Qualified Energized Electrical Workers

- Qualified Electrical Engineers (EEs) and Electrical Technician (ETs) may also work on energized electrical equipment providing they are trained in this standard and are designated and authorized by the Electrical Supervisor for the work to be performed.
- Instrumentation Engineers (IEs) and Instrument Technicians (ITs) may also work on energized electrical equipment up to 125v such as the BLAMS system, the Facility Control System interface, and in various instrumentation racks, etc. They must be designated and authorized by their supervisor to perform this work, and they and their supervisor shall be trained in this standard to understand the limits of their authorization.

Electrical Testing Equipment

No person shall attempt to use any type of test equipment unless they are trained, qualified and competent to do so and are familiar with the equipment, its proper operation and any limitations. (On the job training is acceptable.)

Electrical Standby Persons

Only employees designated and authorized by the Electrical Supervisor to observe electrical work according to the requirements of this Standard may stand by and observe work on energized or potentially energized electrical equipment, wiring, distribution systems, circuits, etc.

Electrical Standby Persons shall be equipped with a level of protection equal to that of the Qualified Electrician performing the work (at a minimum they shall wear high voltage protective gloves of proper rating and safety glasses with side shields), and remain at the site of the work at all times while the work is in progress.

17.4 Use of Protective Equipment

Rubber Insulating Gloves

Use rubber insulating gloves as follows:

- Use rubber insulating gloves of the proper rating when working on energized or potentially energized equipment, circuits etc.
- Wear leather protector gloves with rubber insulating gloves to prevent damage. If the protectors have been used for any other purpose, do not use for protecting insulating gloves. Do not use protectors with holes, tears, cuts, chemical or oil contamination, or any other defects that diminish their capacity to protect.
- Rubber insulating gloves shall be free of any marking, labels, or adhesive tape other than those applied by the manufacturer or testing facility.

Rubber Insulating Blankets

Use rubber insulating blankets as follows:

- Use rubber insulating blankets to shield energized electrical equipment such as terminals, bus works, etc. when performing work on or near energized equipment.
- Use is restricted to providing **temporary** electrical insulation of energized equipment.
- Rubber insulating blankets shall be of the proper class, type and voltage rating for the task being performed.
- Rubber insulating blankets shall be free of any marking, labels, or adhesive tape other than those applied by the manufacturer or testing facility.

Flash Suits and Thermo Gloves

Use flash suits consisting of thermo-insulated pants, coat, hood with integral face shield and gloves as follows:

- Flash suits and thermo gloves shall be NFPA approved.
- Use flash suits and thermo gloves when working on energized or potentially energized equipment, circuits, etc. above 480 volts.
- Flash suits and thermo gloves shall be free of contamination, and damage such as thin wear spots, rips, tears, and holes.

Safety Footwear

Qualified Electricians shall use footwear with an EH (electrical hazard) rating in accordance with ANSI Standard Z41, American National Standard for Personal Protection-Protective Footwear.

Fire Resistant Coveralls

Qualified Electricians shall wear fire resistant coveralls as follows:

- Fire resistant coveralls shall be made of heat resistant fabrics and components, resist ignition and not continue to burn when removed from the ignition source.
- Fire resistant coveralls shall meet the requirements of NFPA 70E (1995 edition) or NFPA 1975 (1994 edition), or meets the flame resistant requirements of ASTM F1506-94, and is acceptable under OSHA Final Rule 1910.269.
- Fire resistant coveralls shall be worn when working on energized or potentially energized equipment, circuits, etc.
- Fire resistant coveralls shall be free of contamination, and damage such as thin wear spots, rips, tears, and holes.
- Fire resistant coveralls shall not be used for fire entry or structural fire fighting activities and will not provide personal protection from chemical exposures.

Eye/Face Protection

Eye and face protection shall meet the requirements set by the American National Standards Institute (ANSI). Document ANSI-Z87.1, Practice For Occupation and Educational Eye and Face Protection. Additionally side shields are required to be used with safety glasses.

Safety glasses with side shields are required when working on energized electrical equipment.

Hot Line Stick

Hot line sticks shall be used when applying grounding cables to a de-energized bus/bus work.

17.5 Inspections, Storage, and Care of Personal Protective and Test Equipment.

Electrical Testing Equipment

Inspection, storage, and care requirements for electrical testing equipment include:

- Electrical test equipment shall be evaluated for proper operation immediately before and after the test.
- Electrical test instruments, equipment, and all associated leads, cables, power cords, probes, connectors, etc. shall be visually inspected for external defects and damage before use. If there is a defect or evidence of damage that could expose someone to injury, the defective or damaged item shall be removed from service, and may not be used again until repaired and tested to assure the equipment is safe to use.
- Voltmeters shall have a current calibration decal attached.
- All electrical test equipment shall be stored in a clean dry location, kept clean, and in good operating condition.
- Voltage tester leads shall be kept in a separate pouch (other than tool pouch), to prevent damage by other objects.

Personal Protective Equipment (General)

General inspection and storage requirements for personal protective equipment include:

- All protective equipment required by this standard, including gloves, mats, safety shoes, clothing, eye and face protection, hoods, flash suits, etc. shall be inspected by the user before and after each use, and be maintained in compliance with this standard and the manufacturers guidelines. Any defective personal protective equipment shall be immediately removed from service and properly repaired or replaced.
- All inspections, repairs, and tests done on protective equipment shall be documented by a Competent Person or approved outside testing facility performing the inspection, repair, and/or test. All such documentation is to be maintained on site and available for review.

Rubber-Insulating Gloves

Inspection, storage, and care requirements for rubber insulating gloves include:

- Rubber insulating gloves shall be electrically tested by an approved outside testing facility at intervals not to exceed six months for used and twelve months for unused. The type, size, class, and latest test date must be clearly marked on each glove. Any glove that fails the electrical test shall be immediately removed from service and destroyed.
- The wearer shall inspect rubber-insulating gloves before each use and at any time there is reason to suspect any defect or damage. They must be inspected over the entire surface and be gently rolled between the hands to expose any defects. If any defects are found (such as holes, tears, punctures or cuts, ozone cutting or checking, imbedded foreign objects, or texture changes such as softening, hardening, becoming sticky or inelastic), the gloves shall be immediately removed from service and destroyed.
- Rubber insulating gloves shall be given an air test before each use and at any time there is reason to suspect damage. Perform this test by rolling the cuff tightly toward the palm in such a manner that air is trapped inside the glove. Once this is accomplished look, listen, and feel for air leaks throughout the glove. If any leaks are found, the glove shall be immediately removed from service and destroyed. Note: No part of the glove is to be stretched more than 1.25 times its normal size.
- Rubber insulating gloves shall be stored in a manner to prevent physical damage. Do not store them folded, creased, or compressed. The storage location should be free from chemicals, solvents, sunlight, heat, moisture, ozone, or any objects that could cause damage.
- Rubber insulating gloves shall be kept and carried in a box, bag, or other container intended exclusively for this purpose. These containers shall be kept free of chemicals, dirt, or any other material that could harm the gloves or protectors.
- Clean rubber insulating gloves of any grease, perspiration, etc. after each use. Use only a mild, non-bleaching soap, and rinse with clean water. The cleaning agent must not degrade the insulating or physical properties of the gloves.

Rubber Insulating Blankets

Inspection, storage, and care requirements for rubber insulating blankets include:

- Rubber insulating blankets shall be electrically tested by an approved outside testing facility at intervals not to exceed twelve months. Any blanket that fails the electrical test shall be repaired and retested before being put back into service.
- The user shall visually inspect rubber-insulating blankets before each use and any time there is reason to suspect any defect or damage. They are to be inspected on both sides over the entire blanket surface for defects and embedded materials. If any defects are found (such as holes, tears, punctures, or cuts, severe corona cutting or ozone checking, imbedded foreign objects, or texture changes such as softening, hardening, becoming sticky or inelastic), the blanket shall be immediately removed from service and repaired and retested by an approved electrical testing facility before being put back into service.
- A designated Competent Person shall visually inspect rubber-insulating blankets at intervals not to exceed six months to determine that the users are maintaining such equipment in a satisfactory condition.
- Rubber insulating blankets shall be stored in a cool, dark, dry location that is free of chemicals, solvents, ozone, vapors, fumes, electrical discharges and sunlight. They are to be stored in a container, bag, box, or compartment designed for and used exclusively for this purpose. They shall not be stored folded, creased or compressed in any manner that would cause stretching, compression, or abrasion.
- Do not use tape to secure blankets for shipment or storage.
- Clean rubber insulating blankets as necessary to remove foreign substances or chemicals. Use only a mild non-bleaching soap, and rinse with clean water. Air-dry the blanket after washing. The cleaning agent must not degrade the insulating or physical properties of the blanket.

Hot Line Sticks

Inspection, storage, and care requirements for hot line sticks include:

- Hot line sticks shall be electrically tested by an approved outside testing facility at intervals not to exceed 24 months. Any hot stick that fails the electrical test (or has any defect or contamination which could adversely effect the insulating qualities or mechanical integrity) shall be repaired and retested before being put back into service.
- Hot line sticks shall be wiped clean and visually inspected by the user before each use, and at any time there is reason to suspect any defect or damage. They are to be inspected for freedom from dirt or oil contamination, for freedom from evidence of corona effects, and for proper physical operation. If any defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the hot stick is present after wiping, it shall be immediately removed from service and repaired and retested by an approved outside testing facility before being put back into service.
- Hot line sticks shall be stored in a manner to prevent damage. The storage location should be free from chemicals, solvents, sunlight, heat, moisture, ozone, or any objects that could cause damage.

Flash Suits and Thermo gloves

Inspection, storage, and care requirements for flash suits include:

- The user shall visually inspect the flash suit and thermo-gloves before each use, and any time there is reason to suspect any defect or damage. If any defects are found (worn spots, rips, tears, holes), or excessive contamination (oil, dirt, grease, etc.) is found, the flash suit or gloves shall be immediately removed from service and repaired, replaced or cleaned as appropriate.
- Flash suit and thermo gloves shall be stored in a manner to prevent damage. The storage location should be free from chemicals, solvents, sunlight, heat, moisture, ozone, or any objects that could cause damage.
- Turn contaminated or damaged flash suits or thermo gloves in to supervisor for cleaning, repair, or replacement.
- A vendor normally cleans the flash suits. Cleaning instructions are to machine-wash with heavy-duty detergent in hot water (140 deg. F / 60 deg. C). Do not bleach. Tumble dry in low heat (160 deg. F / 71 deg. C). Do not line-dry in sunlight.

Safety Shoes

Qualified Electricians shall inspect their safety shoes daily for excessive wear, rips, holes, tears and contamination. If any defects or contamination is found the safety shoes shall be replaced.

Fire Resistant Coveralls

Qualified Electricians shall inspect their coveralls daily for excessive wear, rips, holes, tears and contamination. If any defects or contamination is found the coveralls shall be replaced or laundered as appropriate.

- Turn contaminated or damaged coveralls in to supervisor for cleaning, repair, or replacement.
- The vendor normally cleans Fire resistant coveralls where they were procured.
- Cleaning instructions are to machine-wash and tumble-dry. Use no soap or chlorine bleach.

17.6 Work Practices

General

Every reasonable effort shall be taken to de-energize electrical equipment to be worked on and other electrical equipment in the area that may affect the work to be performed. If the equipment cannot be de-energized because doing so creates additional or increased hazards, or is not feasible due to equipment design or operational limitations, personnel shall obtain approval to proceed from their Supervisor, and/or the Electrical Supervisor, and/or the Facility Chief Engineer as appropriate before starting work. Examples of additional or increased hazards include deactivation of critical control or alarm systems, interruption of hazardous location ventilation equipment, or removal of critical illumination for an area. Examples of work that may be performed on or near energized circuit parts because of infeasibility due to equipment design or operational limitations include testing of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous industrial process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

Before beginning work on energized or potentially energized electrical equipment or circuits, personnel who will be performing the work must complete an Electrical Safety Checklist (FO1-11/03) and obtain the required approval signatures. The checklist documents the safety measures that will be taken to ensure personnel safety while they perform the work, and when approved, authorized the work to commence. The form is available online at http://pubsgroup.arc.nasa.gov/FO_Docs/Forms.html.

After obtaining approval to proceed as described above, and before proceeding, the work crew must develop a Safe Plan of Action (SPA). Completed SPAs shall be reviewed and signed by the Supervisor(s) or Branch Chief/Manager of those who will perform the work. SPAs for work to be performed on an off shift may be evaluated and approved by phone and signed off during the next regularly scheduled shift.

Troubleshooting

The Electrical Supervisor's and the Facility Chief Engineer's approval need not be obtained and the Electrical Safety Checklist and the Safe Plan of Action (SPA) forms do not need to be completed when simple troubleshooting is needed. Though a hazard analysis needs to be done e.g. verifying voltages, proper personal protective equipment is being used etc.

Simple troubleshooting is as follows:

- Maximum voltage is 600 volts or lower.

Continued on the next page

Troubleshooting (Cont.)

- Checking voltages with a multimeter, or checking circuit current with a clamp-on current measuring device to analyze a problem (as long as wires are not being lifted).
- Checking fuse voltages or pulling and replacing fuses.

When analyzing a problem that needs to go beyond simple troubleshooting, then the guidelines stated under 17.6 Work Practices the General paragraph will be followed.

Safe Work Practices

Follow all safe work practices while working on or near energized or potentially energized electrical equipment:

- Only Qualified Electricians shall enter energized electrical substations. Unauthorized Employees may enter when accompanied by a Qualified Electrician; however, the Qualified Electrician must ensure that the clearance distances specified in the "Overhead Power Lines" portion of this section for Unauthorized Employees are maintained at all times.
- Consider every electrical conductor or circuit part to be energized until proven otherwise.
- Never assume that electrical insulation is intact. Take the necessary precautions prior to contacting insulated conductors.
- Wear appropriate head protection, gloves, eye protection, rubber-soled shoes, shields, fire resistant coveralls, and non-conductive clothing when working on energized electrical equipment. See Sec. 17.5 for use of protective equipment.
- Wear clothing, including undergarments, made of cotton. NOTE: It is a good practice for personnel, such as Qualified Electrical Engineers, Qualified Electrical Technicians, Instrument Engineers, and Instrument Technicians who are conducting work under the exclusion notes contained in Section 17.3, Work Functions Restricted to Qualified Electricians, to comply with this practice, however, it is not required that they do so.
- Use insulated tools (screwdrivers, pliers, etc.) of a proper rating for the voltage to be encountered.
- When working near energized terminals, bus works, etc. shield them to prevent inadvertent contact. Use shielding of a proper rating.

Continued on the next page

Safe Work Practices (Cont.)

- Remove all jewelry before working near energized or potentially energized equipment.
- Never reach blindly into electrical cabinets or enclosed areas.
- Ensure all work areas are well lit.
- Secure electrical cabinet doors to prevent them from closing.
- Keep the work area clear of non-essential tools and equipment.
- Handle conductive objects carefully when in the area of electrical equipment.
- Identify all sources of electricity and take the appropriate safety measures before proceeding with the work.
- Clearly visible identification plates shall be provided for electrical equipment.
- Maintain proper clear workspaces and clearances as specified in the Clear Workspaces and Overhead Power Lines paragraphs of this section.

Working on Electrical Equipment Above 480 Volts

Work on energized or potentially energized electrical equipment 480 volts or above is prohibited unless the following conditions are met:

- All work shall be performed in accordance with the provisions set forth in this standard, and in compliance with all other applicable safety requirements. See the review and approval requirements contained in the “General Requirements” subsection of section 17.6.
- A designated Qualified Electrical Standby Person shall be present when work is being performed on energized or potentially energized circuits of 480 volts or above.
- The designated Qualified Electrical Standby Person shall be equipped with a level of protection equal to that of the Qualified Electrician performing the work.
- The Electrical Supervisor shall be notified that such work will be done, the exact location of the work, when the work will begin, and again after the work is complete.

Fuse Handling

When fuses must be installed or removed with one or both terminals energized at more than 300 volts or exposed parts energized at more than 50 volts, the tools and rubber insulating gloves are to be rated for the voltages used. Eye protection with side shields shall be worn when installing or removing fuses.

Racking Breakers

Breaker racking at 480 volts or above is a critical procedure. Breaker racking at 480 volts or above shall only be performed by certified operators who shall follow the associated breaker racking procedure/work instruction available on line at http://pubsgroup.arc.nasa.gov/Maintenance/UPWT.html#Auxiliaries.

Electrical Testing

Only Qualified Electricians shall perform tests on energized or potentially energized electrical circuits or equipment above 50 volts. When performing these tests, adhere to the following:

- Test equipment shall and its use shall adhere to the requirements of Sec. 17.3, Requirements, Electrical Testing Equipment; and Sec. 17.4, Inspections, Storage, and Care, Electrical Testing Equipment.
- Use test equipment, instruments, and their accessories rated for the circuits to which they will be connected, and designed for the environment in which they will be used.
- Test equipment that has been exposed to excessive moisture shall be immediately removed from service and may not be returned to service until repairs and tests have been performed to assure its safe operation.
- Solenoid-type testers (commonly known as “wiggies”) produce a spark during use and shall not be used in flammable or explosive environments. e. g. battery houses, flammable storage areas, oil houses, etc.
- Electrical test equipment rated for use on 2300 volts or higher shall be electrically tested and calibrated by an approved testing facility at intervals not to exceed twelve months. If the integrity of such equipment is suspect, it shall be taken out of service until it is tested at an approved testing facility and deemed accurate and safe for use. Records of all tests and repairs are to be maintained on file.

Note: The same exclusion applies here for EEs, IEs, and Its as previously discussed in Sec. 17.3.

Overhead Power Lines

When working in the vicinity of overhead power lines, Qualified Electricians may not approach nor carry conductive objects any closer than shown in the following table with these exceptions:

- The conductive object has an approved insulating handle.
- The person is insulated from the energized part by the appropriate personal protective equipment rated for the expected voltage.
- The energized part is insulated from the person and all other conductive objects in the area.
- The person is insulated from all conductive objects in the area.

Approach Distances for Overhead Power Lines

300v and less	Avoid Contact
Over 300V, not over 750V	1 ft. 0 in.
Over 750V, not over 2kV	1 ft. 6 in.
Over 2kV, not over 15 kV	2 ft. 0 in.
Over 15kV, not over 37kV	3 ft. 0 in.
Over 37kV, not over 87.5kV	3 ft. 6 in.
Over 87.5kV, not over 121kV	4 ft. 0 in.
Over 121kV, not over 140 kV	4 ft. 6 in.

Unqualified Employees working from the ground or an elevated position near overhead lines, may not use or contact any conductive object that comes closer to unguarded, energized overhead lines than the following distances:

- 10-feet for voltages to ground that are less than or equal to 50kV
- 10-feet plus 4-inches for each additional 1kV above 50 kV.

Conduit and Cable Dismantling

Before commencing the dismantling of conduit or electrical cable, perform the following procedures:

- A Qualified Electrician shall de-energize, lockout, and tagout electrical circuits to be dismantled, in accordance with the Lockout and Tagout Chapter of this manual (Chapter 6).
- Qualified Electricians shall perform all disconnects, identification, and verification of conduits.
- A Qualified Electrician shall check all effected conductors with an appropriate voltage tester to assure the conductors (to be dismantled) have been de-energized and are out of service.
- After determining that all electrical circuits are de-energized, locked, and tagged out, a Qualified Electrician shall disconnect all cables and conductors at all points of termination (energy source and equipment being served).
- A Qualified Electrician shall tag conduit and/or cables to be dismantled at each end, each intersection, and at intervals not to exceed fifty feet in any direction along the entire length of the conduit and/or cable.
- Each identification tag shall clearly specify the name of the Qualified Electrician who performed the work and the date.
- All electrical cable and/or conduit dismantled shall be removed in a safe manner and placed where it will not cause a tripping hazard.
- Make every effort to ensure that the Qualified Electrician who began the dismantling work continues with the work until completion. If the Electrician performing the work is absent or unavailable a second Qualified Electrician may assume the task after verifying the status and energy state of the work.

Clear Workspaces

A clear working space shall be maintained to allow safe access to energized parts operating at 600 volts or less when personnel will be required to gain access to them for examination, adjustment, servicing, or maintenance while energized. The clear working space may not be less than shown in the following table. In addition to the dimensions shown in the table, the workspace may not be less than 30 inches wide in front of the electric equipment. Clearance distances shall be measured from the exposed live parts, or from the front of the enclosure or opening if the energized parts are enclosed. For the purposes of these clearance requirements, concrete, brick, and tile walls are considered to be "grounded parts." Working space is not required in back of assemblies such as dead-front switchboards or motor control centers where there are no replaceable or adjustable parts such as fuses or switches on the back, and where all connections are accessible from locations other than the back.

	Minimum Clear Distance for the Specified Condition		
Nominal Voltage To Ground	**Condition A**	**Condition B**	**Condition C**
0-150	3(1)	3(1)	3
151-600	3(1)	3.6	4

(1) Minimum clear distances may be 2 feet 6 inches for installations built before April 16, 1981.

Condition A: There are exposed live parts on one side and no live or grounded parts on the other side of the working space, or there are exposed live parts on both sides that are effectively guarded by suitable wood or other insulating material. Insulated wire or insulated bus bars operating 300 volts or less are not considered "live parts."

Condition B: There are exposed live parts on one side and grounded parts on the other side.

Condition C: There are exposed live parts on both sides of the workspace [not guarded as provided in Condition (a)] with the operator in between.

17.7 Training

Lockout/Tagout

Before implementing lockout tagout procedures or being allowed to work on electrical equipment, employees shall have completed the Division's lockout/tagout training program.

Qualified Electricians/ Qualified Energized Electrical Workers

All personnel performing work within the scope of the chapter shall possess the experience and education necessary to safely and properly perform this work, and shall have successfully completed the following:

- Wind Tunnel Operations Division Electrical Safety Training Program, Part I (Safe Work Practices).
- Wind Tunnel Operations Division Electrical Safety Training Program, Part II (Qualified Electrician Training).
- Wind Tunnel Operations Division and Support Contractor Safety Manual, Chapter 17 - Energized Electrical Work.
- Division's lockout/tagout training program.

Electrical Standby Persons

Electrical Standby Persons shall be trained in the applicable energized electrical procedures, and in emergency rescue and response for electrical shock victims.

Refresher Training

Refresher Training shall be provided to Qualified Electricians and Electrical Standby Persons on an annual basis. The purpose of this retraining is to briefly reacquaint them with the requirements of this standard and with specific procedures (such as breaker racking), to communicate lessons learned, and to ensure that they are provided with the opportunity to voice any questions or concerns they have with the Electrical Safety Program.

Additional refresher training will be performed whenever:

- There is a change in job assignments.
- A change in equipment or processes that may present new hazards.
- A change in procedures for performing work on energized or potentially energized electrical equipment wiring, distribution systems, circuits, etc.
- A periodic inspection of an energized electrical work procedure reveals reason to believe that there are deviations from or inadequacies in the employee's knowledge or use of the procedure.

On the Job Training	On-the-job training (OJT) is taught over time by supervisors, mentors or other experienced persons during normal working periods (e. g. becoming familiar with prints, learning the main drive electrical system, etc.). After a period of time working in the area(s) a test is given to determine the extent of the knowledge and understanding gained. When the test is passed at 100% then and only then is the person authorized to stand a shift or perform electrical work on his own.

17.8 Definitions

Electrical Equipment	Electrical equipment consists of wiring, circuits, switches, switchgear, fuses, breakers, electrical distribution systems, and any other equipment or systems capable of containing electrical energy.
Energized	Equipment that contains or has the potential to contain electrical energy.
Potentially Energized	Electrical equipment capable of containing electrical energy that has not been locked out, tagged out, and verified as de-energized by proper testing methods.
Competent Person	A person with recognized expertise and extensive experience and knowledge in the applicable field who is capable of inspecting, analyzing, evaluating and specifying procedures and standards for energized electrical work and the associated protective equipment.
Exposure	Where hazards are present, or could be created that might result in harm to personnel, equipment, or the environment if not properly controlled.
Maintenance	Workplace activities such as constructing, installing, setting-up, adjusting, inspecting, modifying, maintaining, cleaning, testing, and servicing equipment.
Qualified Electrical Standby Person	An employee trained in energized electrical procedures, emergency rescue and response for electrical shock victims, and qualified and authorized by the Wind Tunnel Operations Division (delegated to the Electrical Supervisor) to stand by and observe work on energized or potentially energized electrical equipment. In the case of breaker racking procedures, the Electrical Standby Person has a hard copy of the racking procedure in hand, and guides progress through the procedure.
Qualified Electrician	An employee trained and experienced as a journeyman electrician, trained in this Standard, and in energized electrical procedures, and qualified and authorized by the Wind Tunnel Operations Division (delegated to the Electrical Supervisor) to perform work on energized or potentially energized electrical equipment.

Qualified Energized Electrical Workers	Employees, who are designated by the Electrical Supervisor/Supervisor after completing the requirements in the Training section17.7, are authorized to work on energized electrical equipment following the Work Functions in the Requirements section 17.3.
Subcontractors	Individuals or organizations to whom contracts are issued for services either directly by the Wind Tunnel Operations Division, or by the Support Contractor on behalf of the Wind Tunnel Operations Division.
Support Contractor	The company holding the Wind Tunnel Operations Division's Aerospace Testing Facility Operation and Maintenance contract.

17.9 References

Ames and Division Documents	Ames Health and Safety Manual, APG 1700.1
	Wind Tunnel Operations Division Configuration Management Procedures, A027-9391-XB4
	ANSI-Z87.1 - Practice For Occupation and Educational Eye and Face Protection
	ANSI-Z41 – American Standard for Personal Protection-Protective Footwear.
	ASTM F1506 – Standard Performance Specification for Flame Resistant Textile Materials for Weaving Apparel for use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards
	OSHA 29 CFR 1910: Subpart S, Electrical
	OSHA 29 CFR 1926: Subpart K, Electrical
	Electrical Safety Training Part 1: Safe Work Practices Part 2: Qualified Electrician Training
	NFPA 70E - Standard for Electrical Safety Requirements for Employee Workplaces
Forms	Electrical Safety Checklist – Document # FO1-11/03

End of Chapter

18. Respiratory Protection

18.1. Description

Purpose

Wind Tunnel Operations Division (Division) policy is to reduce the risk of occupational illnesses by ensuring that appropriate respiratory protective equipment (PPE) is selected, provided, used, and maintained. It is also Division policy that personnel are trained in its appropriate use and limitations. The purpose of this chapter is to establish requirements and guidelines that implement this policy within the Division.

Scope

This chapter applies to civil servant and support contractor personnel, temporary workers, visitors, subcontractors, and others under the jurisdiction of the Wind Tunnel Operations Division who specify, select, use, or maintain respiratory protection. Those who supervise these individuals or their work activities are also subject to this chapter. Respiratory protective equipment includes:

- Atmosphere supplying respirators such as self-contained breathing apparatus (SCBA) and airline supplied respirators.
- Full-facepiece and half-facepiece chemical and/or particulate air purifying respirators.
- Powered Air Purifying Respirators (PAPR).
- Disposable air purifying respirators, including nuisance dust respirators.

General

OSHA has established stringent requirements for the use of respiratory protective equipment since incorrect usage can have severe consequences, up to and including death.

This chapter contains requirements for respirator selection, use, and maintenance; as well as respirator user training, medical qualification, and fit testing.

This chapter meets OSHA's requirements for a written respiratory protection program.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

18.2. Responsibilities

Managers

Managers are responsible for the following:

- Providing the resources needed for evaluating, designing, and installing engineering controls for airborne contaminants to eliminate the need for respirators when it is feasible to do so.
- Ensuring that supervisors evaluate the feasibility of using means other than respirators for eliminating or controlling employee exposure to airborne contaminants.
- Providing required respiratory protective equipment at no cost to the users.

Supervisors

Supervisors of respirator wearers are responsible for the following:

- Maintaining familiarity with respiratory protection use requirements.
- Substituting less hazardous materials or using engineering controls when feasible to eliminate the need for respirator use.
- Identifying respirator users under their supervision.
- Completing an ARC Form 28, Request for Respirator Training, for each employee who will use a respirator and forwarding it to the Division Safety Office for review, approval, and signature.
- Ensuring that employees receive a medical evaluation and training before being allowed to use a respirator, and annually thereafter.
- Ensuring that employees do not use tight-fitting facepieces under any conditions where there is an interference with the facepiece seal. See the section entitled “General Respirator Descriptions and Requirements.”
- Ensuring respirator users select and use their respirators in accordance with the requirements of this chapter.
- Ensuring that employees clean and store their respirators properly.
- Allowing employees to leave the respirator-use area as necessary to:
    - Wash their faces and respirator face pieces to prevent eye or skin irritation associated with respirator use.
    - Correct problems in respirator function such as: vapor or gas breakthrough, changes in breathing resistance, or leakage of the face piece.
    - Replace the respirator or the filter, cartridge, or canister elements.
- Ensuring that compressed breathing-air systems are properly maintained and tested quarterly.

Respirator Users

Respirator users are responsible for the following:

- Using respiratory protection in accordance with the requirements of this chapter, their training, and the respirator manufacturer's instructions.
- Attending required initial and annual respiratory protection training.
- Obtaining initial and annual respirator medical clearances from the Ames Health Unit or other designated health care professional.
- Wearing only those respirators for which they are specifically trained, fit tested, and authorized.
- Inspecting their respirators before and following each use to identify damage or dysfunctions that would prevent them from providing the expected level of protection. Damaged or dysfunctional respirators shall be repaired or replaced before proceeding with activities that require their use.
- Performing positive and negative pressure fit-checks before each use.
- Informing their supervisor of any situations or conditions that could prevent respirators that they have been fit tested for from sealing properly. Examples of such conditions include changes in facial contours due to: weight gain or loss, the use of dentures, and scaring that resulted from surgery or injuries.
- Ensuring that facial hair does not interfere with the face seal at any time during the respirator's use. See the section entitled "General Respirator Descriptions and Requirements."
- Informing their supervisor of any changes in working conditions or the working environment that may affect the effectiveness of their respirator.
- Cleaning and storing their respirator in accordance with this chapter, their training, and the manufacturer's instructions.
- Marking their respirator or its storage container to prevent others from using it by mistake.

Division Safety Office

The Division Safety Office is responsible for the following:

- Administering the Division's respiratory protection program.
- Maintaining this chapter to ensure that it remains current with respect to regulatory and Center requirements, and Division needs.
- Evaluating respiratory hazards and prescribing appropriate respirators for those that cannot be eliminated or controlled by other means.
- Providing assistance to supervision in identifying and evaluating work activities that require the use of respirators.
- Assisting supervision with the evaluation of using means other than respirators, such as substitution or engineering, to eliminate or control respiratory hazards.
- Assisting supervision with the monitoring of air quality in breathing air systems.
- Performing periodic documented reviews of the Respiratory Protection Program to verify its effectiveness and to meet regulatory requirements.
- Reviewing and approving "Request for Respirator Training" forms completed by supervisors for their employees.

Ames Health Unit or Designated Health Care Professional

The Ames Health Unit or Designated Health Card Professional is responsible for the following:

- Scheduling respirator medical examinations, upon request, for new and current respirator users.
- Performing medical examinations in accordance with the requirements of 29CFR 1910.134 for Division employees whose assigned tasks require them to use respirators.
- Maintaining medical files on individuals who receive respirator medical examinations.
- Completing the ARC Form 28, Request for Respirator Training, or, in the case of the Designated Health Care Professional, providing other respirator use clearance documentation for personnel who receive respirator medical evaluations.

Ames Safety Training Group

The Ames Safety Training Group is responsible for the following:

- Providing regularly scheduled respirator training and fit testing that meets the requirements of 29CFR 1910.134.

18.3. Respirator User Qualification

Respirator Medical Qualification

Only personnel who have successfully completed the required medical evaluation may use respiratory protective equipment.

Note: *There is an exception to this requirement related to voluntary use of dust masks. See the "Voluntary Respirator Use" section of this chapter.*

Initial Medical Evaluation

The Ames Health Unit or a contracted health care professional shall conduct respiratory medical evaluations in accordance with the requirements prescribed 29 CFR 1910.134(e).

Appointments for contractor personnel medical evaluations must be coordinated through the Division Safety Office.

Personnel shall complete the OSHA Mandatory Respirator Medical Evaluation Questionnaire before reporting for the appointment. The form is available to civil servants from the Health Unit. Support contract personnel being evaluated by a contracted health care professional may obtain the questionnaire from the Division Safety Office. The Division Safety Office can assist users in completing the questionnaire.

Annual Follow-up Evaluations

Respirator users shall receive follow-up medical evaluations annually as long as they have a continuing need to use respiratory protection.

Medical Disqualification

If the examining physician or health care professional identifies a medical condition they feel poses an unacceptable risk to the respirator user as the result of respirator use, which cannot be corrected through changes in the prescribed respiratory protection, the user shall be removed from the respiratory protection program and be assigned to work that does not require respirator use.

Respirator User Training

Only perspective respirator users who have attended the respiratory protection course offered by the Ames Research Center's Safety, Health, and Medical Services organization, and demonstrated their understanding of the following information, shall be allowed to use a respirator in the workplace:

- The requirements of this chapter.
- The reason why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator.
- The respirator's acceptable uses and limitations.
- The effective use of the respirator in emergency situations, including situations when the respirator malfunctions.
- The proper ways to inspect, don, use, and remove the respirator.
- The proper methods for checking the respirator's seals.
- The procedures for maintaining and storing the respirator.

- The ways to recognize medical signs and symptoms that may limit or prevent the effective use of respirators.

Re-training

Respirator users shall attend retraining annually and whenever one or more of the following situations occur:

- Changes occur in the workplace or the types of respirators being used that render previous training obsolete
- An employee demonstrates inadequacies in their knowledge or use of the respirator indicating that they have not retained the necessary understanding or skill
- Any other situation arises which indicates that retraining is necessary to ensure safe respirator use

Voluntary User Training

Personnel who request and are approved for voluntary respirator use for other than filtering facepieces shall receive respirator user training and retraining as described above.

Respirator Fit Testing

Due to physical differences in individuals and available respirator facepieces, users of tight-fitting respirators shall undergo fit testing for each individual respirator model that they will use. This is essential to ensure that users receive the expected level of protection. Users shall not be approved for or use facepieces that do not fit properly.

Respirator fit testing shall be conducted for each wearer at least annually or whenever there are changes in the employee's physical condition that could affect respirator fit. Such conditions include, but are not limited to, facial hair, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight.

Perspective respirator users will only be fit tested by the Ames Safety, Health, and Medical Services trainers following their successful completion of the medical evaluation and classroom training.

Quantitative fit testing shall be performed of all tight-fitting respirator facepieces using a Portacount test instrument following accepted OSHA protocols.

18.4. General Respirator Descriptions and Requirements

General Respirator Use Requirements

Respiratory protective equipment may only be used when it is not feasible to control atmospheric contaminants through engineering means such as enclosures, local or general ventilation, or through substitution with less toxic materials. Respiratory protective equipment may be used during interim periods while engineering controls are being designed and installed.

Only personnel who have successfully completed the required medical evaluation, training, and fit testing may use respiratory protective equipment.

Note: *There is an exception to this requirement related to voluntary use of dust masks. See the "Voluntary Respirator Use" section of this chapter.*

Respirators will only be effective in protecting their users when they are: properly selected, maintained, and fitted, and used in accordance with the manufacturer's recommendations.

All respirators, filters, cartridges, and components used by Division personnel shall be tested and approved by the National Institutes for Occupational Safety and Health (NIOSH) for the intended use.

All respirators shall be used within the limits established by the manufacturer and their NIOSH approval.

Components of one manufacturer's respirators such as cartridges, facepieces, straps, valves, hoses, etc., shall not be assembled and used with a different manufacturer's components.

Respirators shall not be used in an environment where the contaminant concentration exceeds the respirator's protection factor as shown in Table 2.

Respirators shall not be modified in any way.

Personnel shall not wear tight-fitting respirators in hazardous environments when any condition exists that may interfere with the effectiveness of their seals. Examples of such conditions include facial hair, temple bars on glasses, and changes in facial contours due to weight gain or loss.

Personnel whose jobs may require them to wear tight-fitting respirators with less than 24-hours of advance notice must remain clean shaven in the respirator's seal area at all times.

Full facepiece users requiring corrective lenses must use vision correction devices that do not interfere with the seal. The corrective devices may be contact lenses or, if necessary, special spectacle frames that attach to the inside of the respirator facepiece and do not have temple bars. Contact the Division Safety Office for assistance in purchasing these spectacles.

All planned uses of respirators in IDLH environments must be reviewed by the Division Safety Office and approved by the Division Office for civil servants or the Support Contractor's General Manager for contract personnel.

Respirator Facepiece Descriptions

Respirator facepieces (the portions of the respirator that cover the mouth and nose) come in a variety of styles. The different styles offer different levels of comfort and protection. Descriptions of facepiece types follow. Examples of commonly available respirators are provided in Table 1.

Loose-fitting Facepiece

A loose-fitting facepiece is a facepiece that forms a partial seal with the face, does not cover the neck and shoulders, and may not offer head impact or penetration protection. These facepieces provide the lowest level of protection because they do not form an airtight seal with the skin. Contaminants can easily enter the facepiece through seal leaks. Loose-fitting facepieces may only be used for protection against nuisance dusts.

Tight-fitting Facepiece

A tight-fitting facepiece is a facepiece that forms a complete seal with the face. Tight-fitting facepieces used by Division personnel include half facepieces and full facepieces as described below. These facepieces can be used with various filters, cartridges, canisters, and, in some instances, supplied air to provide protection against a wide variety of contaminants of low to high hazard/toxicity.

Filtering Facepiece

A filtering facepiece is a disposable loose-fitting facepiece that is composed of the filter media. The most common form of this respirator is a disposable dust mask.

Full Facepiece

A full facepiece is a tight-fitting facepiece that covers the mouth, nose, and eyes. These facepieces are most often used in instances where the contaminant poses an eye irritation hazard in addition to the respiratory hazard. Full facepieces are the least comfortable for the user and can limit visibility and verbal communication. Personnel who wear spectacles will be required to wear specially designed frames that can be attached within the facepiece without temple bars. This is necessary to avoid violation of the seal's integrity. Some manufacturers incorporate "speech diaphragms" into their designs to improve the user's ability to communicate verbally with others during respirator use.

Half Facepiece

A half facepiece is as tight-fitting facepiece that covers the mouth and nose only. These facepieces are lightweight and offer relatively good visibility; however, they can limit verbal communication. When splash or impact eye protection must be used with these facepieces, care must be taken to select eyewear that fits around the respirator, so it will provide the level of impact or splash protection that is required.

Hood

Hoods completely cover the head and neck, and may cover portions of the shoulders. Hoods are usually components of airline supplied or powered-air-purifying-respirators. They can provide a high level of protection against airborne contaminants and chemical splashes; however, they can limit visibility and may not provide impact protection for the eyes.

Respirator Operational Modes

Respiratory protective devices are divided into two general operational modes or categories: air purifying and atmosphere (air) supplying. Each of these modes has distinct advantages, disadvantages, and limitations that are discussed in detail below. When using these devices the user's safety is highly dependent upon their knowledge of the atmospheric hazards and the equipment they are using. Failure to use the correct equipment or to use the

equipment correctly can result in severe illness and/or death.

Respirator Selection Criteria

Each task requiring the use of respiratory protection shall be evaluated before work begins to ensure that other controls were considered and determined to be infeasible, and that the appropriate respiratory protective equipment is selected for use.

Respirators shall be selected and prescribed based on the following:

- The respirator manufacturer's specifications and recommendations
- The ambient atmospheric conditions such as oxygen content, humidity, and temperature.
- The contaminants physical form, chemical properties, warning properties, and chemical composition.
- The severity of hazards posed by the contaminant.
- The contaminant's expected concentration in air.
- The respirator's acceptable uses and limitations such as their protection factors (see Table 2), operational mode, available filter media, and etc.
- The work space's physical characteristics such as size and the presence of physical obstructions.
- The physical tasks to be performed.
- The need for verbal communication.
- Characteristics of the worker such as facial contours, the presence of facial hair, and the need for corrective lenses.
- Worker comfort.

18.5. Respirator Selection Guide

General

Table 1 provides examples of a wide variety of respirator types. Each respirator type has its own advantages and use limitations. These are discussed individually for each respirator type. Advantages often include things such as low weight, low cost, and ease of use. Limitations include things such as the need for specific filters for individual contaminants, a respirator's protection factor (see Table 2) for individual contaminants and environments, dependence on a carried or external air source, reduced mobility, etc. This section provides general guidance on the uses and limitations of various respirator types that may be used in the workplace.

Due to the wide variety of potential airborne contaminants, and greatly varying environmental conditions under which respirators may be used, respirators must be prescribed for each use or groups of similar uses. These "prescriptions" shall be documented on PPE Hazard Assessment (AO4) and Respirator Selection Worksheet (AO2) forms.

Particulate Filter Respirators

Particulate filter respirators provide a physical or mechanical barrier that is porous enough to allow air to pass through, but fine enough to either exclude particles and fibers or trap them within the filter media.

Particulate Filter Selection

Particulate filters shall be selected based on specific regulatory requirements, the physical characteristics of the contaminant particle or fiber, the hazards posed by the contaminant, and worker comfort.

Limitations and Uses

Particulate filter respirators **DO NOT** supply oxygen. **DO NOT** use them in oxygen-deficient (<19.5 % oxygen) atmospheres.

Particulate filter respirators shall not be used in immediately dangerous to life and health (IDLH) atmospheres.

Particulate filters alone shall not be used for protection against toxic vapors or gases.

Particulate filter respirators may be used for protection against non-volatile or low volatility contaminants that have a particulate or fibrous form. Examples include: nuisance dusts, silica-containing dusts, toxic dusts such as lead, particles or water aerosols containing biological organisms, cutting/welding fumes, asbestos fibers, and some oil aerosols/mists.

Loose-fitting facepieces, such as disposable dust masks, may only be used for protection against nuisance dusts materials.

Particulate filters are rated according to their effectiveness in filtering particles of specific sizes and their ability to resist degradation due to oil exposure. Table 3 summarizes particulate filter ratings, acceptable uses, and service life information.

The pores that allow air to pass through particulate filters become blocked by contaminants during use. As a result, airflow will be reduced and breathing resistance will progressively increase. This can increase worker fatigue and increase the potential for seal leaks.

“N” rated filters shall not be used for protection against oil aerosols or mists, or against particles contaminated with oils.

“R” rated filters that have been exposed to oil contamination must be replaced at the end of each shift.

“P” rated filters, even those exposed to oils, may be used for multiple shifts until breathing resistance increases notably.

Higher filter efficiency ratings generally indicate a higher level of protection against particulate or fibrous contaminants.

"95" rated filters may only be used for protection against nuisance dusts.

"99" rated filters may only be used for protection against nuisance dusts and those that pose a low to moderate risk to the user.

"100" rated filters may be used for protection against highly hazardous contaminants such as lead or asbestos.

N100, R100, and P100 filters may be referred to as High-Efficiency Particulate Air (HEPA) filters.

Filter Replacement

All particulate respirators or filters (whether N, R or P rated) should be replaced whenever breathing resistance increases notably. In addition, all "N" rated filters shall be replaced upon being exposed to oils and all "R" rated filters that are exposed to oil aerosols or mists, or particles contaminated with oils shall be replaced at the end of the shift.

Table 1. Common Respirator Facepieces

Loose-Fitting Filtering Facepiece 	**Tight-Fitting Filtering Facepiece**
Tight Fitting Half-Facepiece 	**Tight Fitting Full-Facepiece**
Tight Fitting Airline Supplied Full-Facepiece 	**Tight Fitting Full-Facepiece SCBA**
PAPR Blower and Hood 	**Emergency Escape Packs with Hoods**

Table 2. Respirator Protection Factors

Respirator Type	Facepiece Type	
	Half Mask (1)	Full Facepiece
Air Purifying	10	100
Atmosphere Supplying		
SCBA – Demand (2)	10	100
Airline – Demand	10	100

Respirator Type	Facepiece Type			
	Half Mask	Full Face	Helmet/ Hood	Loose-Fitting Facepiece
Powered Air Purifying	50	1000 (3)	1000 (3)	25
Airline Supplied				
Pressure-Demand	50	1000	-	-
Continuous Flow	50	1000	1000	25
SCBA				
Pressure-Demand, Open Circuit	-	(4)	-	-

1) Includes disposable half masks and masks with elastomeric facepieces.
2) Demand SCBA shall not be used for emergency situations such as fire fighting.
3) Protection factors listed for high-efficiency filters and sorbents. With Dust filters, an assigned protection factor of 100 is to be used due to limitations of the filters.
4) For emergency planning purposes, where concentrations can be estimated, an assigned protection factor of 10,000 or less should be used.

Note: Protection factors do not apply to escape respirators. When combination respirators, such as airline respirators equipped with an air-purifying filter, the current mode of operation (air supplied or air purifying) shall dictate the protection factor to be used.

Table 3. Particulate Filter Ratings and Acceptable Uses

Filter Rating	Oil Resistance	Filter Efficiency (% of particles ≥ 0.3μm)	Acceptable Uses*	Service Life**
N95	Not Oil Resistant	95	NO, N	Breathing Difficult
N99		99	NO, N, L, M	Breathing Difficult
N100		99.97	NO, N, L, M, H	Breathing Difficult
R95	Oil Resistant	95	O, N	Breathing Difficult, EOS
R99		99	O, N, L, M	Breathing Difficult, EOS
R100		99.97	O, N, L, M, H	Breathing Difficult, EOS
P95	Oil Proof	95	O, N	Breathing Difficult
P99		99	O, N, L, M	Breathing Difficult
P100		99.97	O, N, L, M, H	Breathing Difficult

* **N** = Nuisance, **L** = Low Hazard/Toxicity, **M** = Moderate Hazard/Toxicity, **H** = High Hazard/Toxicity, **NO** = No Oil, **O** = Oil

** **EOS** = End of Shift. Must be disposed of at the end of the shift if exposed to oil aerosols or mists, or oil-contaminated particulates.

Chemical Cartridges and Canisters

Chemical cartridges and canisters perform similar functions but canisters are generally much larger and contain significantly more adsorbent or catalytic filter media. The larger quantity of filtering media generally results in an increased service life versus cartridges.

Limitations and Uses

Chemical cartridge and canister respirators **DO NOT** supply oxygen. **DO NOT** use them in oxygen-deficient atmospheres.

Chemical cartridge and canister respirators shall not be used in immediately dangerous to life and health (IDLH) atmospheres.

Chemical cartridges and canisters shall be used only for protection against the compounds for which they were tested and approved by the manufacturer and NIOSH.

Note: *Chemical cartridges and canisters are developed for specific compounds or classes of compounds. They are commonly available for organic vapors, acid gases, and formaldehyde. They are also available for combinations of compounds such as organic vapor/acid gas, ammonia/methylamine, formaldehyde/organic vapor, and etc.*

Users of chemical and cartridge respirators **MUST** have knowledge of the contaminant's properties and concentration, and cartridge/canister limitations before selecting them for use. Cartridges and canisters are developed, tested, and approved for specific airborne contaminants. Because of the wide variety of physical and chemical properties and concentrations of airborne contaminants, no single device will be able to protect the user from all potential contaminants.

Chemical cartridge and canister respirators shall only be used for protection against contaminants that have good warning properties. This will allow users to detect leaks and make appropriate adjustments, or leave the area without the risk of injury or illness.

Chemical cartridges and canisters shall be used only with tight-fitting full and half mask facepieces and with appropriate PAPR hoods and facepieces.

Canisters and cartridges may be used in combination with particulate filters (pre-filters) to protect the user when both chemical and particulate/fibrous contaminants are present when they are approved for this use by the manufacturer and NIOSH. Examples include the spray application of paints or pesticides, and cooling tower cleaning and disinfection using power washers.

Cartridge Replacement

The filter media contained in cartridges and canisters is "consumed" by the airborne contaminants during use. Cartridges or canisters should be replaced according to schedules established based on the contaminant's properties, the work intensity, contaminant concentrations, and ambient environmental conditions. The schedules are documented on the Respirator Selection Worksheet (AO2) form that was completed for the task. Due to varying use conditions, the following additional criteria indicate a need to replace cartridges and canisters regardless of the duration of use:

- Whenever there are signs of physical damage to cartridges or canisters
- When an end-of-service-life device indicates that they have been consumed
- When the user experiences signs of "break-through"

Users who taste or smell contaminants entering the facepiece shall take immediate steps to identify and correct any facepiece seal leaks. If the problem cannot be corrected within a few seconds, it is likely that the cartridge/canister requires replacement or there is a defect in the respirator. Under these circumstances users shall leave the contaminated area to identify and correct the problem.

Users who experience symptoms of exposure shall leave the contaminated area immediately and seek assistance in evaluating what failures occurred that resulted in the exposure.

Powered Air Purifying Respirators (PAPR)

PAPRs are air-purifying respirators that use particulate and/or chemical filters as described above. The difference is that they contain a small electric "blower" that draws air through the filter for the user to eliminate the increased breathing resistance that can result from high efficiency (N100, R100, or P100) particulate and chemical filter use.

Only filters, cartridges, and canisters designed by the respirator's manufacturer specifically for PAPRs shall be used with them.

Limitations and Uses

PAPR's are air-purifying respirators, therefore their uses and limitations are the same as the particulate filters and/or chemical cartridges described above. Since the air pump reduces the user's breathing effort, these devices are most often specified when respiratory protection will be used for extended periods while performing physically demanding tasks.

The PAPR pump units are usually adaptable to a wide variety of hoods, full facepieces, welding helmets, etc., so they can be very versatile.

PAPR pump units contain electric motors and are battery powered. Therefore, users must track their usage and monitor battery life. Users must also ensure that only pumps with intrinsically safe motors and batteries are used in environments containing flammable gases, vapors, or dusts.

PAPR users should maintain a log of their usage on a Powered Air Purifying Respirator Usage Log form (AO1) to assist them in monitoring battery and cartridge life.

PAPR users must measure the air flow through the respirator's cartridges before each use and periodically during use to verify proper functioning of the pump, battery, and cartridges. Corrective actions must be taken immediately if the measured air flow becomes less than that specified by the respirator's manufacturer.

Atmosphere Supplying Respirators

Atmosphere (air) supplying respirators provide uncontaminated air to the user via an airline (hose) from a remote source or from a compressed air cylinder carried by the user. The two basic types of atmosphere-supplying respirators are the airline supplied and the self-contained breathing apparatus (SCBA). Atmosphere-supplying respirators have the advantages of providing the user with a clean supply of air and generally a greater level of protection against contaminants than air purifying respirators. However, they may also restrict movement due to their bulk or dependence on the airline. This may result in worker fatigue due to weight and may pose a tripping hazard. Airline users could loose their air supply suddenly due to failures in compressors or damage to air hoses.

Operational Modes

Atmosphere-supplying respirators have three operational modes: demand, pressure demand, and continuous flow. Some of these devices, such as the Self-Contained Breathing Apparatus (SCBA), are capable of operating in more than one of these modes. Others such as airline respirators may only operate in one mode.

Demand Mode

Some tight-fitting half mask and full facepiece respirators may operate in demand mode only. The interior of these respirators is at a negative pressure with respect to the ambient atmospheric pressure during use. Therefore, any leaks in the respirator's seal can allow contaminated air to enter the interior of the facepiece and result in unacceptable employee exposures. Among the atmosphere-supplying respirators, these generally provide the lowest level of protection (Note the difference in the protection factors for demand and pressure demand modes for the SCBA and airline respirators shown in Table 2).

Pressure Demand Mode

Pressure demand respirators provide the highest levels of protection against airborne contaminants. These are usually tight-fitting full facepiece respirators. They are available in airline-supplied and SCBA configurations. The interior of the respirator's mask/facepiece is maintained at a higher than ambient pressure during use. Pressurized air from inside the respirator's facepiece flows outward when seal leaks occur and prevent contamination from entering and exposing the user. Many pressure demand respirators can operate in the demand or pressure demand modes. Users may set these respirators in the demand mode to allow them to breathe, while preventing them from continuously flowing air during donning or periods of non-use. Once donned and ready for use the user actuates a fast-acting valve to change to the pressure demand mode.

Continuous Flow Mode

Continuous flow respirators are generally limited to those of the airline-supplied type due to the large amount of air that they require. Continuous flow respirators may be of the loose fitting, half mask, full facepiece, or hood/helmet types.

Some 5-10 minute emergency escape respirators are available that provide a continuous flow air supply into a hood. These devices are approved for escape purposes only and may not be used for normal work activities or to attempt emergency rescues.

Airline Supplied Respirators

Airline supplied respirators provide fresh air to the user through an air hose (airline) from a remote source such as a compressor or a bulk air storage system. They may operate in any of the modes described above.

Advantages of supplied air respirators include their compactness, low weight, potentially long-duration air supply, wide adaptability, and the ability to incorporate comfort-enhancing devices such as vortex heating/cooling tubes.

Disadvantages include the user's dependence on a remote air supply, tripping hazards posed by the airlines, and testing and maintenance requirements for the air compressing and/or storage equipment and systems.

Accessories such as vortex heating and cooling devices may be used with continuous flow respirators if the devices are approved for use with the specific respirator and will not result in a deterioration of the respirator's performance.

Limitations and Uses

Airline supplied respirators **SHALL NOT** be used in IDLH atmospheres unless they are full facepiece pressure demand types equipped with an auxiliary self-contained air supply. In these instances, the auxiliary air supply must be large enough to allow the user to safely escape form the work area if the remote air supply is suddenly lost due to hose, compressor, bulk air storage system failure.

Airline supplied respirators shall be used when air purifying filters, cartridges, or canisters are not available for or not effective in controlling the airborne contaminants that will be present, or when the contaminant's physical properties or concentration would result in the need for very frequent filter, cartridge, or canister replacements.

Breathing air hoses (airlines) shall meet the following requirements:

- Airlines must be designed for breathing-air, have NIOSH approval, and be compatible with the specific respirator.
- Airlines shall be protected from damage.
- Airlines shall be arranged to prevent tripping and allow ready access/exit.
- Airlines shall be tagged or labeled as a "Breathing Air Supply Line" by the organization that owns them.
- Airline couplings shall not be compatible with outlets for other gas systems, such as natural gas, inert gas, shop air, etc.
- When not in use, ends of breathing air system pipes and airlines shall be capped or sealed.
- The total airline length shall be limited to a maximum of 300 feet.
- All equipment used from the respirator face piece to the breathing air pump or tank must be from the same manufacturer.

Airline respirator users shall immediately leave the hazardous area in the event of a respirator or air supply failure or an alarm from a carbon monoxide monitoring system.

Self-Contained Breathing Apparatus (SCBA)

A SCBA provides air to the user from a compressed air storage cylinder carried on their back. The air supplies are usually rated for 30 or 60-minutes. They may be operated in the demand or pressure demand modes and most SCBA units have a bypass valve that allows the user to continuously flow air through the facepiece to remove contaminants or fogging.

Limitations and Uses

The primary advantage of SCBA units is their use of an air supply that is carried by the user. This provides their users with a great degree of mobility. The use of the air storage cylinder is also the SCBA's greatest disadvantage since the units have a very limited air supply and are the heaviest and bulkiest of the respiratory protection devices.

Only full facepiece pressure demand SCBA units with a service life rating of at least 30 minutes shall be used in IDLH atmospheres.

SCBA users shall immediately leave the hazardous area upon hearing a low air cylinder pressure alarm or upon experiencing any equipment anomalies or malfunctions.

Emergency Escape Respirators

These respirators usually consist of a small 5-10 minute compressed air cylinder and a clear bag to go over the user's head. They may be used for escape from IDLH atmospheres only. They shall be NIOSH-certified for escape from the atmosphere in which they will be used.

Emergency escape respirators may not be used to reenter an IDLH atmosphere to perform work or attempt a rescue.

18.6. Respirator User Seal Check Procedures

General Breathing Air Requirements

Each time an employees puts on a tight-fitting respirator facepiece they must perform a seal check to ensure that they have an adequate seal. Employees may use either the positive and negative pressure check procedures described below or those recommended by the respirator's manufacturer.

Note: User seal checks are not considered to be acceptable substitutes for the quantitative fit tests required elsewhere in this chapter.

Positive Pressure Check

Step	Action
1.	Place the palm of the hand over the exhalation valve to block it off.
2.	While the exhalation valve is blocked, exhale gently into the facepiece.
3.	The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal.
	NOTE: For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replacing it after the test.

Negative Pressure Check

Step	Action
1.	Remove the respirator filters or canister from the facepiece.
2.	Place the palm of the hand(s) over the canister or cartridge inlet opening(s) to close them off.
3.	With the inlets blocked, inhale gently so that the facepiece collapses slightly, and hold your breath for ten seconds.
4	The tightness of the facepiece is considered satisfactory if it remains in its slightly collapsed condition and no inward leakage of air is detected.
	NOTE: The design of the inlet opening of some cartridges cannot be effectively covered with the palm of the hand. In these instances the test can be performed by covering the inlet opening of the cartridge with a thin latex or nitrile glove.

18.7. Breathing Air Requirements

General Breathing Air Requirements

Compressed breathing air used for respiratory protection purposes shall meet the requirements for Grade D breathing air as prescribed by ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1, as shown in Table 4.

Table 4. Breathing Air Specifications

Breathing Air Constituent	Acceptable Level
Oxygen	19.5 – 23.5%
Hydrocarbon (Condensed)	≤ 5 mg/m^3
Carbon Monoxide (CO)	≤ 10 ppm
Carbon Dioxide (CO_2)	≤ 1000 ppm
Odor	None noticeable

Air in Compressed Gas Cylinders

Cylinders of breathing air must have a certificate of analysis from the supplier demonstrating that the air meets the Grade D specifications. Moisture content in the cylinder shall not exceed a dew point of –50 deg. F at 1 atmosphere of pressure.

Air from Compressors

The following requirements apply to breathing air compressors and systems:

- They shall be constructed to prevent contaminated air from entering the air supply system.

- Steps must be taken to minimize the moisture content of the air they produce to have a dew point that is at least 10 degrees F below the ambient temperature at 1 atmosphere.
- They shall contain the necessary in-line air purifying filters and sorbent beds to ensure air quality. The sorbent beds and filters shall be maintained and replaced per the manufacturers' instructions.
- They shall have a tag attached that identifies the most recent filter/sorbent change date and the name and signature of the individual who was authorized to change them.
- Steps shall be taken to ensure that the carbon monoxide concentration in air produced by non-oil lubricated compressors does not exceed 10 ppm.
- Oil-lubricated compressors shall incorporate high temperature or high carbon monoxide alarms or both to monitor the carbon monoxide levels in the air they produce.

18.8. Voluntary Respirator Use

Voluntary Respirator Use

"Voluntary respirator use" is the use of respiratory protection, at the request of the user, under conditions where it is not legally required and is not required by Center or Division policy. An example is the use of a filtering facepiece (nuisance dust mask) while performing general housekeeping tasks. The use of any respiratory protective device may pose hazards to the user, therefore "voluntary use" will be controlled as follows:

- The immediate supervisor and Safety Office must review and approve each request for voluntary respirator use to ensure that such use will not pose hazards to the requestor.
- Personnel requesting voluntary use of respirators other than filtering facepieces must participate in all aspects of the respiratory program including medical evaluation, training, fit-testing, cleaning, maintenance, and etc.
- Personnel requesting the use of filtering facepieces only must read and sign a Voluntary Respirator Use Information and Certification form (AO3) indicating that they have been advised of the proper use and limitations of the respirator, and agree to comply with the requirements it contains.

Voluntary Respirator User Training

See section 18.3.

18.9. Respirator Inspection, Cleaning, and Storage

Respirator Inspection

Respirators and their components can be soiled or damaged during use, disassembly, cleaning, and storage, and may be reassembled incorrectly following cleaning. Therefore, users shall thoroughly inspect their respirators immediately before and after each use to ensure that they are sanitary, and functioning properly. Inspection items, as they apply to each type of respirator, include verification that:

- The respirator is in a clean and sanitary condition.
- The facepiece is free of cracks, tears, and perforations.
- The filters and/or cartridges are the correct ones for the contaminants specified on the PPE Hazard Assessment (AO4) and Respirator Selection Worksheet (AO2) forms.
- Filters and/or cartridges are properly attached.
- Inhalation and exhalation valves are in place and functioning properly.
- Facepiece straps are pliable and in good condition.
- Buckles for straps, belts, and harnesses are securely attached and function properly.
- Belts and harnesses used to secure respirators on the user are in good condition.
- There is an adequate air supply available for supplied air respirators.
- Air hoses and lines are free from kinks and physical damage.
- There is proper airflow in PAPR, airline supplied respirators, and SCBA units.
- Airflow valves, gages, and alarms function properly.
- Additional inspection items may be required for specific respirators.

Respirator Cleaning and Sanitation

Airborne contaminants such as dirt, facial oil, perspiration, and moisture can accumulate on respirators during use and pose a hazard to the wearer if it is not removed periodically through approved methods.

As a minimum, users of non-disposable facepieces shall clean them with sanitary wipes and allow them to dry at the end of each shift before placing them in their storage bag/container. Supplies of cleaning wipes are available from the Division Safety Office.

At the end of the work task, or as appropriate based on the amount of soiling, users of non-disposable respirators shall completely disassemble, clean, and sanitize them. Equipment and materials required to perform this task are available from the Division Safety Office.

Respirators shall be completely disassembled, cleaned, sanitized, reassembled, and inspected before being provided to different individuals for use.

Procedures for Detailed Cleaning of Respirators

Step	Action
1.	Remove filters, cartridges, or canisters from the facepiece.
2.	Disassemble the facepiece by removing speaking diaphragms, valve covers, straps, diaphragm valves, and valve holders.
3.	Separate any defective parts from the good ones. You may obtain replacement parts or a replacement facepiece from the Division Safety Office.
4.	Wash good components in warm (110 deg. F maximum) water with a mild detergent or with a cleaner recommended by the manufacturer. Use a stiff bristle (not wire) brush to assist removal of stuck-on dirt or debris.
5.	Rinse the components thoroughly in clean warm (110 deg. F maximum), preferably running, water and thoroughly drain them.
6.	If the cleaner does not contain a disinfecting agent, immerse the respirator in one of the following for a period of two minutes: • Hypochlorite solution (50 ppm of chlorine) made by adding approximately one milliliter of laundry bleach to one liter of water at 110 deg. • Another commercially available cleanser of equivalent disinfectant quality as above that is recommended or approved by the respirator's manufacturer.
7.	Rinse components thoroughly in clean warm (110 deg. F maximum), preferably running, water and thoroughly drain.
	NOTE: The importance of thorough rinsing cannot be overemphasized. Detergents or disinfectants that dry on facepieces may result in dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.
8.	Hand-dry the cleaned components with a clean lint-free cloth or air-dry them in a location where they will not become recontaminated.
9.	Reassemble facepiece, and replace filters, cartridges, and canisters where necessary.
10.	Test the respirator to ensure that all components work properly.

Respirator Storage

Respirators shall be stored in sealed bag in a location that protects them from physical damage, chemical agents, airborne contaminants, direct sunlight, temperature extremes, and excessive moisture.

18.10. Records

Fit Test	The results of respirator facepiece fit tests shall be maintained by the respective employer for the period of the respirator user's employment.
Medical Qualification	Records of evaluations conducted by Center or Designated Health Care Providers to qualify employees for or disqualify them from respirator use shall be maintained for the period of the employee's employment plus 30 years. It should be noted that contract employers may only have records of the Designated Health Care Provider's recommendations regarding an employee's respirator usage rather than the specific results of all tests performed by the provider as the basis for their recommendation.
PAPR Usage Log	Copies of Powered Air Purifying Respirator Usage Logs should be forwarded to the Division Safety Office. The Division Safety Office shall retain the logs for a minimum period of 12 months.
PPE Hazard Assessment	Copies of completed PPE Hazard Assessments which specify respirator use shall be retained by the respirator user's supervisor and the Division Safety Office as long as they remain valid for a Division work activity.
Respirator Selection Worksheet	Copies of Respirator Selection Worksheets shall be retained by the respirator user's supervisor and the Division Safety Office as long as they remain valid for a Division work activity.
Sampling and Analysis Results	Industrial Hygiene sampling results that support decisions regarding the need for and the appropriate selection of respiratory protective equipment shall be retained by the respective employer for at least 30 years.
Voluntary Respirator Use Information and Certification	Voluntary Respirator Use Information and Certification forms shall be retained by the respirator user's supervisor and the Division Safety Office as long as they remain valid for the specified respirator and work activity.

18.11. Forms

Note: All of the forms are located on the internal division web site.

	OSHA Mandatory Respirator Medical Evaluation Questionnaire
AO4	Personal Protective Equipment Hazard Assessment
AO1	Powered Air Purifying Respirator Usage Log
ARC Form 28	Request for Respirator Training
AO2	Respirator Selection Worksheet
AO3	Voluntary Respirator Use Information and Certification

18.12. References

Ames Health & Safety Manual	APR 1700.1, Chapter 28, Respiratory Protection
Ames Health & Safety Manual	APR 1700.1, Chapter 33 Personal Protective Equipment: Hazard Assessment & Selection
ANSI	ANSI Z88.2, 1992 – American National Standard for Respiratory Protection
OSHA General Industry Safety Standard	29 CFR 1910.132, Personal Protective Equipment General Requirements
OSHA General Industry Safety Standard	29 CFR 1910.134, Respiratory Protection
OSHA General Industry Safety Standard	29 CFR 1910.1020, Access to Employee Exposure and Medical Records

18.13. Definitions

Assigned Protection Factor	The ratio of the concentration of a contaminant measured in ambient air outside the facepiece to that measured within the facepiece during use. The assigned protection factor is used to establish the maximum contaminant concentration that a respirator can effectively protect the user against. This is done by multiplying the permissible exposure limit (PEL) by the Assigned Protection Factor.
Breakthrough	Infiltration of the airborne contaminant through the respirator's filtering media. This may occur when the filters become consumed or saturated by the contaminant, when the incorrect filtering media is used, or as the result of filter damage.
High Efficiency Particulate Air (HEPA) Filter	A filter that is at least 99.97% efficient in removing mono-disperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.
Immediately Dangerous to Life or Health (IDLH)	An atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.
NIOSH	National Institutes for Occupational Safety and Health.
Oxygen Deficient Atmosphere	An atmosphere with oxygen content below 19.5% by volume.
Quantitative Fit Test	An assessment of the adequacy of respirator fit by numerically measuring the amount of contaminant leakage into the respirator.

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Service Life The period of time that a respirator, filter, sorbent, or other respiratory equipment provides adequate protection to the wearer.

Volatile Rapidly evaporating.

Warning Properties Characteristics of a contaminant such as taste, smell, or irritation that allow the respirator user to detect cartridge or facepiece leaks. Materials are considered to have good warning properties if they are detectible by the respirator user and persistent at concentrations at or below the established exposure limits.

19. Personal Protective Equipment

19.1. Description

Purpose

Wind Tunnel Operations Division (Division) policy is to reduce the risk of occupational injuries and illnesses by ensuring that appropriate personal protective equipment (PPE) is selected, provided, used, and maintained. It is also Division policy that personnel are trained in its appropriate use and limitations. The purpose of this chapter is to establish requirements and guidelines that implement this policy within the Division.

Scope

This chapter applies to civil servant or support contractor personnel, temporary workers, visitors, subcontractors, and others under the jurisdiction of the Wind Tunnel Operations Division, who specify, select, use, or maintain PPE. It also applies to those who supervise these individuals or their work activities.

General

The Division's preferred order (hierarchy) of risk reduction methods is as follows:

1. Eliminating hazards through design or substitution with materials or equipment that pose lower risks.
2. Implementing engineering controls such as guards, enclosures, ventilation, interlocks, alarms, etc.
3. Developing operations and maintenance procedures.
4. Prescribing the use of personal protective equipment.
5. Implementing administrative controls (such as using crew rotation to reduce the exposure of personnel to physical hazards such as noise, radiation, or hazardous materials).

This hierarchy was developed based on the effectiveness of the individual risk reduction techniques and regulatory requirements.

There are instances when it may be necessary to implement temporary controls that are lower in the hierarchy, such as the use of PPE, due to the intermittent nature of the activity creating the hazard, technical or monetary limitations, or during periods when permanent solutions are being designed, funded, installed, or repaired, and during emergency response activities when other options are not available.

PPE is positioned low in the hierarchy because it can only be effective in reducing the potential for injury or illness when it is properly selected, sized, provided, and used. Due to the potential for error in each of these processes,

the use of PPE is less effective in preventing injuries or illnesses when compared to other techniques such as hazard elimination or engineering controls.

Document Control

This chapter of the Wind Tunnel Operations Division and Support Contractor Safety Manual is part of a controlled document. The official version is available on line at http://pubsgroup.arc.nasa.gov/.

19.2. Responsibilities

Managers

Managers are responsible for the following:

- Ensuring overall implementation of and compliance with the requirements of this chapter.
- Ensuring that funds are made available to procure needed personal protective equipment.
- Providing support for eliminating hazards through equipment or material substitutions and engineering means, when feasible, to reduce the need for using PPE as a control method.

Supervisors

Supervisors are responsible for the following:

- Evaluating work assignments to identify those posing hazards that may necessitate the use of protective equipment.
- Evaluating work assignments identified as requiring the use of PPE to determine whether the hazards should be eliminated or controlled through more effective means such as equipment or material substitutions, or engineered safety devices or features rather than PPE.
- Requesting assistance from the Division Safety Office in conducting PPE Hazard Assessments for each task requiring the use of PPE.
- Maintaining copies of PPE Hazard Assessments that are applicable to tasks performed by their personnel.
- Ensuring that PPE users have received the required training (see the Training section of this chapter) for each type of PPE they will be using before they are required or allowed to use it.
- Monitoring their employee's work to ensure that PPE is being properly used and maintained.
- Notifying the Division Safety Office when there are inadequacies in the available PPE.

PPE Users

PPE Users are responsible for the following:

- Using only PPE that they have been trained and fitted for.
- Selecting, using, and maintaining PPE in accordance with training, work instructions, and associated PPE hazard assessments.
- Removing damaged or consumed PPE from service immediately.
- Immediately notifying their supervisor and/or the Division Safety Office of any PPE failures or inadequacies.

Division Safety Office

The Division Safety Office is responsible for the following:

- Assisting in the development and/or review of PPE Hazard Assessments as requested by supervisors and PPE users.
- Assisting in the evaluation, selection, and procurement of PPE for Division staff.
- Monitoring work activities to verify that PPE is being used as prescribed.
- Overseeing the development of and monitoring the implementation of the PPE program.

19.3. PPE Hazard Assessment and Selection

Personal Protective Equipment Hazard Assessment

Personal Protective Equipment (PPE) Hazard Assessments identify the PPE required to protect personnel against the hazards posed by specific tasks or activities. PPE Hazard Assessments must be conducted to identify and document PPE requirements for work activities that pose eye or face, head, foot, or hand hazards. The results of assessments shall be recorded on a Personal Protective Equipment Hazard Assessment form (AO4).

19.4. Requirements

Body Protection

Body protection shall be selected and used based on the nature of the hazards and durability requirements. Body protection must be chosen carefully, since using incorrect protection may increase the risks posed by hazards.

General Use

General use apparel increases employee comfort and/or reduces the potential for soiling the individual's personal clothing. Equipment included in this category includes reusable and disposable aprons, coveralls, and coats.

Hazardous Chemicals

Corrosive, flammable, irritating, sensitizing, and toxic chemicals vary greatly in their chemical and physical properties and the hazards they pose to personnel. Body protection must be carefully selected to ensure that it will be effective in protecting the wearer from the chemical product(s) with which they may come in contact. Available styles of protection include disposable

and reusable coveralls, chemical-resistant coated coveralls, jacket and overall combinations, and encapsulating splash suits. Chemical splash aprons may be used for protection against minor hazards. Care must be taken to ensure that the chemicals being used will not degrade or permeate the protective clothing.

Hazardous Dust and Particulates

Examples of hazardous dusts and particulates include asbestos, lead, silica, animal droppings, and biological aerosols (such as those that may exist in cooling towers). Disposable coveralls are usually specified for protection against these materials since the particulates do not penetrate through them and because there is no need to clean them when the work is complete. Cleaning coveralls contaminated with hazardous material can potentially generate a large volume of liquid waste, since the water used to clean them may become contaminated and require disposal as hazardous waste.

Miscellaneous Equipment

Miscellaneous equipment may include items such as knee pads, elbow pads, or shin protectors. There are no specific standards for these items. They shall be prescribed as needed for individual activities.

Pyrotechnic Hazards

The minimum body protection for handling pyrotechnic devices and gunpowders is anti-static flame retardant coveralls used in conjunction with bonding and grounding devices such as wrist, leg, or foot grounders.

Thermal Hazards

The most common thermal hazards within the Division that may require the use of thermal protective clothing are associated with cutting, welding, and grinding operations. Equipment used for protection against thermal hazards includes insulated jackets, pants, coveralls, and welding leathers. See the Electrical Protective Equipment section for thermal protection related to electric arc-blasts.

Ultraviolet Radiation

The required body protection for ultraviolet (UV) radiation is dependent on the power output and wavelength of the UV light source. Common UV sources include electric arcs from welding, arc lamps, and lamps used for wind tunnel flow-visualization techniques such as pressure sensitive paint and fluorescent oils. In most instances reusable or disposable coveralls with long sleeves will provide adequate protection from UV sources.

Electrical Protective Equipment

Personnel working on or near electrical systems or equipment that may be exposed to the hazards of electric shock, electrocution, thermal burns, and flying debris hazards shall use electrical protective equipment, such as electrician's coveralls or blast suits. Electrically insulating blankets, covers, gloves, line hoses, matting, and sleeves, may also be required as specified in this chapter.

Decisions regarding the appropriate electrical protective equipment to use for a specified activity or hazard shall be documented on a PPE Hazard Assessment form (AO4).

Electrical Body Protection -

Body hazards posed by general electrical work include exposure to heated materials, hot gases, flame, and electric shock or burns resulting from

General

electrical shorting on conductive clothing components such as snaps and zippers. The minimum required protection for electrical work is long sleeve non-conductive (or minimally conductive) flame-retardant coveralls.

Body Protection - High Voltage Breaker Racking

Full-body blast suits including gloves, faceshields, and helmets shall be worn for all high-voltage breaker-racking activities. Blast suit components and their use shall be in accordance with NFPA 70E, *Standard for Electrical Safety In The Workplace*.

Electrical Insulating Equipment – General Requirements

Insulating blankets, covers, gloves, line hoses, matting, and sleeves are available in two types and five classes. The equipment types indicate their resistance to ozone degradation. Type I equipment is not ozone resistant. Type II equipment is ozone resistant. The five classes indicate their maximum allowable voltage as shown in Table 1.

Table 1. Maximum Use and Proof Test Voltages for Electrically Insulating Blankets, Covers, Gloves, Line Hoses, and Matting.

Equipment Class	Maximum Use Voltage	AC Test Voltage	DC Test Voltage
0	1,000	5,000	20,000
1	7,500	10,000	40,000
2	17,000	20,000	50,000
3	26,500	30,000	60,000
4	36,000	40,000	70,000

Electrical Insulating Equipment Inspection and Testing

The insulating properties of this equipment can degrade during use through contact with abrasive or sharp objects, improper storage (such as folding), and through exposure to ozone in the air. Therefore, insulating equipment must be inspected before and after each use and be subjected to periodic electrical testing. The required testing frequencies are shown in Table 2.

Division practice is to establish preventive maintenance work orders in the MAXIMO system for insulating equipment requiring testing and use a vendor to perform it. Gloves that fail the testing process shall be destroyed immediately.

Users shall not attempt to repair damaged electrical insulating equipment.

Table 2. Electrical Insulating Equipment.

Equipment Type	Testing Frequency
Blankets	Before first issue and every twelve months thereafter (1)
Covers	Inspections indicate that the insulating value is suspect
Gloves	Before first issue and every six months thereafter (1)
Line Hose	Inspections indicate that the insulating value is suspect
Sleeves	Before first issue and every twelve months thereafter (1)

(1) Equipment that has been tested but has not been issued for service must be retested before issuance when the time period that has elapsed since testing exceeds 12 months.

Electrically Insulated Gloves

Insulating gloves used for protection against electrical hazards are made of natural or synthetic rubber and are in most instances used in conjunction with leather protector gloves. The protector gloves are worn over the insulating gloves to reduce the potential for cuts, punctures, snags, and tears that would reduce the insulating glove's protective properties. Gloves used for protection against electrical hazards must be manufactured and tested in accordance with ASTM Standard D 120, "Specification for Rubber Insulating Gloves."

Employee-Supplied Protective Equipment

Personal protective equipment that is owned and supplied by the employee shall not be used unless it meets the applicable requirements specified in this chapter and its use has been reviewed and approved by the responsible supervisor and the Division Safety Office.

Eye & Face Protection

Personnel who may be exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids, caustics, chemical gases, chemical vapors, or potentially injurious light radiation shall use appropriate eye and/or face protection as specified in this section.

When there is a hazard from flying objects the minimum acceptable protection is safety spectacles with side shields. Detachable side protectors (e.g. clip-on or slide-on side shields) meeting the pertinent requirements of this section are acceptable.

All eye and face protection used by Division personnel shall meet the design, testing, and marking requirements of ANSI standard Z87.1: "*Practice for Occupational and Educational Eye and Face Protection*."

Eye and face protection shall be selected and used based on the potential hazards as specified in Tables 3, 4, and 5. Decisions regarding the appropriate eye and/or face protection for use with a specific activity or hazard shall be documented on a PPE Hazard Assessment form (AO4).

Table 6 provides examples of various types of eye/face protectors.

Prescription eye protection is available at no cost to the employee at frequencies and within maximum dollar limits established by Ames. Contact your employer or the Division Safety Office to obtain frequency and dollar limit information.

Table 3. Eye and Face Protection Selection Matrix

Activities & Hazards			Protector Example (Table 6)	Protectors	Limitations	Not Recommended
IMPACT	Chipping, grinding, machining, masonry work, riveting, and sanding	Flying fragments or objects, large chips, particles, sand, dirt, and etc.	A, B, D, F, G, I, L, M	Glasses, goggles, faceshields See Notes 1, 3, 5, 6, and 9 For severe exposures add L or M to glasses or goggles	These devices provide limited protection See Note 7	Eyewear without side exposure protection – See Note 9 Filter or tinted lenses that restrict light transmittance, unless it is determined that a glare hazard exists. See Optical Radiation below.
HEAT	Furnace operations, pouring, casting, hot dipping, gas cutting and welding	Hot sparks	A, B, D, F, G, I, L, M	Faceshields, goggles, glasses See Notes 2, 3	Glasses and cover goggles provide only limited face protection. See Note 2.	Any protector that does not provide full side protection.
		Splash from molten metals	L or M*	*Faceshield worn over F or G. See Notes 2, 3		
		High temperature exposure	L or M	Special purpose screen or reflective faceshields	See Note 3	
CHEMICAL	Corrosive and solvent handling	Splash	F, G L or M*	Cover goggles Add L or M for severe exposures	Ventilation devices should be well protected from splash entry	Glasses, directly vented cover goggles and welding shields
		Irritating Mists and gases	(No example provided)	Non-ventilated cover goggle	See Note 3	
DUST	Woodworking, working in dusty environments	Nuisance dust	F, G	Indirectly vented cover goggle	Ambient conditions and restricted can result in fogging and the need for frequent cleaning.	

Table 3. Eye and Face Protection Selection Matrix (Continued)

Activities & Hazards			Protector Example (Table 6)	Protectors	Limitations	Not Recommended
OPTICAL RADIATION	Welding – Electric Arc	Ultraviolet and infrared radiation	N, O	Welding helmet See Table 2 for lens shade selection. See Note 8	The effectiveness of protection against optical radiation is directly related to lens optical density. See Note 4. Select the darkest shade that allows adequate task performance.	Protectors that do not protect against optical radiation.
	Welding – Gas Cutting Torch Brazing	Infrared radiation	J, K, N, O	Welding cover goggle or helmet See Table 2 for lens shade selection. See Note 8	See Note 3	
	Torch Soldering	Infrared radiation	A, B, D, L*, M*	Safety glasses or welding* faceshield		
	Glare		A, B, D, E	Glasses See Notes 8 and 9	Shaded or special purpose lenses as appropriate	
	Laser	Extremely intense visible, infrared, or ultraviolet radiation	C, H	Special purpose safety glasses or goggles	Specifically prescribed specially shaded lenses See Note 10.	Protection that does not provide the required optical density for the wavelength and power level of the specific laser.

Eye and Face Protection Selection Matrix Notes:

(1) The user must consider the possibility of multiple simultaneous exposures, such as chemical and impact and select equipment that provides protection against the worst credible exposures for each of the hazards.

(2) Activities involving heat may also pose optical radiation hazards such as intense visible, infrared or ultraviolet radiation. Care must be taken to select equipment that provides protection against both hazards.

(3) Faceshields may only be used when worn over other primary eye protection such as spectacles or goggles.

(4) Filter lenses shall meet the requirements specified in Table 2 or shall be approved by the appropriate authority (Division Safety Office, Laser Safety Committee, etc.) for a specific hazard and activity.

(5) Personnel who are required to wear prescription corrective lenses shall wear either protective devices fitted with prescription lenses, or devices that were designed to be worn over their prescription eyewear.

(6) Contact lens wearers shall wear eye and/or face protection meeting the requirements of this chapter when entering or working in hazardous environments. Dust or chemical hazards may exclude the use of contact lenses within an

environment or require the wearer to select equipment that provides an increased level of protection against these hazards.

(7) Personnel should avoid the use of metal frame protective devices if there is a potential for contact with an electrical hazard.

(8) Welding helmets or hand shields shall only be used over other primary eye protection such as safety glasses or goggles.

(9) Safety glasses without side shields only provide protection against frontal hazards. They shall not be used instances where there are potential side or top exposure hazards.

(10) Laser eye protection shall be prescribed for each laser application based on the potential for exposure, and the laser's power and wavelength.

Table 4. Filter Lenses Shades for Protection Against Radiant Energy

Operation	Electrode Size (Inch)	Arc Current (Amps)	Min. Prot. Shade
Shielded Metal Arc Welding	<3/32 3/32-5/32 5/32-1/4 >1/4	<60 60-160 160-250 250-550	7 8 10 11
Gas metal arc welding and flux cored arc welding	N/A	<60 60-160 160-250 250-500	7 10 10 10
Gas Tungsten Arc Welding	N/A	<50 50-150 150-500	8 8 10
Air Carbon Arc Cutting	(Light) (Heavy)	<500 500-1000	10 11
Plasma Arc Welding	N/A	<20 20-100 100-400 400-800	6 8 10 11
Plasma Arc Cutting	(Light) (Medium) (Heavy)	<300 300-400 400-800	8 9 10
Torch Brazing	N/A	N/A	3
Torch Soldering	N/A	N/A	2
Carbon Arc Welding	N/A	N/A	14

Table 5. Filter Lenses Shades for Protection Against Radiant Energy from Gas Welding or Cutting

Operation	Plate Thickness (Inches)	Plate Thickness (mm)	Min. Shade
Gas Welding:			
Light	<1/8	<3.2	4
Medium	1/8-1/2	3.2-12.7	5
Heavy	>1/2	>12.7	6
Oxygen Cutting:			
Light	<1	<25	3
Medium	1-6	25-150	4
Heavy	>6	>150	5

Table 6. Eye and Face Protective Device Examples

A. Safety Glasses – Full Sideshield	F. Cover Goggle – Indirect Vent	K. Cover Welding Goggle – Indirect Vent – Flip-Up Shade
B. Safety Glasses – Full Sideshield	G. Cover Goggle – Indirect Vent	L. Faceshield
C. Laser Safety Glasses – Full Sideshield	H. Laser Cover Goggle – Indirect Vent	M. Faceshield with Chin Protector
D. Safety Glasses – Full Sideshield Non-Removable Lens	I. Cover Goggle – Direct Vent	N. Welding Helmet – Stationary Window
E. Safety Glasses – Full Sideshield – Flip-Up Shade	J. Cover Welding Goggle – Indirect Vent	O. Welding Helmet – Flip-Up Window

Fall Protection

See the "Fall Protection and Working at Heights" chapter of this manual.

Foot Protection

Personnel performing tasks that may expose them to the danger of foot injuries due to falling or rolling objects, objects piercing the sole, or electrical hazards shall wear safety footwear in accordance with this section.

Decisions regarding the selection of footwear required for a work activity shall be documented on a PPE Hazard Assessment form (AO4).

Safety Footwear Availability

Safety footwear is available at no cost to all employees who could be exposed to foot injury hazards, within frequency and maximum dollar limits established by Ames. Contact your employer or the Division Safety Office to obtain current frequency and dollar limit information as well as the process for purchasing safety footwear.

Safety Footwear Use Criteria

The mandatory use of safety footwear is required based on job title and/or specific tasks as defined in Table 7.

Table 7. Mandatory Safety Footwear Use by Job Title

Job Title	Tasks Requiring Safety Footwear
Accounting	Not typically required. Special circumstances may dictate use.
Administrative Assistant	Not typically required. Special circumstances may dictate use.
Aerodynamicist	Work in model prep room or tunnel.
Clerk	Field work in tunnel, plant or other industrial areas. Operation of forklift.
Computer Systems Technician	Field work in model prep room or in tunnel test section.
Controls Engineer	Field work in tunnel, plant or other industrial areas.
Electrical Engineer	Field work in tunnel, plant or other industrial areas.
Electrician	Mandatory use for all tasks.
Engineering Technician	Field work in tunnel, plant or other industrial areas.
Instrument Engineer	Field work in tunnel, plant or other industrial areas.
Instrument Technician	Mandatory use for all tasks.
Mechanic/Engineering Technician	Mandatory use for all tasks.
Mechanical Engineer	Field work in tunnel, plant or other industrial areas.
Network Administrator	Field work in tunnel, plant or other industrial areas. Moving of computer equipment.
Operating Engineer	Mandatory use for all tasks.
Procurement	Operation of forklift. Shipping /receiving activities involving moving of equipment.
Safety Engineers	Field work or investigations in tunnel, plant or other industrial areas.
Stress Analyst	Field work in tunnel, plant or other industrial areas.
Supervisor/Manager	Not typically required. Special circumstances may dictate use.
Test Engineer	Work in model prep room or tunnel.

While the above criteria are established to provide protection to the employee for the defined tasks, it is recommended that employees wear safety footwear for the duration of their work shifts. This is especially true of employees who spend portions of their time in multiple work locations.

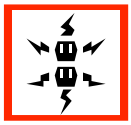
Safety Footwear Specifications

All footwear worn to comply with the requirements of this policy shall meet the specifications and labeling (see examples below) requirements of ANSI Standard Z41-1999 (or later): "*Personal Protection – Protective Footwear*."

All safety footwear shall have an ANSI compression rating of C/75 and an ANSI impact rating of I/75.

Personnel who could be exposed to electrical shock hazards shall wear footwear with an ANSI electrical hazard (EH) or static dissipative (SD) rating.

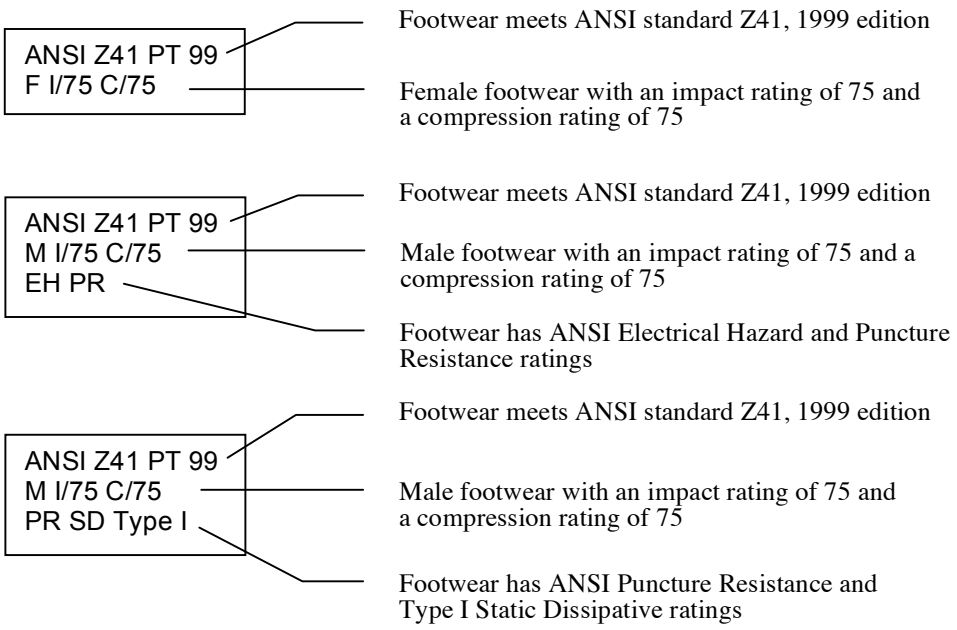
WARNING



Personnel requiring electrical protection **MUST NOT** purchase safety footwear with a "Conductive" or "Cd" rating. Footwear with a "Cd" rating will allow enough electrical current flow to pose a serious electric shock hazard to the wearer.

Personnel who perform tasks that expose them to foot puncture hazards should purchase footwear with an ANSI puncture resistance (PR) rating.

ANSI-Compliant Label Examples



Hand Protection

Personnel whose hands may be exposed to injuries such as skin absorption of harmful substances, severe cuts, lacerations, severe abrasions, punctures, chemical burns, thermal burns, and harmful temperature extremes shall use hand protection in accordance with in this section.

A variety of protection is available for most of these hazards, however, they all have use limitations so each application must be evaluated before their use.

Hand Protection Properties

Physical characteristics of hand protection include abrasion, cut, puncture, and tear resistance as well as chemical degradation, chemical permeation, electrical insulation, heat/cold insulation, and resistance to heat degradation.

Selection of Hand Protection

All hand protection shall be selected based on an assessment of the hazards posed by the work activity, physical properties of the hand-wear, and task-specific requirements, such as dexterity. Selections shall be documented on a PPE Hazard Assessment form (AO4).

Chemical Hazards

Chemicals pose the potential for chemical burns, dermatitis, local poisoning, systemic poisoning, sensitization, and skin irritation. Table 8 provides a summary of glove-type performance for common chemical products.

Table 8. Chemical Protective Glove Performance

	Glove Type				
Hazard	**Butyl**	**Latex**	**Neoprene**	**Nitrile**	**PVC**
Acetone	E	G	F	NR	P
Acids - Mild	E		E	E	E
Ammonium Hydroxide	G	G	E	E	G
Caustics - Mild	E		E	E	E
Diesel Fuel	E		NR	VG	E
Ethyl Alcohol	G		VG to E	VG to E	E
Greases - General	NR		NR	VG to E	E
Hydrochloric Acid	E		E	E	E
Isopropyl Alcohol	G		VG to E	E	E
Lubricating Oils - General	NR		NR	VG	E
Methyl Ethyl Ketone	E	P-F	P to G	NR	NR
Methyl Isobutyl Ketone	VG		P	NR	NR
Nitric Acid	P	P	P	P	G
PCB					
Sodium Hydroxide	E	G	E	E	E
Sodium Hypochlorite	E	G	P	F	G

Mechanical Hazards

Mechanical hazards pose the potential for abrasion, amputation, bruising, fracture, incision, laceration, nerve damage, pinching, and puncture. The primary sources of mechanical hand hazards include moving, rotating, and cutting machinery as well as manual material handling and powered and un-powered hand tools. Gloves used for protection against mechanical hazards may be made of leather, natural fiber, synthetic fibers, or a combination of these materials. They may also be available with abrasion, cut, puncture, and slip resistant coatings. Care must be taken to avoid using gloves around moving or rotating tools or equipment where the gloves could become entangled and draw the wearer's hand into the tools or equipment.

Radiant Energy Hazards

Radiant hazards pose the potential for burns. Sources include heated equipment, materials, and processes as well as sunlight, electric arc cutting or welding, plasma cutting and welding, or intense light radiation such as from lasers. Leather and thermal insulating gloves may be used for protection against radiant energy hazards.

Thermal Hazards

Thermal hazards pose the potential for burns and frostbite primarily through direct contact with heated or cooled materials or equipment. Leather or thermal insulating gloves may be used for protection depending on the temperature of the equipment or materials.

Vibration Hazards

Vibration hazards arise primarily from powered (electric, hydraulic, pneumatic) tools and equipment. Vibration reducing gloves may be made of leather or synthetic materials and contain vibration/shock absorbing padding on the palm, thumb, and fingers.

Head Protection

Personnel who work in areas where there is a potential for head injuries due to falling objects or bumping against stationary objects, structure, or equipment shall wear head protection as identified in this section.

Decisions regarding the selection of head protection required for a work activity shall be documented on a PPE Hazard Assessment form (AO4).

Bump Caps

Bump caps are intended for protection incidental bumping and lacerations. They do not conform to any standard testing criteria and **MUST NOT** be worn for protection against falling or flying objects. Personnel who are working in locations where they could strike their heads against stationary objects, structures, or equipment should wear bump caps.

Hard Hats

Hard hats shall be worn in areas where there is a potential for head injuries due to falling or flying objects.

Hard hats shall meet the design, testing, and labeling requirements of ANSI Standard Z89.1 1997 or 1986 revisions.

Hard hats manufactured under the 1997 standard shall be labeled as meeting Type II, Class E requirements (helmets providing protection for impacts on or off center and to reduce the danger of exposure to high voltage conductors). Head protection manufactured under the 1986 standard shall be labeled as Type II Class B (helmets providing protection from the impact of falling objects and electric shock and burn).

Hearing Protection

See the Hearing Conservation chapter of this manual.

Respiratory Protection

See the Respiratory Protection chapter of this manual.

19.5. Training

Initial Training

Employees who are required to use eye, face, head, foot, or hand protection shall be trained to know at least the following:

- When their PPE is necessary.
- What PPE is necessary.
- How to properly put on, take off, adjust, and wear their PPE.
- The appropriate uses and limitations of their PPE.
- The proper care, maintenance, useful life, and disposal of their PPE

Each PPE user shall demonstrate their understanding of the training and their ability to use PPE properly, before they will be allowed to perform work requiring the use of PPE.

Users of electrical, hearing, and respiratory protective equipment shall be trained in accordance with the requirements of their respective chapters of this safety manual.

Retraining

PPE users shall be retrained whenever there is reason to believe that they do not have the understanding and skill required to use their PPE safely and effectively. In addition, retraining shall be required whenever:

- There have been changes in the workplace that render previous training obsolete.
- There have been changes in the types of PPE being used which render previous training obsolete.

19.6. Forms

AO4	Personal Protective Equipment Hazard Assessment

19.7. Records

Training	A written record shall be maintained of the training required by this chapter. The record shall contain the subject of the training received, date(s) of training, name of each employee trained, name of the instructor, and an indication of whether the employee completed the training successfully.
Personal Protective Equipment Hazard Assessment	Copies of completed Personal Protective Equipment Hazard assessments shall be maintained by the affected employee's supervisor and the Division Safety Office.

19.8. References

ANSI Z41	American National Standard for Personal Protection – Protective Footwear
ANSI Z87.1	American National Standard Practice for Occupational and Educational Eye and Face Protection
ANSI Z89.1	American National Standard for Industrial Head Protection
ANSI/ISEA 105	American National Standard for Hand Protection Selection Criteria
ASTM D 120	Specification for Rubber Insulating Gloves
ASTM D 178	Specification for Rubber Insulating Matting
ASTM D 1048	Specification for Rubber Insulating Blankets
ASTM D 1049	Specification for Rubber Insulating Covers
ASTM D 1050	Specification for Rubber Insulating Line Hose
ASTM D 1051	Specification for Rubber Insulating Sleeves
NFPA 70E	Standard for Electrical Safety in the Workplace
OSHA	1910.133 - Eye and Face Protection
OSHA	1910.135 - Head Protection
OSHA	1910.136 - Occupational Foot Protection
OSHA	1910.137 - Electrical Protective Devices
OSHA	1910.138 - Hand Protection

19.9. Definitions

ASTM	American Society for Testing and Materials, a non-regulatory consensus standard organization.
ANSI	American National Standards Institute, a non-regulatory consensus standard organization.
NFPA	National Fire Protection Association, a non-regulatory consensus standard organization.