Comments and questions regarding this section may be directed to the person listed below:

Jim Withers, ESH&A
G40 TASF
294-2153

NOTE: This Section's approval record is maintained in the Training & Records Management office, 151 TASF.

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SECTION 4 – INDUSTRIAL HYGIENE PROGRAM

REVISION / REVIEW LOG

SECTION 4 – INDUSTRIAL HYGIENE PROGRAM

Review Number:	Effective Date:	Contact Person:	Pages Affected:	Description of Revision:
0	10/11/99	Jim Withers	All	Original Issue
1	2/13/06	Jim Withers	See Revision Description	G:ESHA/Document Control/Revision Descriptions/ ESH&A Manual/Manual 10200.002 Section 4 revdesc.doc
2	1/8/07	Jim Withers	See Revision Description	G:ESHA/Document Control/Revision Descriptions/ ESH&A Manual/Manual 10200.002 Section 4 revdesc.doc
3	4/1/09	Jim Withers	See Revision Description	G:ESHA/Document Control/Revision Descriptions/ ESH&A Manual/Manual 10200.002 Section 4 revdesc.doc
4	8/1/10	Jim Withers	See Revision Description	G:ESHA/Document Control/Revision Descriptions/ ESH&A Manual/Manual 10200.002 Section 4 revdesc.doc
5	8/15/11	Jim Withers	See Revision Description	G:ESHA/Document Control/Revision Descriptions/ ESH&A Manual/Manual 10200.002 Section 4 revdesc.doc

SIGN-OFF RECORD

The Environment, Safety Health and Assurance Program Manual has been reviewed and approved as documented below:

Record Sign-Off

Reviewed by: _____ Date: _____
Amy J. Tehan, ESH&A, Document Control Coordinator

Approved by: _____ Date: _____
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Approved by: _____ Date: _____
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Bruce N. Harmon, Deputy Director

Approved by: _____ Date: _____
Alexander H. King, Laboratory Director

Note: Original approval record with signatures is on file with Training & Records Management.

4.0 INDUSTRIAL HYGIENE PROGRAM

4.1 HAZARD COMMUNICATION (RIGHT TO KNOW) PROGRAM

Applicability Statement: *This section applies ONLY to those Groups/Departments whose employees use hazardous chemicals in a non-laboratory environment (hazardous chemical use in research laboratories is specifically covered by Section 4.2, Chemical Hygiene Program).*

This section also applies to the Environment, Safety, Health & Assurance (ESH&A) office which is charged with ensuring compliance with specific sections of the Iowa Chemical Risks Right To Know Law.

4.1.1 REFERENCES

29 CFR 1910.1200, Hazard Communication
347 IAC Iowa Chemical Risks Right To Know (Chapters 110, 120, 130, and 140)
Iowa State University Worker Right-To-Know Program

4.1.2 BACKGROUND

The purpose of the Hazard Communication regulation is to ensure that the hazards of all chemicals produced or imported are evaluated, and that information concerning their hazards is transmitted to employers and employees. This transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets (MSDSs) and employee training. The key components of the Laboratory's Hazard Communication Program are an integral component of the Chemical Hygiene Program described in Section 4.2.

4.1.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in ISU's Worker Right To Know Manual. Information on ISU's program can be found at:

http://www.ehs.iastate.edu/publications/manuals/wrtk.pdf

The basic elements of the Laboratory's program are: Worker or Employee Right to Know, Community Right to Know and Emergency Right to Know.

4.1.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

CHEMICAL HAZARD COMMUNICATION	**AL-137**
Intended Audience:	*Mandatory for personnel who work with hazardous chemicals.*
Module Format:	*Classroom Instruction with Material Safety Data Sheet exercise. Estimated completion time: 2.0 hours*
Associated Retrain Period & Format:	*5 year retrain. Classroom or Computer-Based Training instruction.*

HAZARD COMMUNICATION FOR EMPLOYEES THAT DON'T USE CHEMICALS	**AL-150**
Intended Audience:	*Mandatory for all AL personnel who don't work with hazardous chemicals.*
Module Format:	*Administered during General Employee Training via a handout. Estimated completion time: 10 minutes*
Associated Retrain Period & Format:	*No retrain. Course administered during General Employee Training.*

Group or activity-specific training shall be given to each employee prior to work that includes a discussion of chemical hazards, hazard mitigation, location of MSDSs and other safety information, emergency response measures and any other procedural information. Verification of group or activity-specific shall be conducted during the Readiness Review of activities involving the use of chemicals.

4.1.5 PERFORMANCE CHECKLISTS

Group Leader / Department Manager shall:

- Assure that all activities have been identified, reviewed and approved by the Laboratory's Safety Review Committee via Readiness Review.
- Attend Ames Laboratory "Chemical Hazard Communication" (AL-137) training. Group Leaders receive Hazard Communication training through another course (Chemical Hygiene Training for Group Leaders) but need not attend Chemical Hazard Communication.
- Assure Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- Conduct group or activity-specific hazard communication training for each employee prior to work that includes a discussion of chemical hazards, hazard mitigation, location of MSDSs and other safety information, emergency response measures and any other procedural information. Verification of this training shall be conducted during Readiness Review.
- Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.

- Assure that Material Safety Data Sheets (MSDSs) for all hazardous chemicals are present and accessible.
- Submit chemical inventories to ESH&A annually.
- Assure that chemical container labeling is complete and in accordance with guidelines given in the ISU Worker Right-To-Know Manual.

Employees shall**:**
- Attend Ames Laboratory "Chemical Hazard Communication", (AL-137) training.
- Attend Ames Laboratory and / or ISU chemical safety training as indicated by Employee Training Profile.
- Receive activity / experiment-specific training prior to working with hazardous chemicals including a discussion of hazard awareness and emergency procedures.
- Perform work in accordance with group Standard Operating Procedures (SOPs).

Environment, Safety, Health & Assurance (ESH&A) shall**:**
- Maintain access to MSDS information and make it available to Laboratory staff during normal business hours and emergency response personnel upon request.
- Assure NFPA 704 signage is present and accurate for all hazardous chemical storage areas.
- Conduct training modules and provide consultations on request that assist Laboratory personnel in the implementation of a group-specific Hazard Communication Program.
- Assure that Ames Laboratory is in compliance with the provisions of Chapters 130 (Community Right To Know) and 140 (Iowa Public Safety/Emergency Response Right To Know) of the Iowa Chemical Risks Right To Know law.

4.2 CHEMICAL HYGIENE PROGRAM

Applicability Statement: *This section applies to groups/departments whose employees use hazardous chemicals in a laboratory environment. Employees who use hazardous chemicals in a non-laboratory environment should refer to the Hazard Communication (Right to Know) Program discussed in Section 4.1.*

4.2.1 REFERENCES

29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories
Iowa State University Laboratory Safety Manual

4.2.2 BACKGROUND

Use of a wide variety of hazardous chemicals is critical to fulfillment of the Laboratory's research mission. Many of the Laboratory's research programs use hazardous chemicals. The Laboratory has nearly 20,000 chemicals in its inventory. The hazards associated with chemical use are significant and demand an effective management program. This section describes the mechanisms by which worker and environmental protection from deleterious effects of hazardous chemicals is assured.

4.2.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in ISU's Laboratory Safety Manual. The Manual is a written program that sets forth the policies, procedures, and practices, both for employees who work with hazardous chemicals and for those whose responsibilities include the supervision of such work. The Manual can be found at:

http://www.ehs.iastate.edu/publications/manuals/labsm.pdf

4.2.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

CHEMICAL HYGIENE TRAINING FOR GROUP LEADERS AL-127	
Intended Audience:	*Mandatory for group leaders who supervise personnel who work with hazardous chemicals in a research laboratory.*
Module Format:	*Computer-Based Instruction. Estimated completion time: 2.0 hours*
Associated Retrain Period & Format:	*No retrain.*

CHEMICAL HAZARD COMMUNICATION	**AL-137**
Intended Audience:	*Mandatory for personnel who work with hazardous chemicals.*
Module Format:	*Classroom Instruction with Material Safety Data Sheet exercise. Estimated completion time: 2.0 hours*
Associated Retrain Period & Format:	*5 year retrain. Classroom or Computer-Based Training instruction.*

Group / activity-specific training on chemical hygiene policies and procedures shall be given to each employee prior to work that includes a discussion of chemical hazards, hazard mitigation, location of MSDSs and other safety information, emergency response measures and any other procedural information. Verification of training shall be conducted during Readiness Review.

4.2.5 PERFORMANCE CHECKLISTS

Group Leaders / Department Managers shall**:**

- Assure that all research activities have been identified, reviewed and approved by the Laboratory's Safety Review Committee via Readiness Review.
- Attend "Chemical Hygiene Training for Ames Laboratory Group Leaders", (AL-127) training (NOTE: Hazard Communication training is also presented in this module.)
- Assure that Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- Conduct group or activity-specific chemical hygiene training for each employee prior to work that includes a discussion of chemical hazards, hazard mitigation, location of MSDSs or other safety information, emergency response measures and any other procedural information. Verification of this training will be conducted during Readiness Review.
- Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.

Employees shall**:**

- Attend "Chemical Hazard Communication", (AL-137) training.
- Attend Ames Laboratory and/or ISU chemical safety training courses as identified on a n Employee Training Profile.
- Receive group / activity-specific chemical hygiene training prior to work that includes a discussion of chemical hazards and their mitigation.
- Perform work in accordance with group Standard Operating Procedures (SOPs).

Environment, Safety, Health & Assurance (ESH&A) shall**:**

- Assist employees with hazard determinations including the performance of monitoring, procedure reviews, hazard control recommendations, etc.
- Conduct training modules and provide consultations, upon request, that assist Laboratory personnel in the implementation of a group-specific Chemical Hygiene Program.

4.3 COMPRESSED / LIQUIFIED GASES

Applicability Statement: *This section applies to Ames Laboratory employees who handle, store or use compressed / liquefied gases.*

4.3.1 REFERENCES

ISU Document: *Cylinder Safety Guidelines*

4.3.2 BACKGROUND

Compressed and liquefied gases are routinely used in laboratory and various other operations at ISU and have the potential for creating hazardous working environments. An effective chemical management program includes the safe use of compressed and liquefied gases. Because of the diversity of gases used at Ames Laboratory and the associated acute hazards, the topic is addressed separate from the Chemical Hygiene Program section.

4.3.3 PROGRAM INFORMATION

Ames Laboratory's policies and procedures for the safe handling of compressed and liquefied gases are discussed in the document "Cylinder Safety Guidelines". This document is applicable to all handling of gases at Iowa State University. The basic principles of an effective management program for compressed and liquefied gases are: hazard classification, employee training, proper set-up and operation of systems as dictated by Standard Operating Procedures (SOPs), control of hazards through engineering controls /administrative controls / personnel protective equipment and emergency procedures.

Detailed programmatic information is provided via the training module listed in Section 4.3.4.

4.3.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

CYLINDER SAFETY	**AL-022**
Intended Audience:	*Mandatory for personnel who work with compressed gas cylinders.*
Module Format:	*Computer-based instruction with quiz. Estimated completion time: 1 hour.*
Associated Retrain Period & Format:	*No retrain.*

Group / activity-specific training on compressed gas usage shall be given to each employee prior to work that includes a discussion of specific hazards, hazard mitigation, equipment operation, location of MSDSs and other safety information, emergency response measures and any other procedural information. Verification of group-specific training is conducted during Readiness Reviews.

4.3.5 PERFORMANCE CHECKLISTS

Group Leaders / Department Managers shall:

- Assure that all activities that involve use of compressed/liquefied gases are identified, reviewed and approved via the Readiness Review procedure.
- Attend Cylinder Safety (AL-022) training.
- Assure that Hazard Inventory / Job Task Analyses packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- Conduct and document group or activity-specific training prior to work that includes a discussion of compressed and liquefied gas usage, associated hazards and their mitigation, location of MSDSs or other safety information, emergency response measures and any other procedural information.
- Assure that group or activity-specific Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.

Employee shall:

- Attend Cylinder Safety (AL-022) training.
- Receive group / activity specific training on the safe use of compressed and liquefied gases prior to work.
- Perform work in accordance with group Standard Operating Procedures (SOPs).

Environment, Safety, Health & Assurance shall:

- Provide technical assistance to Ames Laboratory employees on the safe use of gases via workplace consultations and training sessions.

4.4 EXPOSURE ASSESSMENTS / MEDICAL SURVEILLANCE

Applicability Statement: *This section applies to all Ames Laboratory employees.*

4.4.1 REFERENCES

Iowa State University document: *Occupational Medicine Program*

4.4.2 BACKGROUND

The accurate characterization of employee exposures to chemical, physical, biological and ergonomic exposures is a fundamental component of the Industrial Hygiene Program. Accurate characterization is critical to the successful reduction or elimination of potentially harmful agents.

Medical surveillance is a vital component of any employee health and safety program and is closely linked to data gleaned from exposure assessments. Medical surveillance is one indicator that existing control measures are adequate. Occupational Medicine also prevents injury and illness by identifying potential problems and dealing with them before they have deleterious health impacts.

4.4.3 PROGRAM INFORMATION

The Occupational Medicine Program provides comprehensive occupational health services to Ames Laboratory employees and is described in detail in ISU's "Occupational Medicine Manual". The main mission of the Occupational Medicine Program is compliance with applicable Federal, State and local law with emphasis on prevention, early recognition, and treatment of occupationally related illness and injury.

All Ames Laboratory employees and / or their supervisors are required to complete a Hazard Inventory prior to their employment. Supervisory personnel are required to keep these documents complete and current for each employee throughout their tenure at Ames Laboratory. Successful completion of these documents assures that the employee's hazards and activities will be reviewed as a part of the Industrial Hygiene and Occupational Medicine Programs.

4.4.4 TRAINING

There is no specific training module associated with this sub-section. All employees are introduced to the Hazard Inventory in "General Employee Training", (AL-001) which is discussed in Section 3 (Training) of this manual.

4.4.5 PERFORMANCE CHECKLISTS

Group Leaders / Department Managers shall:
- Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- Assure that Hazard Inventory for all personnel are complete and current.
- Review employee Hazard Inventories on an annual basis and / or whenever activities change and update if necessary.
- Assure that employees receive required medical examinations per notification by Occupational Medicine.
- Assure that employees report to Occupational Medicine with work-related injuries.

Employees shall:
- Complete Hazard Inventory and Training Needs Questionnaires (TNQs) in collaboration with supervisor at time of initial employment and whenever job functions and associated hazards change.
- Receive mandatory medical examinations as notified by Occupational Medicine.
- Report to Occupational Medicine with work-related injuries and / or illnesses.

Occupational Medicine shall:
- Conduct mandatory medical surveillance examinations.
- Assure that employees receive medical surveillance examinations.
- Identify potential or actual health effects resulting from work site exposures.
- Communicate information regarding workplace health hazards to management, workers, and those responsible for mitigating work site hazards.

Environment, Safety, Health & Assurance (ESH&A) shall:
- Review site survey information and perform monitoring, as indicated, to characterize worker exposures.
- Report exposure monitoring results to employees and Occupational Medicine as indicated.

4.5 ERGONOMICS

Applicability Statement: *This section applies to groups/departments whose activities involve repetitive motions that may lead to cumulative trauma disorders. Examples include frequent use of computer keyboards and frequent lifting.*

4.5.1 REFERENCES

ISU document: "Introduction to Ergonomics"

4.5.2 BACKGROUND

Working Americans spend about 2000 hours a year in the workplace. Not surprisingly, all of these hours can take a toll on an employee's eyes, back, hands and neck. Poorly designed working environments can result in momentary pain or long-term injury and lead to reduced efficiency and production, loss of income, increased medical claims and permanent disability

Ergonomics is the art and science of designing the workplace to fit the worker. The primary goal of an ergonomics program is the prevention of musculoskeletal injuries caused by poor lifting techniques and/or repetitive motions associated with job tasks.

Occupational Medicine and Ames Laboratory's Environment, Safety, Health & Assurance (ESH&A) are available to assist employees in the resolution of any potential ergonomic problems. The following is provided as guidance information on ergonomics.

4.5.3 PROGRAM INFORMATION

Ames Laboratory follows the procedures described in the ISU document "Introduction to Ergonomics" (appended to the end of this section). All employees should be familiar with the basic information in this document. It's especially important that employees know the signs and symptoms associated with ergonomic injuries including musculoskeletal disorders or MSDs and how to get assistance from Occupational Medicine and safety personnel. Using ergonomically friendly equipment such as keyboard trays and chairs is another important part of minimizing the risk of ergonomic injuries. Education and awareness through training is critical and employees are encouraged to take advantage of the numerous courses on ergonomics that are offered on campus.

4.5.4 TRAINING

As stated previously, ISU EH&S offers a variety of training opportunities that are detailed in the attached document. Ames Laboratory also offers the following module:

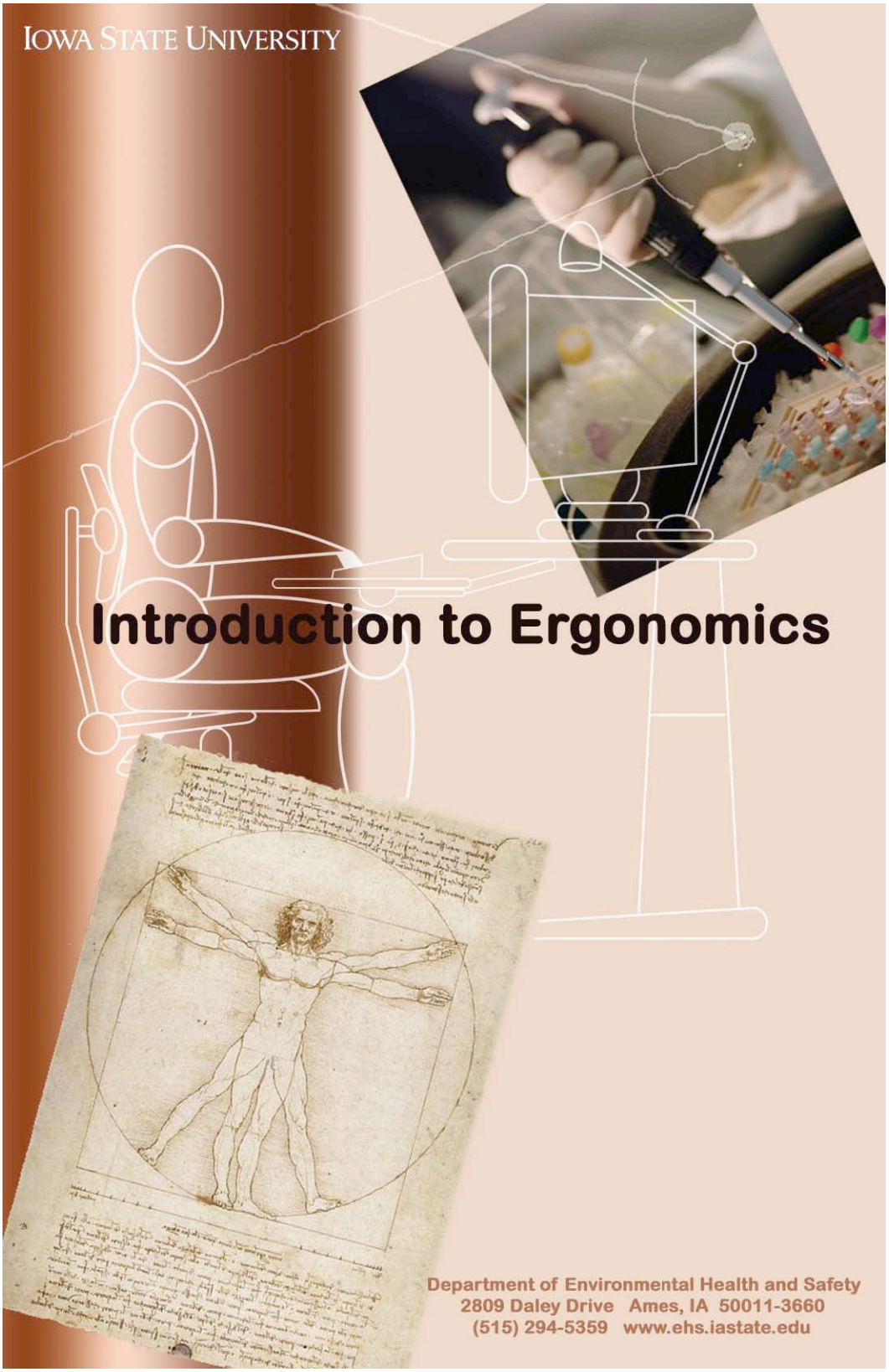
SPRAINS & STRAINS PREVENTION TRAINING	**AL-183**
Intended Audience:	*Provides employees with information on sprains and strains, contributing factors, body postures, engineering controls and safe lifting practices. This course is required for all employees who lift, push/pull objects that weigh more than 40 pounds or who frequently lift, push/pull objects that weigh 20-40 pounds.*
Module Format:	*Computer-based instruction. Estimated completion time: 0.5 hours.*
Associated Retrain Period & Format:	*No retrain.*

4.5.5 PERFORMANCE CHECKLISTS

Group Leader / Department Manager shall:
- Assess group activities for repetitive motions including use of computers and materials handling (lifting, etc.).
- Assure that all activities including those with repetitive motions and lifting are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- Assure that Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- Encourage group members to attend ergonomic training courses as listed on the ISU and / or Ames Laboratory training schedules.
- Review ergonomic training course offerings as listed on the ISU and / or Ames Laboratory training schedules and attend, as appropriate.
- Request ergonomic consultations from Occupational Medicine and Industrial Hygiene personnel, as needed.

Employee shall:
- Be aware of ergonomic hazards in the work environment and signs/symptoms of ergonomic stress.
- Attend applicable ISU and AL courses on ergonomics as indicated by activities and supervisor.
- Notify supervisor of any ergonomic issues in the work environment.
- Request ergonomic consultations from Occupational Medicine and Industrial Hygiene personnel as appropriate.

Environment, Safety, Health & Assurance shall:
- Assess ergonomic issues identified via Readiness Review or employee notification.
- Provide ergonomic consultations to employees upon request, in conjunction with Occupational Medicine personnel.
- Assist supervisors and employees with resolving ergonomic issues in the work environment.


IOWA STATE UNIVERSITY
Introduction to Ergonomics
Department of Environmental Health and Safety
2809 Daley Drive Ames, IA 50011-3660
(515) 294-5359 www.ehs.iastate.edu

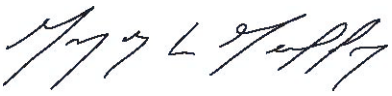
Iowa State University
Safety Policy

It is the policy of Iowa State University to provide and ensure a safe and healthful environment for employees, students and the general public.

Each person in a supervisory or management capacity is responsible for the provision and maintenance of safe working conditions in his or her respective area, and for proper adherence to all authorized and applicable environmental, health and safety policies, rules and regulations.

Each employee and student is responsible for complying with environmental, health and safety rules and for using any safety equipment that is provided or required. Each failure to comply with applicable rules, as well as environmental releases, safety hazards and accidents, shall be reported to supervisory personnel and, if necessary, referred to the proper environmental, health or safety authority.

It is the intent of this policy to promote environmental stewardship and prevent accidents and injuries to the Iowa State University community.



July 2001

Dr. Gregory L. Geoffroy
President
Iowa State University

What is Ergonomics?

Ergonomics is the science of fitting jobs to the people who work in them so that a balance is created between work demands and worker capabilities. The goal of an ergonomics program is to achieve a balance between work and the workers that will optimize productivity and, at the same time, preserve the health and safety of the workforce.

Examples of ergonomic injuries/illnesses

The most common types of ergonomic injuries and illnesses are musculoskeletal disorders (MSDs). MSDs are injuries/illnesses that affect muscles, nerves, tendons, ligaments, joints or spinal discs. Employees may suffer ergonomic injuries/illnesses when major portions of their jobs include reaching, bending over, lifting heavy objects, using continuous force, working with vibrating equipment and/or performing repetitive motions.

MSD injuries/illnesses come under many different names depending on the part of the body affected. If you suffer an ergonomic injury/illness, your doctor may diagnose one of the following common MSDs:

- Carpal tunnel syndrome
- Carpet layer's knee
- De Quervain's disease
- Epicondylitis
- Hand-arm vibration syndrome
- Herniated spinal disc
- Low back pain
- Raynaud's phenomenon
- Rotator cuff syndrome
- Sciatica
- Tendinitis
- Tension neck syndrome
- Trigger finger

What are the signs and symptoms of an MSD?

Employees suffering from MSDs may experience lessened strength for gripping, decreased range of motion, loss of muscle function and inability to do everyday tasks. Common symptoms include:

- Back or neck pain
- Burning sensation
- Fingers or toes turning white
- Pain, tingling or numbness in hands or feet
- Pain in wrists, shoulders, forearms or knees

- Painful joints
- Shooting or stabbing pains in arms or legs
- Stiffness
- Swelling or inflammation

What causes MSDs?
As is the case with many medical conditions, exact causes of MSDs are not always known. Both non-occupational and occupational factors can contribute to the development of MSDs. Work-related MSDs may be caused or exacerbated by exposure to the following risk factors:

Contact stress: Pressing the body against a hard or sharp edge can result in placing too much pressure on nerves, tendons and blood vessels. For example, using the palm of your hand as a hammer or resting your arms against sharp countertop or desk edges can increase your risk of suffering an MSD.

Awkward postures: Posture is the position your body is in and affects muscle groups that are involved in physical activity. Awkward postures include repeated or prolonged reaching, twisting, bending, kneeling, squatting, working overhead with your hands or arms or holding fixed positions.

Forceful exertions:
Force is the amount of physical effort required to perform a task (such as heavy lifting) or maintain control of equipment or tools. The amount of force depends on the type of grip, the weight of an object, body posture, the type of activity and the duration of the task.

Repetition: Doing the same motions over and over again places stress on muscles and tendons. The severity of risk depends on how often the action is repeated, the speed of the movement, the number of muscles involved and the required force.

Vibration: Operating vibrating tools over extended periods of time may lead to nerve damage. Examples of vibrating tools include sanders, grinders, chippers, routers, drills and saws.

Does Iowa State have an ergonomics program?
Yes. As part of a comprehensive health and safety program, the Department of Environmental Health and Safety (EH&S) offers Iowa State University personnel a variety of ergonomic resources. Employees can choose from ergonomic workstation evaluations, classroom training or online resource information. If you would like to learn more about a particular topic, please see our online ergonomics page at www.ehs.iastate.edu/oh/ergo.htm. Online information includes ergonomic services available to the Iowa State University community, e-books for training on various ergonomically related topics and information on ergonomic risk factors. Additional links provide information on lifting, computer use concerns, stretching and workstation ergonomic checklists.

Worksite evaluations
EH&S offers ergonomic worksite evaluations. The purpose of an ergonomic evaluation is to identify occupational injury risk factors and make appropriate recommendations based on

current guidelines. To request a worksite evaluation:

1. Inform your supervisor about your concerns and that you would like to schedule an ergonomic worksite evaluation with EH&S.
2. Call EH&S at 294-5359 to schedule an ergonomic worksite evaluation. Either the employee or supervisor can schedule an ergonomic worksite evaluation, but EH&S encourages the participation of both parties in the evaluation process.

What ergonomic features should I look for in office furniture?

Desks and writing surfaces
Just like one pair of shoes will not fi t everyone in your department, desks, chairs and writing surfaces may not fi t everyone who works at them. Most of the furniture purchased at Iowa State University should have height adjustment that allows the furniture to fit the user. Office furniture should be made of durable materials, have rounded edges and be adjustable for comfortable typing and writing. Through worksite evaluations, EH&S can make recommendations for correct work surface heights related to writing and typing.

Chairs
Since chairs must accommodate a person's individual characteristics, one is not restricted to a specific manufacturer, but should purchase a quality ergonomic chair. Desirable ergonomic features to consider when choosing a new desk chair include backrests and chair heights that are adjustable, seat pan angle adjustments and adjustable armrests. Other important chair features are discussed in EH&S's e-book entitled "Features to Consider When Purchasing a Chair."

If you are considering buying a new chair, you should work with FP&M interior designers to select the chair that best meets your needs and to determine colors that will work with your office finishes. Central Stores stocks several styles of chairs for immediate purchase. In addition, FP&M's Architectural and Engineering Design Services has samples of several of the more popular styles. Contact Design Services (294-1710) to try them out. Finally, you may visit Storey Kenworthy/ASI Office Solutions in Ames to see samples of the Allsteel chairs, or visit the furniture dealers in Des Moines to see other manufacturer's chairs.

Ergonomic accessory installation and furniture alterations
To schedule ergonomic accessory installation (such as keyboard tray placement) or workstation furniture adjustment or relocation, contact Central Stores at 294-8484. If your office area will be relocated or needs to be redesigned, submit a Request for Services to FP&M at www.fpm.iastate.edu/forms/ servicerequest/ and request that one of their designers assist with the redesign. Design Services can evaluate your work areas and develop an efficient layout for office furniture.

Where can I get information and training on ergonomics?

Classroom training
An ergonomics training course entitled "Office Ergonomics" is available through EH&S. This course focuses on the prevention of repetitive motion injury, as well as proper workstation

configurations and adjustment. Information on low back pain and computer-related eyestrain is also presented. If you would like to sign up for the classroom training course or arrange for on-site ergonomics training for campus personnel, please contact EH&S Training at 294-5359.

Ergonomics electronic books or "e-books"
E-books are online training guides designed to offer easily accessible and timely information. EH&S e-books can be accessed at www.ehs.iastate.edu/training/ebooks.htm. Current titles include:

Alternative Keyboards and Pointing Devices
Computer Workstation Ergonomics Checklist
Eliminating Computer Eyestrain
Features to Consider When Purchasing a Chair
Introduction to Ergonomics
Low Back Pain
Manual Materials Handling
Sitting Down on the Job: Ergonomics Tips
Stretching at Work

Where do I go if I have an ergonomic medical concern?
All employees seeking treatment for work-related injuries or illnesses, including ergonomic medical concerns, should first notify their departmental supervisors.

Supervisors must deliver completed "First Report of Injury" forms to the Office of Risk Management at 1350 Beards-hear Hall within 24 hours of reporting the incident. Reports may be faxed to 294-1621 to the attention of the Claims Administrator.

Medical care - Ames area employees
McFarland Clinic Occupational HealthWorks is the workers compensation provider for Ames area Iowa State University employees. Occupational HealthWorks provides treatment and consultation for occupationally related accidents, illnesses and injuries. The clinic is located at 1215 Duff Avenue, and office hours are 8:00 a.m. to 5:00 p.m., Monday through Friday. Supervisors should call 239-4496 to schedule appointments for medical care. Access is available on the north and east sides, including handicap accessibility. Free parking is available to the north and east, with limited spaces available on the west side of the building.

Medical care – Employees working outside the Ames area
A list of approved workers compensation medical providers outside the Ames area is available by calling the Office of Risk Management at 294-7711.

Is there an OSHA regulation for ergonomics?
Not currently. A final standard was published on November 13, 2000, that was to go into effect on January 16, 2001. This standard was overturned by Congress under the Congressional Review Act in March 2001, and subsequently repealed with the signature of President George W. Bush shortly thereafter. However, ergonomic hazards must still be addressed in the workplace. Under Section 5(a)(1) of the Occupational Safety and Health Act, OSHA requires that Iowa State University furnish to each employee a place of employment free from recognized hazards that are causing or are likely to cause death or serious physical harm to its employees.

4.6 RESPIRATORY PROTECTION

Applicability Statement: *This section applies to employees who use respiratory protection in the workplace. Respiratory protection includes conventional rubber/silicon masks as well as single use disposable dust masks.*

4.6.1 REFERENCES

29 CFR 1910.134, Respiratory Protection
ISU Respiratory Protection Program Manual

4.6.2 BACKGROUND

Hazards can be effectively controlled through engineering, administrative and / or personal protective equipment controls. Engineering controls contain hazards at the source and are considered the most effective. Administrative controls include standard operating procedures and, when followed, effectively reduce or eliminate hazards. The last form of control is personal protective equipment and includes gloves, hard hats, steel-toed shoes and respirators.

4.6.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in the ISU document "Respiratory Protection Program". Respirator users are identified by the Occupational Medicine database or by employees contacting ESH&A. Hazard evaluations are conducted to evaluate the need for any type of respiratory protection including the use of disposable dust masks. Fit-testing and training are conducted initially and annually thereafter.

Detailed programmatic information is discussed via the training module listed in Section 4.6.4.

4.6.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

RESPIRATOR FIT-TESTING & TRAINING	**AL-011**
Intended Audience:	*Mandatory for employees who use any type of tight-fitting respirators.*
Module Format:	*Laboratory instruction with quiz. Estimated completion time: 30 minutes.*
Associated Retrain Period & Format:	*Annual retrain. Written information and quiz.*

DUST MASK TRAINING	**AL-211**
Intended Audience:	*Mandatory for employees who use a disposable dust mask.*
Module Format:	*Personal instruction provided by ESH&A personnel. Estimated completion time: 15 min.*
Associated Retrain Period & Format:	*No retrain; OSHA information reviewed.*

4.6.5 PERFORMANCE CHECKLISTS

Group Leaders / Department Managers shall:
- Assure all activities are identified, reviewed and approved via the Readiness Review procedure.
- Attend respirator fit-testing and training prior to using any tight-fitting respirator including disposable dust masks.
- Assure Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) are complete and current for each employee.

Employees shall:
- Attend respirator fit-testing and training prior to using any tight-fitting respirator including disposable dust masks.
- Notify ESH&A of any usage of single-use, disposable dust masks.
- Perform work in accordance with group Standard Operating Procedures (SOPs).

Environment, Safety, Health & Assurance shall:
- Administer the ISU Respiratory Protection Program that includes conducting training, notifying employees of the need for refresher training, recordkeeping, etc.
- Provide exposure evaluations, upon request, that will assist employees in determining the need for respiratory protection.

Occupational Medicine shall:
- Administer medical surveillance to respirator users, as required.

4.7 BIOHAZARDOUS MATERIALS

Applicability Statement: *This section applies to groups/departments whose employees work with or may be exposed to biohazardous materials as part of their job responsibilities.*

4.7.1 REFERENCES

ISU Biosafety Manual

4.7.2 BACKGROUND

Research with biohazardous materials is increasing at Ames Laboratory. The ISU Biosafety Manual defines biohazardous materials as follows:

> "Biohazardous materials are those materials of biological origin that could potentially cause harm to humans, domestic or wild animals, or plants. Examples include recombinant DNA; transgenic animals or plants; human, animal or plant pathogens; biological toxins (such as tetanus toxin); human blood and certain human body fluids; and human or primate cell cultures."

Included in this definition are bloodborne pathogens as defined by OSHA's Bloodborne Pathogen regulation. Traditionally, occupational exposures to potentially infectious materials has been the biohazardous material of primary concern at Ames Laboratory. A ***bloodborne pathogen*** is defined as any pathogenic microorganism present in human blood that can cause disease in humans. These pathogens include the Human Immunodeficiency Virus (HIV) or AIDS virus, Hepatitis B virus (HBV) and other bloodborne infectious agents. The information in this section describes the mechanisms by which biohazardous materials are evaluated and controlled.

4.7.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in ISU's Biosafety Manual. The Manual along with the information in this section constitute the Laboratory's written program. Additional programmatic information is provided via the modules listed in section 4.7.4.

The three areas of concern when using biohazardous materials are as follows:

Licensing: Does the Group Leader have a signed agreement with the vendor of the material that states the details of their use and disposition?

Safety: Are the materials pathogenic to humans, animals or plants? Is so, has the project received Institutional Biosafety Committee approval? Have employees received Biohazardous Materials and Bloodborne Pathogen training, as appropriate?

Confidentiality: Are there any unique identifiers associated with the samples? If so, has the project received Institutional Review Board approval?

The primary mechanism by which work with biohazardous materials is evaluated is Readiness Review (described in Section 1). Group Leaders should consult with ESH&A on the requirements for work with biohazardous materials early in the planning of research and prior to any research being conducte as many biohazardous materials have strict regulatory requirements for shipment, use and disposition.

4.7.4 TRAINING

The following institutional training modules provide detailed information to the student on biohazardous materials:

BIOHAZARDOUS MATERIALS: AN INTRODUCTION	**AL 202**
Intended Audience:	*Mandatory for personnel who work with or supervise work with biohazardous materials as defined previously as a part of their job.*
Module Format:	*Web-based training. Estimated completion time: 1.0 hour.*
Associated Retrain Period & Format:	*No retrain.*

BLOODBORNE PATHOGEN EXPOSURE CONTROL PLAN TRAINING	**AL035**
Intended Audience:	*Mandatory for personnel who work with or supervise employees who work with potentially infectious materials as a part of their job.*
Module Format:	*Classroom or web-based instruction. Estimated completion time: 1.5 hours.*
Associated Retrain Period & Format:	*Annual retrain.*

In addition to the institutional modules above, group / activity-specific training shall be given to each employee prior to work that includes a discussion of hazards associated with biohazardous materials in use, hazard mitigation, location of MSDSs and other safety information, emergency response measures and any other procedural information. Verification of group-specific training shall be conducted during Readiness Reviews.

4.7.5 PERFORMANCE CHECKLISTS

Group Leaders / Department Managers shall:

- Maintain an inventory of all biohazardous materials (see definition above).
- Assure that all research activities involving biohazardous materials are identified, reviewed and approved via the Readiness Review procedure. This approval will include verification of all ISU committee approvals including the Institutional Biosafety Committee and Institutional Review Board.
- Complete the “Biohazardous Materials: An Introduction” course and, if appropriate the “Bloodborne Pathogen Exposure Control Plan Training” course.
- Assure Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current and reflect work with biohazardous materials.

- Conduct and document group or activity-specific training prior to work that includes a discussion of the hazards of biohazardous materials, hazard mitigation, location of MSDSs or other safety information, emergency response measures and any other procedural information.
- Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.
- Consult Environment, Safety, Health and Assurance with any questions related to biohazardous materials.

Employees shall:
- Attend "Biohazardous Materials: An Introduction" and "Bloodborne Pathogen Exposure Control Plan Training" as appropriate.
- Receive group or activity-specific training prior to work that includes a discussion of the hazards associated with the potentially infectious materials being used.
- Perform work in accordance with group Standard Operating Procedures (SOPs).

Environment, Safety, Health & Assurance shall:
- Maintain a facility-wide inventory of biohazardous materials and submit an annual report to the Ames Site Office.
- Facilitate completion of Readiness Review and any applicable ISU committee approvals.
- Assist employees with hazard determinations including the performance of monitoring, procedure reviews, hazard control recommendations, etc.
- Conduct training module and provide consultations, upon request, that assist Laboratory personnel in the implementation of requirements of this section.

4.8 ASBESTOS

Applicability Statement: *This section applies to groups/department whose employees remediate asbestos as certified asbestos abatement workers.*

4.8.1 REFERENCES

29 CFR 1910.1001, Asbestos
ISU Asbestos Management Program Manual

4.8.2 BACKGROUND

Health effects from asbestos exposure include asbestosis and mesothelioma. Asbestos-containing materials are prevalent throughout Ames Laboratory buildings and periodically require removal or encapsulation. This section of the Program Manual describes how to implement the program that ensures all affected employees are protected from occupational exposure to asbestos.

4.8.3 PROGRAM INFORMATION

The purpose of the Asbestos Management Program is to assure the safe handling of asbestos during treatment, removal and disposal. The program consists of comprehensive safe operating practices (which includes guidelines for all scales of asbestos projects).

4.8.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

SUPERVISOR / WORKER TRAINING	**AL-159**
Intended Audience:	*This is required for supervisors and workers who conduct asbestos abatement work.*
Module Format:	*Classroom Instruction. Estimated completion time: 4.0 days. Course conducted by off-site vendor.*
Associated Retrain Period & Format:	*Annual retrain; 8-hour refresher.*

ASBESTOS AWARENESS TRAINING	**AL-125**
Intended Audience:	*This is required for all employees who may potentially encounter asbestos in the course of their normal duties but do not handle it directly.*
Module Format:	*Classroom instruction. Estimated completion time: 1.0 day.*
Associated Retrain Period & Format:	*Annual retrain.*

4.8.5 PERFORMANCE CHECKLISTS

Group Leaders / Department Managers shall:
- Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- Assure that Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- Attend initial "Supervisor/Worker Training" and receive annual refresher training.
- Assure that employees are performing work in accordance with policies and procedures that mitigate hazards associated with asbestos.

Employees shall:
- Attend initial "Supervisor/Worker Training" and receive annual refresher training.
- Perform work in accordance with group Standard Operating Procedures (SOPs).

Environment, Safety, Health & Assurance shall:
- Provide consultations, upon request, to determine potential for asbestos exposure.
- Collaborate with Facilities Services on work activities, bulk samples, training, waste disposal, state notifications and other programmatic elements.

Facilities Services shall:
- Perform asbestos remediation work in accordance with established policies and procedures.

4.9 LEAD

Applicability Statement: *This section applies to groups/departments whose activities involve the use, maintenance, and disturbance of lead-containing materials. At Ames Laboratory this primarily applies to Facilities Services. Lead use in a research activity is covered by the Chemical Hygiene Program section.*

4.9.1 REFERENCES

29 CFR 1910.1025, Lead

4.9.2 BACKGROUND

Health effects from lead exposure continue to be a concern in the workplace and in the home. Since the ban on lead in gasoline, lead levels detected in areas near roadway have decreased dramatically; however, lead based paint used in buildings and housing prior to 1980 continue to serve as significant sources of exposure.

4.9.3 PROGRAM INFORMATION

The Laboratory follows the policies and procedures detailed in the ISU document "Guidelines for Working with Lead-Containing Materials". The information in this document applies to the use, maintenance and/or disturbance of lead-containing materials at ISU. The purpose of the document is to assure that lead and lead-containing materials are properly maintained and handled.

Laboratory use of lead is covered in the Chemical Hygiene Program, Section 4.2.

Detailed programmatic information is provided via the training modules listed in Section 4.9.4.

4.9.4 TRAINING

Detailed programmatic information is provided via the following institutional training modules:

LEAD AWARENESS TRAINING	**ISU INH06**
Intended Audience:	*Employees and their supervisors who may sand, scrape, abrade or otherwise disturb lead containing building materials during construction, renovation or maintenance activities.*
Module Format:	*Classroom instruction. Estimated completion time: 2.0 hours.*
Associated Retrain Period & Format:	*No retrain.*

4.9.5 PERFORMANCE CHECKLISTS

Group Leaders / Department Managers shall:
- Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- Attend ISU "Lead Awareness Training", (INH06).
- Assure that Hazard Inventory / Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- Assure that all work conducted by employees is done in accordance with the provisions of the ISU document "Guidelines for Working with Lead-Containing Materials".

Employees shall:
- Attend ISU "Lead Awareness Training", (INH06).
- Conduct work in accordance with the provisions of the ISU document "Guidelines for Working with Lead-Containing Materials".

Environment, Safety, Health & Assurance (ESH&A) shall:
- Assist employees with hazard determinations including the performance of monitoring, procedure reviews, hazard control recommendations, etc.
- Provide consultations, upon request, that assist Laboratory personnel in the implementation of a group-specific program that assures the safe handling and use of lead and lead-containing materials.

4.10 LABORATORY CHEMICAL HOOD TESTING PROGRAM

Applicability Statement: *This section applies to groups/departments whose activities involve the testing and maintenance of chemical hoods. At Ames Laboratory this primarily applies to Environment, Safety, Health & Assurance and Facilities Services.*

4.10.1 REFERENCES

29 CFR 1910.1450, Occupational Exposures to Hazardous Chemicals in Laboratories
ISU Laboratory Hood Manual (http://www.ehs.iastate.edu/publications/manuals/labhood.pdf)

4.10.2 BACKGROUND

Laboratory chemical hoods are the primary engineering control utilized at Ames Laboratory for chemical safety. When properly used, chemical hoods are effective in reducing or eliminating worker exposures to chemical vapors produced as a result of work with hazardous chemicals. Regular testing and certification of chemical hoods is essential to ensuring adequate performance. This section describes the protocol for annual testing of chemical hoods at Ames Laboratory.

4.10.3 PROGRAM INFORMATION

The Environment, Safety, Health & Assurance office tests chemical hoods on an annual basis. In general, performance criteria include a face velocity of 100 feet per minute at a sash height of 18 inches. Industrial Hygiene personnel evaluate current usage of the chemical hood and make a determination of the adequacy of the face velocity rating. ESH&A personnel consult with Facilities Services when face velocity adjustments are necessary.

4.10.4 TRAINING

There is no specific institutional training module associated with hood usage. Chemical hoods and their proper operation are discussed in the Chemical Hazard Communication (AL-137) training course.

4.10.5 PERFORMANCE CHECKLISTS

Group Leaders / Department Managers shall:
- Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- Assure chemical hoods are used correctly and in accordance with the guidelines in the ISU Laboratory Hood Manual.
- Report chemical hood performance deficiencies to ESH&A for correction.

Employees shall:
- Use chemical hoods in accordance with guidelines in the ISU Laboratory Hood Manual.
- Report chemical hood performance deficiencies to supervisor.

Environment, Safety, Health & Assurance (ESH&A) shall:

- Test chemical hood face velocities on an annual basis and request any modifications from Facilities Services.
- Provide consultations, upon request, to Laboratory personnel on the use of chemical hoods.

Facilities Services shall:

- Modify chemical hoods as requested by ESH&A.

4.11 LASERS

Applicability Statement: *This section applies to Groups/Departments that use lasers.*

4.11.1 REFERENCES

Iowa State University *Laser Safety Manual*

4.11.2 BACKGROUND

Use of laser systems is an important part of research conducted at Ames Laboratory. The hazards associated with lasers are significant and demand an effective management program. This section describes the basic elements of the Laboratory's Laser Safety Program.

4.11.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in Iowa State University's *Laser Safety Manual*. This document can be viewed at:

http://www.ehs.iastate.edu/publications/manuals/laser.pdf

The basic elements of the ISU document are: Responsibilities, Basic Laser Characteristics, Classes of Lasers, Beam Hazards, Associated Hazards, Laser Safety Practices, Requirements for Laser Operations, Personal Protective Equipment, Warning Labels & Signs, Laser Safety Standard Operating Procedures, Laser Safety Training, Medical Surveillance & Exposure Incidents. The following is an abbreviated summary of each of these elements. All users of Class 3B & 4 lasers at Ames Laboratory are required to review the information in this Section of the ESH&A Program Manual and the ISU Laser Safety Manual.

4.11.3.1 Responsibilities

Environment, Safety, Health & Assurance (ESH&A) is responsible for maintaining an inventory of all Class 3B & 4 lasers, reviewing procedures, providing technical assistance, verifying training records and facilitating the completion of training. The Laboratory's Laser Safety Officer (LSO) is Jim Withers; Deputy LSO's are Mike McGuigan and Shawn Nelson.

Occupational Medicine is responsible for providing laser safety eye exams to all users of Class 3b & 4 lasers.

Engineering Services is responsible for installing and performing annual maintenance checks on door interlock systems.

Laser user is responsible for meeting all applicable requirements including training and medical surveillance before operating a Class 3b or 4 laser and following safe work practices when working with lasers including the use of appropriate PPE.

Laser System Supervisor is responsible for ensuring that all laser systems are set up and operated in a mode that ensures the lowest potential for exposure; Group Leaders also shall ensure that all laser users are authorized, trained and medically-approved to use lasers and that an approved Standard Operating Procedure (SOP) is being followed that includes the use of appropriate Personal Protective Equipment (PPE). Work practices are regularly observed and any deficiencies corrected.

4.11.3.2 Basic Laser Characteristics

A complete discussion of the characteristics of lasers is given in the video as well as in the ISU Laser Safety Manual.

In general, lasers produce radiant energy that is deposited in the form of heat. The principle target organs of concern are the eyes and skin. The degree of hazard for laser radiation is dependent on the wavelength, the intensity or power and the duration of exposure. The principal goal of the Laser Safety Program is to minimize to the lowest extent possible the potential for exposure to laser beams either via direct exposure or reflection.

4.11.3.2 Classes of Lasers

A complete description of laser classes is given in the video and in the ISU Laser Safety Manual. A brief summary is as follows:

Class 1 & 1M Laser: low power, completely enclosed, exempt from any control measures.

Class 2 & 2M Laser: power <1 milliwatt, blink reflex of human eye is usually adequate control, training and medical surveillance not required.

Class 3R Laser: power levels of 1-5 milliwatts, significant hazards when viewed through optical instruments, training and medical surveillance not required.

Class 3B Laser – power levels of 5-500 milliwatts, hazardous upon direct viewing or diffuse/specular reflection, training and medical surveillance required.

Class 4 Laser – power levels >500 milliwatts, hazardous upon direct viewing or diffuse/specular reflection, potential for fire hazards, training and medical surveillance required. Door interlock systems required at Ames Laboratory.

4.11.3.3 Beam Hazards

The nature of laser beam damage is dependent on the wavelength of light, energy of the beam, divergence and exposure duration. The primary organ of concern is the eye with heating of the tissue being a principle adverse effect. The retina is the part of the eye of particular concern as this tissue does not regenerate.

4.11.3.4 Associated Hazards

There are additional hazards associated with lasers. Electrical hazards are a concern due the high-voltages required to power lasers. Chemicals such as dyes are sometimes used with laser and can be toxic. Collateral radiation can be given off as a “by-product” of the primary laser and

can include forms of ionizing radiation. A fire hazard can be created by any combustible material that is exposed to high beam irradiance for more than a few seconds. Explosion hazards exist with high-pressure lamps, filament lamps and capacitors.

4.11.3.5 Laser Safety Practices

The requirements for safe operation of a laser are stated in the ISU Laser Safety Manual. Some highlights are as follows:

Common work area safety practices include: isolating the laser from uninformed or curious by standers, setting up the laser operation above or below normal eye level, enclosing the beam when practical, reducing the potential for reflections and covering windows to hallways. Laser use safety practices include: avoiding direct beam observations, keeping unauthorized personnel out of laser labs and the use of appropriate Personal Protective Equipment (PPE).

All Class 3B and 4 laser systems shall be reviewed and approved by the LSO or Deputy LSO via completion of a Laser Hazard Assessment or LHA. The LHA is formal review that documents a complete hazard assessment that assures that exposure potentials have been minimized to the greatest extent.

4.11.3.6 Engineering Controls

When setting up a laser system, utmost consideration shall be given to minimizing the potential for accidental exposures. This is best accomplished via a hierarchy of controls starting with engineering controls followed by administrative and personal protective equipment controls. Priority should be given to enclosure of the laser beam to fullest amount practicable.

Remote interlock systems (most typically door interlocks) must be in place for all Class 4 systems. Remote interlock systems provide additional protection against incidental eye exposures to individuals entering the laser controlled area. Deviations from this policy are strongly discouraged and shall only be allowed after review and approval by the LSO.

Laser control areas shall be designated for use of Class 3b and 4 systems (in most applications, the laser control area is the entire lab). As stated previously, all beams shall be enclosed to the fullest extent and remote interlock systems shall be required for Class 4 systems. Control areas must be appropriately signed and designated for authorized personnel only.

4.11.3.7 Personal Protective Equipment

Laser protective eyewear is a fundamental part of a group-specific laser safety program. The LHA process is used to calculate and confirm the appropriate necessary Optical Density (OD) rating for eyewear based on the parameters of usage. Goggles must be stored properly and maintained in good condition. Occasionally, protective clothing such as gloves and forearm covers might be required to avoid damage to the skin.

4.11.3.8 Warning Labels and Signs

Lasers and laser systems require appropriate signage. The verbiage on signage is specific to the class of laser. ANSI Z136.1 requirements will be followed for all laser signage.

4.11.3.9 Laser Safety Standard Operating Procedures (SOPs)

A written SOP is required for laser Class 3b and 4 laser operations. SOPs are a sequential list of actions taken during a particular activity and typically include a discussion of potential hazards and associated control measures such as the use of beam enclosures and laser safety eyewear. The level of detail in a SOP is commensurate with the level of hazard. For example, the SOP for a Class 4 laser operated in an open beam configuration will be more detailed than the SOP for a totally enclosed or Class 1 laser system.

Since most laser exposure events occur during alignments, the SOP will include specific information on how alignments are done and both the laser user and the system supervisor shall assure that training on conducting alignments is complete and the potential hazard associated with this activity has been reduced to the lowest possible extent.

There is no prescriptive format for a laser system SOP. Ames Laboratory has a standardized SOP template that is available for use with a laser system. Once prepared, SOPs can be used to document training of laser users. It is imperative that SOPs be periodically review for adequacy and updated as necessary (e.g. addition of new lasers, new users, etc.). SOPs shall be readily available in the laser lab and reviewed by ESH&A during annual laser system reviews.

4.11.3.10 Training

All Class 3b and 4 laser operators are required to take the Ames Laboratory laser safety training module. Additionally, 3-year refresher training is required for all Class 3b & 4 laser users. Laser system-specific training is also required and shall be conducted by the Laser System Supervisor or an authorized designee. Documentation related to group-specific training shall be available in the laser laboratory.

4.11.3.11 Medical Surveillance & Exposure Incidents

Baseline eye exams are required for all Class 3b & 4 laser users. Eye exams are conducted at the Occupational Medicine department in G11 TASF and consist of several visual acuity tests. There is no charge for the exam. Additional medical exams may be indicated if an ocular abnormality is detected or in the event of an exposure. Employees are required to report all laser exposure events.

4.12 TRAINING

LASER SAFETY TRAINING	**AL-070**
Intended Audience:	*Mandatory for all workers who work with Class 3b and 4 lasers.*
Module Format:	*Module consists of a video; computer based training. The participant shall also complete a*

	base line eye exam. Estimated completion time: 1.5 hours.
Associated Retrain Period & Format:	*3 year retrain via a Web-based course.*

Group / activity-specific training shall be given to each employee prior to work that includes a discussion of laser hazards and hazards associated with the laser, such as laser dyes, electrical hazards, chemical concerns, etc. In addition, the group or activity training shall review emergency response measures and any other procedural information.

4.11.5 PERFORMANCE CHECKLISTS

Laser System Supervisor shall:
- ❑ Assure that all research activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ❑ Assure that all Class 3B & 4 laser systems have been reviewed and approved via completion of a Laser Hazard Assessment.
- ❑ Attend Ames Laboratory "Laser Safety" training, (AL-070) if working with Class 3b and 4 lasers and receive baseline and exit eye exams.
- ❑ Assure Hazard Inventory/Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ❑ Assure that all laser users have completed both institutional and group-specific training prior to work.
- ❑ Conduct periodic observations of work to ensure that safe work practices are being conducted.
- ❑ Assure that group Standard Operating Procedures (SOPs) are current and address all laser operations including any specific activities such as performing alignments that may involve a higher risk of exposure; supervisors shall assure that work is performed within established guidelines.
- ❑ Assure that laser laboratory is set up in accordance with the ISU Laser Safety Manual.

Employees shall**:**
- ❑ Attend Ames Laboratory "Laser Safety" training, (AL-070) if working with Class 3b and 4 lasers and receive baseline and exit eye exams.
- ❑ Receive activity or experiment-specific training prior to working with lasers.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs) including the use of appropriate PPE.
- ❑ Report any discrepancies or any off-normal events to the Group Leader for correction.

Environment, Safety, Health and Assurance (ESH&A) shall:
- ❑ Perform Laser Hazard Assessments initially and review on an annual basis. LHAs may also be done if significant changes are made in the set up of a laser system.
- ❑ Advice Laboratory personnel on the safe use of lasers and assist with group-specific implementation.

Occupational Medicine shall:
- ❑ Facilitate the completion of laser eye exams for Laboratory personnel.

4.12 RADIO FREQUENCY (RF) RADIATION-GENERATING DEVICES

Applicability Statement: *This section applies to Groups/Departments that use RF radiation-generating devices.*

4.12.1 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH) Handbook "Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices"

ANSI/IEEE Standard C95.1 Safe Levels With Respect to Human Exposure to RF Radiation, 3kHz to 300 GHz

4.12.2 BACKGROUND

Use of devices that generate RF radiation is an important part of several of the Laboratory's research programs. The hazards associated with RF radiation are potentially significant and demand an effective management program. This section describes the health physics protection mechanisms designed to ensure worker protection from RF radiation.

4.12.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in American Conference of Governmental Industrial Hygienists (ACGIH) Handbook entitled "Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices" and ANSI/IEEE Standard C95.1, "Safe Levels With Respect to Human Exposure to RF Radiation, 3kHz to 300 GHz." These documents, along with the information contained in this section of the Ames Laboratory ESH&A Program Manual and the training information presented below constitute the Laboratory's written program. The basic elements of the Laboratory's program are: ESH&A surveys of RF systems, Readiness Review procedures and the group-specific safety training for laser users.

4.12.3.1 EMFs and RFR

Electromagnetic energy exists in a variety of forms: television and radio waves, heat lamp radiation, microwaves, light from the sun and other sources, and electrical currents passing through wires. Electromagnetic energy occurs in two forms. When current passes through electrical wires, electromagnetic energy is created as fields around the wires. These fields, called electromagnetic fields (EMFs), have both an electric and magnetic component. Electromagnetic energy can also move from one point to another by waves propagated through space, such as visible light and radio waves. As defined by the Institute of Electrical and Electronics Engineers (IEEE), radiofrequency radiation (RFR) are waves moving through space which lie in the frequency range of 3 kHz to 300 GHz. (Figure 4.12-1 below)

Frequency Range (Hz)	Wavelength Range	Type of Radiation
10E20-10E24	10E-12 - 10E-16 m	Gamma-rays
10E17 - 10E20	1 nm - 1 pm	x-rays
10E15 - 10E17	400 - 1 nm	Ultraviolet light
4.3 - 7.5x10E14	700-400 nm	visible light
10E12 - 10E14	2.5 um - 700 nm	Infrared light
10E8 - 10E12	1 mm - 2.5 um	Microwaves
10E0 - 10E8	10e8 - 1 m	radio waves

Figure 4.12-1 – The Electromagnetic Spectrum

Health effects caused by the magnetic field portion of EMFs have been a subject of intense debate. Beginning in 1979, researchers began to suggest a link between EMFs and leukemia. Some feel that continuing research since 1979 has confirmed the correlation between EMFs and leukemia. However, the National Academy of Science report of October 31, 1996, "Possible Health Effects of Exposure to Residential Electric and Magnetic Fields, "concluded that no conclusive evidence exists which shows that EMFs play a role in the development of cancer."

4.12.3.2 Characteristics of Radio Frequency Radiation

Transmitted electromagnetic waves travel at the speed of light. RFR radiates outward from its transmission source in energy packets that combine the characteristics of waves and particles. Once generated, these waves of energy travel from their transmitter through space, where they are reflected from, refracted around, or absorbed by, their intended receivers or by any object in its path. The absorbed energy is the source of health-related concerns.

Based on the characteristics of the wave and the material that absorbs it, the absorbed energy might affect the absorbing material in a number of ways. The absorbed energy could cause a resonating electrical effect in some conducting materials, as occurs in receiving antennas in radio and TV systems. It could be re-emitted as electromagnetic energy such as fluorescence in visible or ultraviolet light. As higher energy forms it could interact with chemical bonds in complex molecules resulting in changes to the nature of the molecule. This interaction is the basis for sunburns caused by ultraviolet light, and "radiation" burns caused by gamma ray irradiation. Some electromagnetic waves, like X-rays and certain forms of gamma radiation, may pass completely through some materials without being absorbed. (Each of these types of electromagnetic waves are in frequency ranges much higher than RFR.) Most commonly, electromagnetic energy is simply absorbed by materials and converted into heat energy. ESH&A will measure RFR levels and determine if they exceed the TLVs. If they do, shielding in the form of some type of wire mesh, around the RFR source has been found to be very effective in reducing the RFR emission rate. Care must be taken not to allow the mesh to come in contact with surfaces that would be effected by heat energy, since the mesh absorbs the RFR, which is converted to heat in the mesh.

Electromagnetic waves can be characterized by three attributes - frequency, amplitude and intensity. Frequency is the rate at which electromagnetic waves are generated or pass a fixed point. Frequency determines wavelength, with longer waves having lower frequency and shorter waves a higher frequency. Frequency is measured in cycles per second units, called hertz (Hz) (60 Hz = 60 cycles/second).

Amplitude is a relative measure of a wave's energy level. Waves at the same frequency with higher amplitude deliver more energy. Waves with the same amplitude at higher frequencies carry more energy. Two waves with the same frequency can have different amplitudes based upon how much energy is put into each wave's production.

Intensity, or power density, is the rate at which energy is transmitted through a given area (measured in milliwatts per square centimeter - mW/cm2). Intensity is therefore a measure of a wave's total energy after traveling a given distance from its source. A wave radiating away from its source has its energy spread more thinly the farther it travels. As a radio wave radiates outward, its energy is dispersed over an ever-increasing area resulting in an inverse-square

principle. Every time the distance from an emitting source is doubled, the area covered increases by a factor of four and the power density decreases by a factor of four. A wave registering a certain power level when measured at a distance of fifty feet from the antenna would then register one-fourth that power level at one hundred feet and one-sixteenth at two hundred feet. Radio waves can also diminish in intensity as they are absorbed or scattered by air, fog or objects.

An electromagnetic wave's basic properties may be manipulated to encode information within the wave. This process is called modulation. The amplitude of the wave may be varied as in AM radio, or the frequency of the wave may be varied as in FM radio. The frequency or amplitude of the continuous wave is changed in proportion to an imposed signal. The imposed signal is the information such as a radio, TV, or radar signal. RFR is generally of lower frequencies and lower energy levels than many other types of artificially generated electromagnetic energy.

Refer to the previous chart of the electronic spectrum provided as Figure 4.12-1. Specific ranges and segregation of frequencies for RFR are identified below.

RFR, in general 3 kHz to 300 GHz

AM Radio 550 - 1600 kHz

FM Radio, TV channels 2-13 30 - 300 MHZ

UHF Television 470 - 806 MHZ

Commercial Paging 35, 43, 152, 158, 454, 931 MHZ

Cellular Telephone 824-849 MHZ, 869-894 MHZ

Specialized Mobile Radio (SMR) "800 MHZ" (806-821/851-866 MHZ)

"900 MHZ" (896-901/935-941 MHZ)

Personal Communication Services (PCS) 901-941, 1850-1990 MHZ

4.12.3.3 Ionizing and Non-ionizing Radiation

Radiation is characterized by its effect upon absorption as either ionizing or non-ionizing radiation. Ionizing means that there is sufficient energy to change the chemical structure of the absorbing matter by removing one or more electrons, creating an electrically charged particle (ion). Non-ionizing means that there is not enough energy in the radiation to create ions. Instead, the energy is absorbed only as heat. Because of its low energy, RFR is non-ionizing radiation.

With their high frequencies and energies, X-rays, some gamma rays and radiation from nuclear processes are ionizing radiation. When ionizing radiation interacts with living structures, it can cause chemical bonds of molecules struck by high-energy particles to be broken. If the absorbing molecules are DNA or other genetic materials, cellular metabolism can be interfered with and the cell's ability to reproduce itself can be altered. Correlations have been made between the incidence of cancer and high rates of exposure to ionizing radiation (National Research Council, 1990).

Non-ionizing RFR does not directly alter molecular structure. When RFR is absorbed, it results in an increase in molecular movement. This is sensed as heat. RFR, which is low frequency and low-energy, produces relatively low amounts of heat in biological tissue. Non-ionizing radiation is not known to damage DNA in the manner that ionizing radiation does.

A useful concept to measure the effect of non-ionizing radiation is specific absorption rate (SAR). SAR is the measurement of power absorbed by whomever or whatever is being studied. It is the power deposited in tissue by the electromagnetic wave, measured in Watts per kilogram of body mass (W/kg).

Group / activity-specific training shall be given to each employee prior to work that includes a discussion of RF hazards and other safety information. In addition the group/activity training shall review emergency response measures and any other procedural information. This training shall be documented by the Group Leader / Department Manager.

4.12.4 TRAINING

Currently, there is no institutional training module for the Radio Frequency (RF) Radiation-Generating Devices Program. However, all affected populations are required to read this program and comply with the requirements discussed in the section.

4.12.5 PERFORMANCE CHECKLISTS

Group Leader / Department Manager shall:

- ❑ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ❑ Review the safety training section for RF in this Manual.
- ❑ Assure Hazard Inventory/Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ❑ Conduct and document group/activity-specific training for each employee prior to work that includes a discussion of RFR, hazard mitigation, and emergency procedures.

- ❑ Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.
- ❑ Assure that equipment and room where potentially high levels of RFR will be produced are marked and labeled in accordance with the guidelines in the ACGIH Handbook.
- ❑ Assure that all activities that include use of RF radiation-generating devices receive Readiness Review.

Employees shall**:**

- ❑ Review the safety training section for RF in this Manual.
- ❑ Receive activity or experiment-specific training prior to working with radioactive materials.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs).

4.13 ULTRAVIOLET (UV) LIGHT –GENERATING DEVICES

Applicability Statement: *This section applies to Groups/Departments using devices that generate UV light.*

4.13.1 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH) Handbook entitled "Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices"
ANSI/IEEE Standard C95.1, "Safe Levels With Respect to Human Exposure to UV Radiation"

4.13.2 BACKGROUND

Use of devices that generate UV light is an important part of several of the Laboratory's research programs. The hazards associated with UV light are significant and demand an effective management program. This section describes the health physics protection mechanisms designed to ensure worker protection from UV light.

4.13.3 PROGRAM INFORMATION

Ames Laboratory follows the requirements listed in American Conference of Governmental Industrial Hygienists (ACGIH) Handbook entitled "Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices" and ANSI/IEEE Standard C95.1, "Safe Levels With Respect to Human Exposure to UV Radiation." These documents, along with the information contained in this section of the Ames Laboratory Program Manual and the training module constitute the Laboratory's written program.

4.13.3.1 What is Ultraviolet Radiation?

Ultraviolet radiation is the portion of the invisible light spectrum between approximately 100 and 400 nanometers (nm). The primary source of UV is the sun, but artificial sources include welder's flash, sunlamps or tanning parlors, high-intensity mercury vapor lamps used for night sports, special lamps used in infant care units, xenon arc lamps, and lasers.

Ultraviolet is composed of three segments, designated as A, B, and C. UV-C (below 280 nm) is filtered by the earth's ozone layer and does not reach earth. Because it never reaches us, UVC currently does not pose a threat. There is much evidence, however, that exposure to both UV-A and UV-B can have adverse short-term and long-term effects on your eyes and visual health.

4.13.3.2 Possible Effects of UV

The most common short-term effects of UV exposure are termed "snow blindness" and "welder's flash." Both of these conditions result from corneal exposure to excessive amounts of UV radiation over a short amount time. This is like a sunburn of the eye. The exposure can come from a welding arc or from long hours spent in snowy altitudes or the beach without proper eye protection. Symptoms include red eyes, a gritty or foreign sandy sensation, extreme light sensitivity, and tearing. Though painful, these symptoms are usually temporary and rarely cause

permanent damage. Long-term effects of UV radiation, on the other hand, are usually gradual and painless. Vision impairment can result from premature cataract formation due to the cumulative effects of UV exposure. It has been reported that 10 percent of cataract operations are necessitated by this type of UV exposure.

Long-term exposure to UV radiation has also been implicated in age-related macular degeneration. This condition affects 10 percent of the U.S. population over the age of 52, and increases to 33 percent in people over age 75. Age-related macular degeneration is the leading cause of vision loss in older Americans.

4.13.3.3 Recommendations for Protection

Here are some helpful tips from the American Optometric Association that can be used when selecting sunglasses.

Sunglasses should:

- block 99-100 percent of both UV-A and UV-B radiation;
- screen out 75 to 90 percent of visible light; and
- are perfectly matched in color and absorption, and are free of distortion and imperfections.

You should also wear clothing to cover areas of the body possibly exposed to UVR.

Group / activity-specific training shall be given to each employee prior to work that includes a discussion of UV hazards and other safety information. In addition the group/activity training shall review emergency response measures and any other procedural information. This training shall be documented by the Group Leader / Department Manager.

4.13.4 TRAINING

Currently, there is no institutional training module for UV Radiation-Generating Devices. However, it is imperative that supervisory personnel are aware of all sources of UV exposures and potential for adverse health affects and inform all personnel as to how to protect themselves. At a minimum, both supervisory personnel and research group members with potential to interact with sources of UV shall be required to read this program and comply with the safety requirements discussed in the section.

4.13.5 PERFORMANCE CHECKLISTS

Group Leader / Department Manager shall:

- ❑ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ❑ Review the UV training information in this Manual.
- ❑ Assure Hazard Inventory/Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ❑ Conduct and document group/activity-specific training for each employee prior to work that includes a discussion of UVR, hazard mitigation, and emergency procedures.

- ❑ Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.
- ❑ Assure that equipment emitting potentially hazardous levels of UVR and laboratories are properly marked and labeled in accordance with guidelines given in the ACGIH.
- ❑ Assure that all activities that include work with UV radiation-generating devices receive Readiness Review.

Employees shall**:**

- ❑ Review the UV training information in this Manual.
- ❑ Receive activity/experiment-specific training prior to work with UV radiation-generating devices.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs).

4.14 MAGNET SYTEMS

Applicability Statement: *This section applies to groups/departments that conduct research using magnet systems.*

4.14.1 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH) TLV booklet entitled "Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices". Specifically, the section entitled "Non-Ionizing Radiation and Fields (pp. 152-156) addresses acceptable magnetic and electric field exposure levels for these systems.

4.14.2 BACKGROUND

Use of magnet systems is an important part of research conducted at Ames Laboratory. The hazards associated with high-powered magnets are significant and demand an effective management program. This section describes the designed to minimize employee exposures and therefore ensure worker protection from electric and magnetic fields.

4.14.3 PROGRAM INFORMATION

4.14.3.1 Exposure Limits

The ACGIH TLV values and associated text are as follows:

4.14.3.1.1 Static Magnetic Fields

These TLVs refer to static magnetic field flux densities to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. These values should be used as guides in the control of exposure to static magnetic fields and should not be regarded as fine lines between safe and dangerous levels.

Routine occupational exposures should not exceed 60 millitesla (mT), equivalent to 600 gauss (G), whole body or 600 mT (6,000 G) to the limbs on a daily, TWA basis [1 tesla (T) = 10,000 G]. Recommended ceiling values are 2 T for the whole body and 5 T for the limbs. Safety hazards may exist from the mechanical forces exerted by the magnetic field upon ferromagnetic tools and medical implants. Cardiac pacemaker and similar medical electronic devices wearers should not be exposed to field levels exceeding 0.5 mT (5 G). Adverse effects may also be produced at higher flux densities resulting from forces upon other implanted devices such as suture staples, aneurism clips, prostheses, etc. These TLVs are summarized in Table 1.

TABLE 1. TLVs for Static Magnetic Fields

	8-hour TWA	Ceiling
Whole body	60 mT	2 T
Limbs	600 mT	5 T
Medical electronic device wearers	—	0.5 mT

4.14.3.1.2 Sub-Radiofrequency (30 kHz and below) and Magnetic Fields

These TLVs refer to the amplitude of the magnetic flux density (B) of sub-radiofrequency (sub-RF) magnetic fields in the frequency range of 30 kilohertz (kHz) and below to which it is believed that nearly all workers may be exposed repeatedly without adverse health effects. The magnetic field strengths in these TLVs are root-mean-square (rms) values. These values should be used as guides in the control of exposure to sub-radiofrequency magnetic fields and should not be regarded as fine lines between safe and dangerous levels.

Occupational exposures in the extremely-lowfrequency (ELF) range from 1 to 300 hertz (Hz) should not exceed the ceiling value given by the equation:

$$B_{TLV} = 60 / f$$

where: f = the frequency in Hz, B_{TLV} = the magnetic flux density in millitesla (mT).

For frequencies in the range of 300 Hz to 30 kHz (which includes the voice frequency [VF] band from 300 Hz to 3 kHz and the very-low-frequency [VLF] band from 3 to 30 kHz), occupational exposures should not exceed the ceiling value of 0.2 mT.

These ceiling values for frequencies of 300 Hz to 30 kHz are intended for both partial-body and whole-body exposures. For frequencies below 300 Hz, the TLV for exposure of the extremities can be increased by a factor of 10 for the hands and feet and by a factor of 5 for the arms and legs.

The magnetic flux density of 60 mT/f at 60 Hz corresponds to a maximum permissible flux density of 1 mT. At 30 kHz, the TLV is 0.2 mT, which corresponds to a magnetic field intensity of 160 A/m.

Contact currents from touching ungrounded objects that have acquired an induced electrical charge in a strong sub-RF magnetic field should not exceed the following point contact levels to avoid startle responses or severe electrical shocks:

A. 1.0 milliampere (mA) at frequencies from 1 Hz to 2.5 kHz.
B. 0.4f mA at frequencies from 2.5 to 30 kHz, where f is the frequency expressed in kHz.

4.14.3.1.3 Sub-Radiofrequency (30 kHz and below) and Static Electric Fields

These TLVs refer to the maximum unprotected workplace field strengths of sub-radiofrequency electric fields (30 kHz and below) and static electric fields that represent conditions under which it is believed that nearly all workers may be exposed repeatedly without adverse health effects. The electric field intensities in these TLVs are root-mean-square (rms) values. The values should be used as guides in the control of exposure and, due to individual susceptibility, should not be regarded as a fine line between safe and dangerous levels. The electric field strengths stated in these TLVs refer to the field levels present in air, away from the surfaces of conductors (where spark discharges and contact currents may pose significant hazards).

Occupational exposures should not exceed a field strength of 25 kilovolts per meter (kV/m) from 0 hertz (Hz) (direct current [DC]) to 100 Hz. For frequencies in the range of 100 to 4 kilohertz (kHz), the ceiling value is given by:

$$E_{TLV} = 2.5 \text{ X } 10^6 / f$$

where: f = the frequency in Hz; ETLV = the electric field strength in volts per meter (V/m).

A value of 625 V/m is the ceiling value for frequencies from 4 to 30 kHz. These ceiling values 0 to 30 kHz are intended for both partial-body and whole-body exposures.

Notes:

1. These TLVs are based on limiting currents on the body surface and induced internal currents to levels below those that are believed to produce adverse health effects. Certain biological effects have been demonstrated in laboratory studies at electric field strengths below those permitted in the TLV; however, there is no convincing evidence at the present time that occupational exposure to these field levels leads to adverse health effects.

   Modifications of the TLVs will be made if warranted by new information. At this time, there is insufficient information on human responses and possible health effects of electric fields in the frequency range of 0 to 30 kHz to permit the establishment of a TLV for time-weighted average exposures.

2. Field strengths greater than approximately 5 to 7 kV/m can produce a wide range of safety hazards such as startle reactions associated with spark discharges and contact currents from ungrounded conductors within the field. In addition, safety hazards associated with combustion, ignition of flammable materials, and electro-explosive devices may exist when a high-intensity electric field is present. Care should be taken to eliminate underground objects, to ground such objects, or to use insulated gloves when ungrounded objects must be handled. Prudence dictates the use of protective devices (e.g., suits, gloves, and insulation) in all fields exceeding 15 kV/m.

3. For workers with cardiac pacemakers, the TLV may not protect against electromagnetic interference with pacemaker function. Some models of cardiac pacemakers have been shown to be susceptible to interference by power frequency (50/60 Hz) electric fields as low as 2 kV/m. It is recommended that, lacking specific information on electromagnetic interference from the manufacturer, the exposure of pacemaker and medical electronic device wearers should be maintained at or below 1 kV/m.

4.14.3.2 Signage & Other Types of Notifications

As stated previously, certain segments of the population (e.g. people with pacemakers) may be susceptible to 5 Gauss fields. To address that potential hazard, employee notification is

paramount. There are many methods of notification including signage, barricades, floor markings. Examples are given below:

Picture 1. Sample magnetic field warning sign on laboratory door denoting 5 Gauss line.

Picture 2. Sample magnetic field warning sign on unit denoting 5 Gauss line.

Picture 3. Warning sign on stanchions and floor markings denoting 5 and 10 Gauss lines.

It shall be the Group Leaders responsibility to determine the best means of employee notification in their respective research areas. Door signage is considered to the minimum form of employee notification. ESH&A can provide assistance in determining the most effective means of employee notifications and can custom make signage upon request.

4.14.3.3 Training

Currently, there is no institutional training module for the operation of magnets or magnet systems. Group or activity-specific training shall be given to each employee prior to work that includes a discussion of magnetic fields and other pertinent safety information. Verification of group or activity-specific training is conducted during Readiness Review.

4.14.5 PERFORMANCE CHECKLISTS

Group Leader / Department Manager shall:

- ❑ Assure that all activities are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ❑ Review the safety training presented in this Manual on magnets.
- ❑ Assure Hazard Inventory/Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ❑ Conduct and document group/activity-specific training for each employee prior to work that includes a discussion of magnets with potential hazards and controls.
- ❑ Assure that group Standard Operating Procedures (SOPs) are current and that work is performed within established guidelines.
- ❑ Assure that equipment and laboratories are properly labeled so occupants are notified of 5 Gauss fields.

Employees shall**:**

- ❑ Review the safety information on magnets contained in this section of the Manual.
- ❑ Receive group/activity-specific training prior to working with magnet systems.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs).

Environment, Safety, Health and Assurance shall:

- ❑ Provide consultations upon request on issues related to management of potential hazards associated with magnet systems including signage and other forms of employee notifications.

4.15 NANOMATERIALS

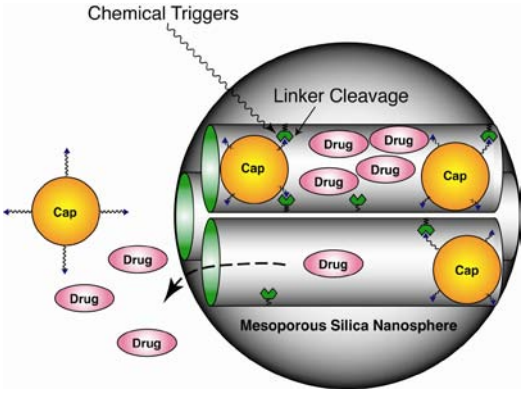
Applicability Statement: *This section applies to groups/departments that use unbound nanoscale materials (particles with diameters less than 100 nanometers).*

4.15.1 REFERENCES

Department of Energy Nanoscale Science Research Centers - Approach to Nanomaterial ES&H - Revision 3a – May 2008

DOE Order 456.1 – The Safe Handling of Unbound Engineered Nanoparticles

4.15.2 BACKGROUND



Ames Laboratory has limited activities involving unbound nanomaterials. Potential hazards associated with unbound nanomaterials work are addressed through the Laboratory's Integrated Safety Management System (ISMS) and specifically the Readiness Review process. Readiness Review provides the identification and evaluation of potential hazards and establishes effective control mechanisms to ensure protection of the employee and the environment. To date, hazards associated with projects involving unbound nanomaterials have been determined to be amenable to conventional controls such as ventilation and use of personal protective equipment. The Laboratory recognizes that nanotechnology is an emerging field and that many of the associated ES&H concerns related to work with these materials are still being investigated. Ames Laboratory safety professionals monitor professional sources of information to identify new control strategies associated with nanomaterials research.

The DOE Notice 456.1 – The Safe Handling of Unbound Engineered Nanoparticles delineates the expectations in the following areas:

1) Nanotechnology Policies and Procedures
2) Training
3) Exposure Assessment
4) Medical Surveillance
5) Controls
6) Posting and Labeling
7) Transportation
8) Waste Management

In addition, Ames Laboratory utilizes the Department of Energy Nanoscale Science Research Centers *Approach to Nanomaterial ES&H(Revision 3a – June 2008)* document as a resource for evaluating health and safety risks associated with use of unbound nanoscale materials.

4.15.3 PROGRAM INFORMATION

4.15.3.1 Nanomaterial Hazard Assessment

All work with unbound nanoscale materials will undergo a Nanomaterials Hazard Assessment (Form 10200.187). The assessment is the mechanism by which data is collected and an analysis of the hazards, exposure potential and controls. Specifically, the assessment includes a review of specific usages, Material Safety Data Sheets, Standard Operating Procedures, toxicity, routes of exposure and controls in place (e.g. ventilation, Personal Protective Equipment). Documentation generated as a result of this assessment is maintained in the Readiness Review file for that particular research activity. Readiness Review records are maintained by ESH&A.

4.15.3.2 Readiness Review

Nanoscale work is identified via Readiness Review (Procedure 10200.006). Specifically, the physical hazard of nanomaterials is addressed on the ES&H Hazard Identification Checklist by the following statements:

Section A – Chemical & Biological Concerns: *A14 Nanoscale materials.*

For each identified hazard, the Activity Supervisor develops associated Hazard Management Statements that explain what controls are in place to minimize exposure potential. Standard Operating Procedures (SOPs) are also reviewed for adequacy along with a check of training records.

4.15.3.3 Training

Laboratory personnel identify work with nanomaterials via completion of a Training Needs Questionnaire (TNQ). The TNQ question on nanomaterials work is as follows:

"Do you work with nanoscale materials (particles with diameters less than 100 nanometers)?" If answered "yes", the employee's training profile is updated and reflects the need for completion of the Lab's nanomaterials safety module entitled "Nanotechnology Awareness (AL-208)". This course is computer-based, takes 30 minutes to complete and requires an 80% or higher score on a Learning Assessment Tool. Subjects covered in the training module include:

- Introduction to Nanomaterials
- Definitions
- Overview of inhalation, dermal, ingestion routes of exposure
- Safety precautions including engineering controls, respiratory protection
- Work practices including spill clean up
- Waste management
- Transportation
- Training
- Medical surveillance
- Lab postings and labeling
- Points of contact

New health and safety information related to nanoscale materials is emerging on a regular basis. By necessity, training will need to be assessed for adequacy on a regular basis. Any new or refresher information will be provided all employees who have completed the module via e-mail updates within an approximate timeframe of 90 days of receipt.

4.15.3.4 Medical Surveillance

The Hazard Inventory form is completed by all Ames Laboratory employees. "A"-listed hazards are located on the first page of the form and are those agents that have special requirements such as medical surveillance. Hazard "A265" denotes use of nanoscale materials. Laboratory employees with exposure potential to nanoscale materials will be offered a baseline medical exam at Occupational Medicine (G11 TASF). The baseline exam will consist of a general physical, general blood work, pulmonary function test and chest x-ray. Other tests such as a chest x-ray will be recommended at the discretion of the Occupational Medicine physician. Recall frequency will also be determined by the physician.

4.15.3.5 Exposure Monitoring

There are currently no accepted methods for exposure monitoring of nanoscale materials. IH personnel will continue to monitor progress on the development of monitoring equipment through professional sources of information including ISU EH&S personnel.

4.15.3.6 Exposure Controls

Engineering controls such as a ventilated enclosure or chemical hood will be evaluated for all work with dispersible (able to be inhaled) nanoparticles. If engineering controls are deemed not feasible, respiratory protection will be implemented with the employee being placed on the Respiratory Protection Program which includes fit-testing and training. Other personal protective equipment that will be recommended as standard issue for work with nanoparticles includes a lab coat and latex gloves with extensions.

4.15.3.7 Posting and Labeling

Laboratories where work with dispersible nanoparticles occurs will have signage commensurate with the risk of exposure. An example of a sign that would be appropriate for work with dispersible particles used outside of a ventilated enclosure with occupants wearing respiratory protection would be as follows:

"NOTICE
Nanoscale materials used in this lab. The health and physical hazards of these materials have not been fully evaluated. Only authorized personnel are allowed to work with nanoscale materials. Other personnel entering the lab should first verify that work with nanoscale materials is not being conducted. For more information, contact PI listed on the emergency door card or a safety office representative."

In other cases, updating the emergency door card may be sufficient in terms of signage. The ESH&A office should be consulted regarding appropriate laboratory signage.

4.15.3.7 Transportation

All shipments of nanoscale materials will be in accordance with Department of Transportation regulations. Innermost receptacles used for waste shipments will have a label attached that communicates an appropriate level of caution and description of contents.

4.15.3.8 Waste Management

Handling and disposal of nanoscale material-containing waste will be done in accordance with procedures described in the waste management section of this Manual.

4.15.3.9 Feedback Mechanisms

Feedback on the adequacy of the mechanisms in place for identifying, evaluating and controlling hazards associated with research involving work with nanoscale materials is ensured via a variety of mechanisms. As previously stated, Readiness Review provides a mechanism by which safe use of nanomaterials is assured. Topical appraisals and external reviews also provide feedback on program effectiveness.

4.15.4 PERFORMANCE CHECKLISTS

Group Leader / Department Manager shall:

- ❑ Assure that all activities involving work with nanoscale materials are identified, reviewed and approved via the Laboratory's Readiness Review procedure and have undergone a Nanomaterials Hazard Assessment.
- ❑ Assure that all employees working with dispersible nanoscale materials complete Nanomaterials Awareness (AL-206) training.
- ❑ Assure Hazard Inventory/Job Task Analysis packets and Training Needs Questionnaires (TNQs) for all personnel are complete and current.
- ❑ Conduct and document group/activity-specific training for each employee prior to work that includes a discussion of nanoscale materials with potential hazards and controls.
- ❑ Assure group Standard Operating Procedures are current and sufficiently detailed to perform work within established guidelines and reduce exposure potentials to the lowest possible level.

Employees shall**:**

- ❑ Complete the Nanomaterials Awareness (AL-206) course.
- ❑ Receive group/activity-specific training prior to working with nanoscale materials.
- ❑ Perform work in accordance with group Standard Operating Procedures (SOPs) including use of appropriate control measures such as chemical hood and PPE.

Environment, Safety, Health and Assurance shall:

- ❑ Review activities involving nanoscale materials to determine exposure potential surveillance.
- ❑ Provide consultations upon request on issues related to management of potential hazards associated with nanoscale materials.

Occupational Medicine shall:

- ❑ Provide appropriate medical surveillance to nanoscale materials users including history, basic exam, blood work, pulmonary function test and chest x-ray.

4.16 BERYLLIUM

Applicability Statement: *This section applies to groups/departments that have potential to interact with research-derived beryllium as a result of experimental or operational activities.*

4.16.1 REFERENCES

10 CFR 850 Chronic Beryllium Disease Prevention Plan
Ames Laboratory Chronic Beryllium Disease Prevention Plan

4.16.2 BACKGROUND

In the early 1940's, Iowa State College, now Iowa State University (ISU), participated in a classified research and development effort, known as the Manhattan Project. These efforts produced over one thousand tons of uranium from 1942 to 1945 by a metallothermic reduction process. After the war, other metals were produced in limited quantities, thorium being the next most prevalent in the production process. Beryllium, as beryllia, was used in crucibles, and produced by the reduction of beryllium fluoride.

In 1952, the AEC (Atomic Energy Commission, now DOE) Chicago Operations Office assessed occupational exposure to thorium at Ames Laboratory and conducted a brief study of several beryllium operations. The beryllium results indicated that several of the operations in Wilhelm Hall exposed technicians to concentrations exceeding the AEC maximum concentration for a single exposure by 6 to 8 times. No other surveys were made in other buildings.

Evidence of documented beryllium testing exists from episodic beryllium activities, including limited production of beryllium crucibles in the 1960's, indicate that safety practices, oversight, and monitoring were utilized, with the level of rigor and analytical accuracy available at that time. Discussions with researchers revealed that sporadic research activities with beryllium have taken place since the 1960's that included a significantly greater amount of safety oversight.

In 2005-2009, several beryllium surveys were conducted. Early surveys focused on exhaust stacks and 29 were found to have beryllium concentrations above limits established by the Department of Energy. This contamination was unexpected due to the historical understanding that beryllium work had been very limited in Spedding Hall and not of the type that would result in residual contamination. Further characterization efforts revealed isolated contamination (above DOE limits) in Metals Development and Wilhelm.

However, the exposure potential to current workers, building visitors, and the public is extremely low as the contaminated areas are not accessible to the general workforce and the public. The contaminated areas are periodically accessed by crafts people, but appropriate precautions are applied to ensure their safety, and personnel monitoring has confirmed the efficacy of the procedural controls. The Laboratory continues to assess the need for periodic sampling as beryllium characterization and remediation activities are performed and during the performance of remodeling and maintenance activities in areas of known or suspected beryllium contamination.

4.16.3 PROGRAM INFORMATION

4.16.3.1 Chronic Beryllium Disease Prevention Plan

The Chronic Beryllium Disease Prevention Plan (CBDPP) stated in 10 CFR Part 850 – Chronic Beryllium Disease Prevention Program describes existing conditions at the Ames Laboratory and the procedural controls in place that ensure employee protection from exposures that may cause adverse health effects such as berylliosis and chronic beryllium disease.

4.16.3.2 Readiness Review

All activities that have potential to interact with research-derived beryllium are reviewed and approved via the Readiness Review (Procedure 10200.006).

4.16.3.3 Training

There is no institutional training specific to beryllium. Employees that perform activities that have potential to interact with research-derived beryllium receive activity-specific information that ensures exposure potentials are minimized to the lowest possible extent.

4.16.3.4 Medical Surveillance

Laboratory employees with an A213 beryllium and beryllium compounds will be sent a questionnaire requesting information on how the material is used and what controls are in place to reduce exposure. Upon completion of an exposure assessment by industrial hygiene personnel, the employee may be offered appropriate medical screening at Occupational Medicine (G11 TASF).

4.16.3.5 Exposure Monitoring & Controls

Extensive characterization and exposure monitoring has been conducted throughout the Laboratory. Results generated have been used to develop specific work controls or verify their adequacy.

4.16.4 PERFORMANCE CHECKLISTS

Group Leader / Department Manager shall:

- ❑ Assure that all activities involving work with beryllium-containing materials are identified, reviewed and approved via the Laboratory's Readiness Review procedure.
- ❑ Assure that Hazard Inventory and Training Needs Questionnaire documents for each employee are complete and current.

- ❑ Assure group Standard Operating Procedures are current and sufficiently detailed to perform work within established guidelines and reduce exposure potentials to the lowest possible level.

Employees shall**:**

- ❑ Perform work in accordance with group Standard Operating Procedures including use of appropriate control measures such as ventilation and and PPE.

Environment, Safety, Health and Assurance shall:

- ❑ Provide consultations upon request on issues related to management of potential hazards associated with beryllium-containing materials/contamination.

Occupational Medicine shall:

- ❑ Provide appropriate medical surveillance to current workers in accordance with the Chronic Beryllium Disease Prevention Plan.