CHEMICAL HYGIENE PLAN

2004

Environmental Research Division

Argonne National Laboratory

Management has read this document and has given its authority to implement the Laboratory Standard in compliance with the OSHA regulation. All employees are required to abide faithfully by the intent of this document for their own health and welfare and those of their fellow employees.

Approvals:

David P. Peterson _____ 10/21/04

Division Chemical Hygiene Officer Date

J L Woodring _____ 10/19/2004

Site Chemical Hygiene Officer Date

BWA (Barry A. Wright) _____ 10/21/04

ER Division Director Date

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ACRONYMS

ACES	Argonne Chemical Exchange System
ALARA	as low as reasonably achievable (radiation exposure goal)
ANL	Argonne National Laboratory
ANL WHPM	*Waste Handling Procedures Manual* (Argonne)
ANL ESH Manual	*Environment, Safety and Health Manual* (Argonne)
CAS#	Chemical Abstract Service number
CFR	Code of Federal Regulations
CHO	Chemical Hygiene Officer
CMS	Chemical Management System (Argonne)
CTS	Chemical Tracking System (Argonne)
ECR	Environmental Compliance Representative
ER	Environmental Research Division (Argonne)
ER SHE Manual	*Environmental Research Division Safety, Health, and Environmental Protection Policy and Procedures Manual*
ESH	environment, safety, and health
EQO	Office of ESH and QA Oversight (Argonne)
IBC	Institutional Biosafety Committee (Argonne)
IH	Industrial Hygiene (Argonne)
FM	Factory Mutual Engineering Corporation
LC50	Concentration of a chemical in air that results in 50% lethality
LD50	Oral dose of a chemical (e.g., mg/kg) that results in 50% lethality
MSDS	Material Safety Data Sheet
NA	not available
NIH	National Institutes of Health (U.S.)
OSHA	Occupational Safety and Health Administration (U.S.)
PEL	permissible exposure limit (OSHA)
PFS	Plant Facilities and Services Division (Argonne)
PPE	personal protective equipment
QA	quality assurance
SCBA	self-contained breathing apparatus
SOP	standard operating procedure
STEL	short-term exposure limit
TLV	threshold limit value
TWA	time-weighted average
UL	Underwriters Laboratory
WMO	Waste Management Operations (Argonne)

CHEMICAL HYGIENE PLAN
ENVIRONMENTAL RESEARCH DIVISION

1 PURPOSE AND PRINCIPLES

1.1 Purpose

The purpose of this *Chemical Hygiene Plan* for the Environmental Research (ER) Division is to establish a program that will ensure the implementation of control methods adequate to prevent unacceptable exposures to hazardous chemicals in laboratories.

1.1.1 Scope

This *Chemical Hygiene Plan* applies to laboratory operations using hazardous chemicals in relatively small quantities. For operations that involve chemicals but are not designated as laboratory operations, all other Occupational Safety and Health Administration (OSHA) standards in 29 CFR Part 1910, including exposure standards, continue to apply. Most of the general requirements and procedures described in this *Chemical Hygiene Plan* are also discussed in the Argonne *Environment, Safety, and Health Manual*, available online and in Room H102, Building 203; and the *Environmental Research Division Safety, Health, and Environmental Protection Policy and Procedures Manual*, available online and in print upon request to the ER Division office.

1.1.2 Objective

The objective of this *Chemical Hygiene Plan* is to promote the improvement of laboratory health and safety. The specified procedures and training and the written *Chemical Hygiene Plan* itself are in compliance with 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories" (also known as the OSHA Laboratory Standard, available online), and with other applicable regulations that Argonne is required to follow.

A form to certify that training of laboratory workers and documentation of the training are in compliance with the OSHA Laboratory Standard is in Appendix A. This form must be signed, dated, and returned to the ER Chemical Hygiene Officer when training under the *Chemical Hygiene Plan* is completed.

1.2 General Principles

All chemicals, because of concentration, toxicity, flammability, carcinogenicity, or other characteristics, are potential health hazards. The intent of this *Chemical Hygiene Plan* is to provide workers with guidelines for handling and using chemicals without causing harm to

themselves, other employees, or laboratory environment. General principles to keep in mind are summarized here.

1.2.1 Minimize Exposure

Minimize exposures, even to substances with no known significant hazard. Take special precautions in working with substances that present special hazards. Always use engineering controls first and personal protective equipment (PPE) last to minimize exposures.

1.2.2 Avoid Underestimating Risk

Assume that a mixture presents at least all the hazards of its individual components. Assume that all substances of unknown toxicity are toxic.

1.2.3 Assess Employee Exposure

Maintain employee exposures below the Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) and other applicable exposure limits. To minimize exposures, make informed assessments of potential exposures, and monitor the workplace as appropriate.

1.2.4 Use Engineering Controls

Apply control methods such as laboratory hoods, local exhaust ventilation, enclosures, and wet methods rather than depending primarily on PPE such as respirators.

1.2.5 Use Supporting Documents

The current policies, manuals, and procedures maintained by the Environmental Research (ER) Division and Argonne are cited in appropriate sections of this *Chemical Hygiene Plan*. A list of available documents is in Section 11.

1.2.6 Applicability

The provisions of this *Chemical Hygiene Plan* apply to all ER Division activities involving the use of chemicals or occurring in locations where chemical hazards might exist, including all designated ER Division laboratories and chemical storage areas and off-site locations where ER Division employees conduct ER Division business that may be considered laboratory operations.

2 LEVELS OF RESPONSIBILITY

This section defines the responsibilities of the ER Division Director, the Argonne site Chemical Hygiene Officer (CHO), the ER CHO, laboratory supervisors, laboratory workers, and other employees.

2.1 Division Director

The ER Division Director has organizational responsibility for providing continuing support for chemical hygiene activities and for ensuring the health and safety of ER Division employees.

2.2 Site Chemical Hygiene Officer

The Argonne site CHO provides sitewide coordination and technical guidance in the development and implementation of the *Chemical Hygiene Plan*.

2.3 ER Division Chemical Hygiene Officer

The ER CHO is a technically qualified individual designated by Argonne management as having the responsibilities outlined in Section 3. The role of the ER CHO is to provide technical guidance in developing and implementing the provisions of this *Chemical Hygiene Plan.*

2.4 Laboratory Supervisors

Each room under the control of the ER Division that is designated a laboratory has an identified laboratory supervisor. This individual is listed first on the contact list on the emergency notification card posted outside the laboratory entrance. The laboratory supervisor has overall responsibility for chemical hygiene in each laboratory for which he or she is the designated supervisor. The laboratory supervisor is assigned the following tasks:

- Know the current legal requirements concerning regulated substances stored, used, or generated in his or her area of responsibility.
- Ensure that each new project or operation is subjected to a formal safety analysis review as detailed in Section 6 of the *Environmental Research Division Safety, Health, and Environmental Protection Policy and Procedures Manual (ER SHE Manual)*, and that the specific health, safety, and environmental protection controls resulting from such a safety analysis review are compatible with (not contrary to) the provisions of this *Chemical Hygiene Plan*.
- Help project directors establish procedures and develop facilities that conform with the OSHA Laboratory Standard.

- Work with Argonne management, the ER CHO, and other employees to develop and implement appropriate hygiene policies and practices.
- Ensure that the facilities are adequate for any new hazard introduced into the laboratory and are maintained in adequate working order.
- Ensure that employees know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that training and information have been provided. This task includes assuring that material safety data sheets (MSDSs) are readily available for hazardous chemicals used in the laboratory under his/her supervision.
- Determine the required levels of PPE.
- Monitor the procurement, use, storage, and disposal of chemicals and wastes used or created in the laboratory.
- Maintain compliance with this *Chemical Hygiene Plan*.

2.5 Laboratory Workers

All laboratory workers must plan and conduct each operation in compliance with established procedures and good personal chemical hygiene practices.

Laboratory workers are responsible for placing warning signs and labels on chemical containers, on equipment, and in areas where special or unusual hazards exist.

2.6 Other Employees

Employees not considered to be laboratory workers will not be held responsible for complying with all aspects of this *Chemical Hygiene Plan*. They will, however, be required to be familiar with the concept of hazard communication as defined in Title 29 CFR 1910.1200 and to adhere to all postings and access controls established for laboratories in accordance with the provisions of this *Chemical Hygiene Plan*.

3 ER DIVISION CHEMICAL HYGIENE OFFICER

The ER CHO, David Peterson, has his office in Building 203, Room H102 (telephone 2-3924; pager 630-314-4045).

The role of the ER CHO is to provide technical guidance in developing and implementing the provisions of this *Chemical Hygiene Plan*. The ER CHO is assigned the following tasks:

- Know the current legal requirements concerning regulated substances and maintain appropriate reference materials.
- Help principal investigators establish technical procedures and develop facilities and operational procedures that conform with the OSHA Laboratory Standard.
- Work with administrators and employees to develop and implement appropriate chemical hygiene policies and practices.
- Monitor the procurement, storage, use, and disposal of chemicals in the ER Division, in conjunction with laboratory supervisors.
- Review and approve operations as required by this *Chemical Hygiene Plan*.
- Oversee the implementation of this *Chemical Hygiene Plan*.
- Ensure that periodic audits of the chemical hygiene program are conducted.
- Maintain auditable records of training and information related to chemical hygiene.
- Conduct regular chemical hygiene and housekeeping inspections.
- Annually review, evaluate, and update this *Chemical Hygiene Plan* for the ER Division.

4 EXPOSURE ASSESSMENT AND REDUCTION

This section describes the requirements for hazard identification, chemical procurement, distribution, and storage of chemicals. Safe laboratory operating procedures are described, including handling of toxic and hazardous chemicals and laboratory workplace hygiene principles and practice.

4.1 Hazard Identification

Laboratory workers must have sufficient information about the hazardous and toxic properties of chemicals to allow them to handle the chemicals safely. Workers using chemicals that present an unusual hazard (e.g., unstable compounds, pyrophoric materials, or highly toxic materials) are required to notify the ER CHO or obtain his approval, as specified in Section 4.3.1.

Workers must observe good chemical labeling practices. Labels on incoming containers must not be removed or defaced. When materials are transferred from their original containers, the container into which the material is placed must be properly labeled and compatible with the material being transferred. Refer to the Argonne *Environment, Safety and Health Manual (ANL ESH Manual),* Chapters 4.1, 4.3, and 4.5, for proper labeling practices. In general, all repackaged chemical containers must be labeled with the following information:

- The identity of the chemical (Common names are acceptable, but chemical formulas or structures are not.)
- Hazard warnings (flammable, corrosive, toxic, carcinogenic, etc.)
- Whether the chemical is unstable in storage (e.g., a peroxide former)
- Special storage information (e.g., refrigeration needed, storage under nitrogen)

A chemical of known composition produced in a laboratory must be evaluated, by reviewing the available literature, to determine whether it is a hazardous substance. A chemical of unknown composition must be treated as a hazardous substance. Workers who synthesize chemicals must use all relevant process information to identify or anticipate the hazards associated with the synthesized chemical.

Material safety data sheets are available on the Argonne intranet for all chemical substances. The online Chemical Management System (CMS) is the official source of MSDSs. If an MSDS for a chemical you plan to use is not available in the CMS, request an MSDS in the purchase requisition. If an MSDS you receive with a purchased chemical is not in the CMS, give the original MSDS to the ER CHO, who will send it to EQO-IH (Office of ESH and QA Oversight [EQO]-Industrial Hygiene [IH]) so that the MSDS can be added to the Argonne collection. You may also make available printed MSDSs for your chemical inventory or selected items in your inventory for local use by laboratory workers and supervisors.

A chemical produced for shipment off-site must have a hazard warning label. Prepare an MSDS for such a chemical and give it to the user. Base the information in this MSDS on the known properties of the product's constituents. Have the ER CHO and EQO-IH staff (2-3310) review the MSDS before you send the chemical outside Argonne.

Hazard information is required for highly toxic chemicals, select carcinogens, and reproductive hazards regulated by the OSHA Laboratory Standard. This information may be in the form of MSDSs, vendor-supplied product information sheets, or reprints from appropriate reference sources. If this hazard information is not available when you receive a substance, contact the ER CHO before you handle the chemical, and he will obtain the information. All other required information about hazardous chemicals should already be available on MSDSs or product labels.

4.2 Chemical Procurement, Distribution, and Storage

The following sections provide information on ER-specific procedures for procurement, storage, and distribution of chemicals within the ER Division.

4.2.1 Procurement

When a chemical is received, information on proper handling, storage, and disposal must be available to personnel who handle it. Any chemical container that does not have an adequate identifying label should be returned to its source.

The ER CHO maintains an inventory of ER Division chemicals and chemical products and coordinates this inventory with the sitewide inventory program. Consult the ER CHO and the CMS for availability and suitability of surplus chemicals before you order new chemicals. The CMS includes an online Argonne Chemical Exchange System (ACES) to promote the exchange of surplus chemicals.

Any employee who obtains a chemical from a source other than Argonne's Procurement service is personally responsible to notify the ER CHO about the chemical. Regardless of the source, all ER chemical purchases and complimentary samples of new products must adhere to ER Division procurement requirements (memo from B.M. Lesht to ER Division staff, June 9, 2003; see Appendix B).

A copy of a current ER prepurchase requisition, properly filled out, is in Appendix C. Specific procedures for the ER Division are as follows:

- Purchase requisitions for chemicals submitted to the ER Division office need to indicate the following:
    - The Argonne MSDS number for the chemical.

- If no MSDS is available in the CMS for the specific chemical, write "U" (unavailable) in the MSDS column on the prepurchase requisition. The ER CHO will be notified that the MSDS is needed, and he will request one from the supplier. When you receive the chemical and the MSDS, give the original MSDS to the ER CHO.

- If you receive chemicals from other Argonne divisions, you are responsible to ensure that the appropriate MSDS is available in the CMS. If no MSDS is available, contact the ER CHO to receive instructions on how to obtain one. Also give the ER CHO information on the manufacturer, the quantity you have, the storage location, and the individual who will be responsible for the chemical, so that the ER chemical inventory can be kept current.

4.2.2 Laboratory Use and Storage of Chemicals

Chemical storage within laboratories must be limited to reasonable quantities that are consistent with work in progress. Waste Management Operations (WMO; 2-5865) may be contacted to arrange for disposal of outdated chemicals. Consult the online Argonne *Waste Handling Procedures Manual (ANL WHPM*) for detailed instructions on waste disposal. Contact the ER CHO and advise him of the availability of surplus chemicals, which can be shared within the ER Division or within Argonne through the CMS.

Chemicals that have a limited usable lifetime must be dated upon receipt in the laboratory if they have not been dated by the manufacturer. Potentially unstable chemicals such as picric acid, certain metal azides, and compounds that form peroxides (isopropyl ether, dioxane, tetrahydrofuran, and others) need special attention and handling. Refer to the *ANL ESH Manual,* Chapter 4.3, for recommendations on storage, use, and disposal of ethers. Detailed information on the recognition and handling of peroxidizable compounds is in Appendix A of Chapter 4.3 of the *ANL ESH Manual*. Additional detail can be found in *Prudent Practices for Handling Hazardous Chemicals in Laboratories*, National Academy Press, 1995 (pages 54-56); the ER CHO has a copy, as do the Building 200 and Building 202 libraries (reference sections).

Store flammable and combustible liquids in accordance with the *ANL ESH Manual*, Chapter 11.3. In general, flammable materials in quantities of 1-5 gal must be stored in safety containers approved by the Underwriters Laboratory (UL) or Factory Mutual Engineering Corporation (FM), and aggregate quantities of 5-60 gal must be stored in UL- or FM-approved flammable material storage cabinets. Flammable materials must not be stored in refrigerators unless the refrigerators are UL approved for such use.

Chemical storage in chemical vapor hoods is generally not acceptable. An exception can be made for highly volatile or noxious materials in containers that may not be vapor tight, when placement in the hood does not interfere with proper hood operation. Note that storage of volatile waste materials in a chemical vapor hood to allow for evaporation is expressly prohibited by federal and state environmental regulations. Criminal and civil penalties can be imposed upon individuals responsible.

Compressed gas storage is addressed in Chapter 13.2 of the *ANL ESH Manual* and Section 10.2.3 of the *ER SHE Manual*. Summary guidelines are as follows:

- Secure all compressed gas cylinders used in laboratories, regardless of size, to the laboratory bench, the building wall, or other suitable structure with appropriate hardware. Securing gas cylinders to pipes or other plumbing fixtures is not acceptable.

- When cylinders are not in use, store them with the main tank valve in the fully closed position (i.e., with no pressure registering on the primary or secondary pressure regulator).

- Remove pressure regulators from cylinders not expected to be used for long periods, and install protective caps.

- Avoid long-term storage of cylinders. Order cylinders as needed, in volumes appropriate for usage in 2-4 weeks.

- Attach tags to cylinders placed in the outdoor cylinder storeroom to indicate the researcher to whom the tank is assigned, the date the tank was purchased, and the contents of the tank.

- Deliver empty gas cylinders to the loading dock, and place them in the appropriate storage room for radiation survey, pickup, and return to the vendor.

- Unless their coincident use is required (as on a portable welding cart) or there is an approved variance for required coincident use or storage, do not store pressure cylinders of oxygen and any other combustible or flammable gas adjacent to one another. Separate cylinders of oxygen from other combustible and flammable gases by a distance of at least 20 ft or by a noncombustible barrier at least 5 ft high, with a fire-resistant rating of at least 0.5 hr.

- Do not store corrosive gases longer than one year or beyond the manufacturer's recommended storage period, whichever is less.

Participation in the sitewide chemical inventory effort is required. Locate and properly dispose of unwanted or outdated chemicals as part of this process. Return barcodes from empty chemical containers to the ER CHO for deletion from the ER chemical inventory. Advise the ER CHO of the availability of surplus chemicals, which can be shared within the ER Division or within Argonne through the CMS.

4.2.3 Laboratory Storage of Chemical Wastes

Hazardous waste storage must conform to the procedures in Chapter 1.2 in the *ANL WHPM*. ER Division waste generators who store the waste must complete a registration form that gives the division information on the type of waste being accumulated in the specific satellite accumulation area. In addition, waste generators must take specific training courses and maintain accurate, auditable records of waste accumulated. For more detailed information, consult the *ANL WHPM* or contact the ER Division Environmental Compliance Representative (ECR), David Peterson, Building 203, Room H102 (telephone 2-3924).

4.3 Safe Laboratory Operating Procedures

The following sections provide general and specific guidance on safe laboratory operating procedures, including procedures for use of toxic or hazardous chemicals and information on maintaining good laboratory workplace hygiene.

4.3.1 Handling Toxic and Hazardous Chemicals

This section provides general and specific guidance for handling chemicals. Additional requirements are specified in the *ANL ESH Manual* and the *ER SHE Manual*. Both manuals are available on the Argonne intranet.

Consult with EQO-IH staff to identify appropriate PPE, such as eye protection, chemical-resistant gloves, and respiratory equipment.

Each laboratory worker is responsible for compliance with policies and procedures for the use of PPE, and for removing contaminated equipment before he/she leaves the area where chemicals are used.

Review by and concurrence of the ER CHO are required for the following procedures:

- *Work with highly toxic materials.* As a general rule, this requirement applies to substances with exposure limits below 1 ppm or 0.5 mg/m^3 of air.

- *Work with Class 1 carcinogens.* Class 1 carcinogens are chemicals identified by the International Agency for Research on Cancer as carcinogenic to humans. Refer also to the *ER SHE Manual*, Section 12, and the *ANL ESH Manual,* Chapter 4.5.

- *Work with DNA clones.* All recombinant DNA protocols and all work with microorganisms must be reviewed by the Argonne Institutional Biosafety Committee (IBC). Presently, only organisms that do not infect humans are used for recombinant DNA techniques, and they are therefore exempt from National Institutes of Health (NIH) requirements but not from IBC review. Contacts for the IBC are D. Haugen (Office of Energy and Environmental Science and Technology), Chair, and

G. VanGorp (EQO), Biosafety Officer. Additional information is in the *ANL ESH Manual*, Chapter 4.9.

New projects using hazardous chemicals require safety reviews before operations begin. Consult the *ER SHE Manual,* Section 6, and the *ANL ESH Manual*, Chapter 21.2.

4.3.2 Working with Carcinogens

Carcinogen use and storage must be in conformance with Chapter 4.5 of the *ANL ESH Manual.* The following paragraph highlights some of the requirements of that chapter, but familiarity with Chapter 4.5 of the *ANL ESH Manual* is needed for compliance with the comprehensive set of Argonne policy and procedures for carcinogen use. Management responsibilities with respect to the use and disposal of carcinogenic substances are defined in that chapter.

Argonne policy is to keep employee exposure to carcinogens *as low as reasonably achievable* (ALARA). Carcinogens may only be used in designated areas. Use of class 1 carcinogens requires a written standard operating procedure (SOP) that addresses safe practices. The SOP must be reviewed by the ER CHO and EQO-IH (2-3310) before work begins. Use of class 2 carcinogens requires a written SOP that is reviewed and maintained by the ER CHO, with copies provided to EQO-IH.

The use of the ER *Chemical Hygiene Plan* as the SOP for work with class 1 and class 2 carcinogens having low to moderate risk of exposure is acceptable practice as defined in the *ANL ESH Manual*, Chapter 4.5. Work with carcinogens having a high risk of exposure requires a separate SOP that has been reviewed by the ER CHO and EQO-IH. The principal investigator is responsible for determining the risk level. The brief descriptions of projects required for carcinogen work by the *ANL ESH Manual*, Chapter 4.5, can be those prepared as part of the Project Safety Analysis for the overall activity.

Work involving carcinogens, planned for hours outside the normal business day, must be approved by the line supervisor and cannot be conducting while working alone.

If the ER *Chemical Hygiene Plan* is used as the SOP, all work with carcinogens is restricted to previously identified designated areas described in Appendix D of this document (laboratory fume hoods).

Carcinogen containers must be labeled according to the general requirements of OSHA's Laboratory Standard and *ANL ESH Manual* provisions. The presence of a carcinogen must be indicated by one of the following labels:

- Class 1 Carcinogens — DANGER/Cancer Hazard (white/black/red)
- Class 2 Carcinogens — CAUTION/Cancer Hazard (yellow/black)

Administrative and engineering controls used to control exposures to carcinogens include posting of designated areas, continuous operation of laboratory exhaust hoods, use of impermeable work surfaces, and work in laboratory areas that provide continuous negative pressure with respect to the corridor and other adjacent areas. Where possible, purchase materials that are already prepared and do not require the use or weighing of powder or neat liquids.

Work practices to achieve the ALARA goal for exposures include the following:

- Use closed, unbreakable containers to transport carcinogenic materials outside storage areas, laboratory hoods, or glove boxes.
- Perform procedures that can generate air contaminants (pouring, weighing powders, dropping liquid droplets onto surfaces, etc.) in a laboratory hood.
- Conduct procedures that intentionally generate significant aerosols of a carcinogen in a glove box.
- Never pipette by mouth, eat, drink, smoke, chew gum, apply makeup, or place anything in the mouth or eyes when you are handling carcinogens or when working in designated carcinogen areas.
- Avoid the use of sharp objects (hypodermic needles, syringes, scalpels) when you are handling carcinogens to prevent exposure by puncture.
- Dispose of sharp objects contaminated with carcinogens in approved, labeled waste containers.
- Wear the appropriate PPE for the job, including buttoned laboratory coats, aprons, respirators (if required), and protective gloves. Do not remove potentially contaminated PPE, especially gloves, from the designated work area. Clean PPE known to be contaminated as soon as possible or dispose of it appropriately.

4.3.3 Laboratory Workplace Hygiene

General guidance for handling toxic and hazardous chemicals is in Section 10 of the *ER SHE Manual* and the *ANL ESH Manual*, Chapters 4.1, 4.3, and 4.5. The National Research Council's *Prudent Practices for Handling Hazardous Chemicals in Laboratories* is available from the ER CHO and in the reference sections of the Building 200 and Building 202 libraries. Refer to each chemical's MSDS for necessary and appropriate PPE.

Controls for handling toxic and hazardous chemicals are as follows:

- Engineering controls
  - Avoid releasing toxic substances in mechanically controlled cold rooms and warm rooms, either of which may contain recirculated atmospheres.

- Use hazardous chemicals only in rooms that have direct exhaust ventilation. Recirculation of air from chemical laboratories to other rooms is not acceptable.

- Properly ventilate ovens used to process hazardous chemicals to control hazardous emissions.

- Use a hood for operations that could release toxic gases, vapors, or particulates. Place hazardous materials back at least 6 inches from the face of the hood. Do not block the hood exhaust with equipment. As a rule of thumb, use engineering controls to handle any volatile substance with a threshold limit value (TLV) below 50 ppm, an LC50 value (concentration of vapor in air that results in 50% lethality) below 200 ppm, or an oral LD50 value (oral dose which that results in 50% lethality) below 50 mg/kg of body weight.

• Personnel and other protective equipment

- Know the locations of eyewash and shower facilities for your laboratory, as well as their proper operation. These facilities are required in (or in the immediate vicinity of) each laboratory where hazardous chemicals are used.

- Practice good personal hygiene.

- Avoid unnecessary exposure to chemicals by any route. Do not deliberately smell or taste chemicals.

- Do not store food or beverages in laboratory areas or in refrigerators used for laboratory operations. Such storage is prohibited.

- The principal investigator and/or laboratory supervisor must evaluate hazards associated with the work being performed, determine appropriate prohibitions and/or restrictions, and establish specific PPE requirements.

- Use face shields, impermeable gloves, laboratory coats, and aprons, as appropriate, to avoid contact with chemicals. Safety glasses or chemical goggles are necessary in addition to face shields.

- Wear appropriate PPE to prevent hand contact with allergens or substances of unknown allergenic activity (e.g., diazomethane, formaldehyde, isocyanates, benzylic and allylic halides, and certain phenol derivatives).

- Information about glove selection is available from EQO-IH staff (2-3310) and the *Protective Glove Selection Guide* (available from the ER CHO).

• Administrative and procedural controls

- Seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment before any new operation begins.

- When containers are vented or containers are set up with pressure relief joints or valves, ensure that the discharge is directed safely or is filtered. Relieve gas pressure before cylinder regulators are disconnected. Stand back from the gauge faces when regulator valves are opened.

- Ensure that the plan for each laboratory operation includes provisions and training for waste disposal (*ER SHE Manual*, Section 10.2.21). Minimize waste whenever feasible. Observe the following specific guidelines:

    - Place only paper and other lightweight items (no heavy glass, metal, or liquids) in wastebaskets.

    - Ensure that waste materials that may once have been near radioactive materials are surveyed by building health physics personnel before they are discarded.

    - Place large quantities of paper printouts, magazines, or books; metals; and uncontaminated glass on the floor next to a wastebasket and label them "DISCARD." Place broken uncontaminated glass in a container such as a cardboard box for disposal.

    - Do not dispose of contaminated glass, radioactive materials, and hazardous chemicals (including polychlorinated biphenyl oils) by any of the above methods. Contact building health physics personnel and consult the *ANL WHPM* for proper procedures and forms for radioactive and hazardous material disposal. Contact the ER ECR or WMO (2-5865) with questions about disposal of radioactive, hazardous, or mixed wastes.

- Sandals and open-toed shoes are prohibited in laboratories. Shorts, cutoffs, and miniskirts are also inappropriate.

- Constrain long hair and loose clothing. Do not wear jewelry such as rings, bracelets, and watches. The purpose is to avoid chemical seepage under the jewelry, contact with electrical sources, catching on equipment, and damage to the jewelry itself.

- To dilute concentrated acid, add acid to water (A to W). Use an ice bath or have a cold water source available to reduce the reactivity hazards from extremely exothermic acid-base reactions.

- Record the date of receipt and the date of opening on containers of chemicals that could present a long-term storage hazard (e.g., peroxide-forming ethers). Follow the recommendations of the National Safety Council for storage time limits and testing of peroxide-forming ethers (Appendix A to Chapter 4.3 of the *ANL ESH Manual*).

- Whenever possible, substitute alternative temperature measuring devices (such as alcohol thermometers or electronic temperature measuring devices) for mercury thermometers.

- If chemicals are to be used outside a laboratory hood, evaluate the potential for air contamination, the need for monitoring by EQO-IH, and the possible need for respiratory protection or other controls.

- During the first trimester of pregnancy, the fetus is extremely sensitive to toxins. Pregnant laboratory workers must take special care to minimize chemical exposure, including a review of chemical handling practices. The *ANL ESH Manual* (Chapter 3.1.9) encourages any employee ". . . who plans a pregnancy, suspects a pregnancy, or has a positive diagnosis of pregnancy . . ." to contact the Argonne Medical Department (2-2800). Notification of the Medical Department will begin an evaluation of the health status and work environment of the employee and will ensure that the employee is afforded the maximum protection against toxic substances, mutagens, carcinogens, and radiation. Notification of the ER CHO is encouraged.

4.4 Determining and Evaluating Employee Exposure

The current and proposed uses of hazardous chemicals must be assessed to evaluate the potential for workplace exposure. The criteria to be used in determining the adequacy of controls include whether airborne exposures may exceed established limits and whether dermal exposure can cause skin injury or absorption of toxic quantities. For materials that can have irreversible toxic effects or are classified as carcinogens, the ALARA goal for exposure should be pursued. Factors to be considered in determining exposure potentials include the following:

- The physical and chemical properties of the compound or mixture.

- The quantity used and the frequency of use outside a chemical vapor hood.

- Whether the container is open or covered and the potential for airborne exposure.

- The exposure controls currently in place.

- The chemical stability of the compound.

- The volatility or vapor pressure of the substance.

- The established occupational exposure limits, such as PELs (OSHA), TLVs (American Conference of Governmental Industrial Hygienists), recommended exposure limits (National Institute for Occupational Safety and Health) or workplace environmental exposure levels (American Academy of Industrial Hygiene).

- Toxicology information about the substance.

- The handling precautions and hazards indicated on the manufacturer's MSDS.

An initial review of exposure potential must be made by the laboratory supervisor. This review must be documented; it can be part of the Project Safety Analysis required in Section 6 of the *ER SHE Manual*. If a concern exists about the possible extent of exposures or if additional information is needed, seek assistance from the ER CHO or EQO-IH staff (2-3310).

Where the need is indicated, EQO-IH personnel will review the work site and determine exposures. The results of this monitoring will be reported to the ER CHO and the laboratory supervisor within 15 working days of receipt of the laboratory results. Laboratory supervisors must report the results in writing to the affected employees, either by personal communication or by posting the results.

When monitoring has demonstrated that PELs may be exceeded, attempts must be made to identify readily achievable improvements that can reduce exposures, and such improvements must be implemented. Guidance for implementing these changes will be provided by the laboratory supervisor, the ER CHO, and EQO-IH.

4.5 Engineering Controls

All laboratory chemical vapor hoods must be tested at least annually by the Plant Facilities and Services (PFS) Division's building maintenance personnel. Hoods designated for general chemical use (class C) must maintain a minimum face velocity of 100 ft/min; those for radioactive or highly toxic materials (class R) must maintain a velocity of 135 ± 15 ft/min.

The laboratory supervisor must bring to the attention of PFS building maintenance personnel any hoods that are not posted as having been tested and having met the above criteria within the past year.

Hoods that fail to meet the above test criteria will be tagged by PFS building maintenance personnel at the time of testing, and a written notice of the failure will be sent to the ER Division office. Hoods so tagged must be taken out of service until they are repaired or posted to allow restricted service, as approved by the ER CHO. A list of hoods in ER Division spaces is in Appendix D.

4.6 Designated Areas

Work involving particularly hazardous chemicals requires additional evaluation of employee protection. A designated area (generally a chemical vapor hood, but possibly a specially designed laboratory) must be assigned for use when Argonne class 1 or class 2 carcinogens (Appendix E and *ANL ESH Manual*, Chapter 4.5) are being handled. Designated areas must also be assigned for the use of acutely toxic chemicals or reproductive toxins. Take special precautions with chemicals having an 8-hr time-weighted-average (TWA) exposure limit or a short-term exposure limit (STEL) below 1 ppm (0.5 mg/m^3 of air).

Many exhaust ventilation systems are connected to the Central Surveillance System, which activates an alarm if the flow fails. Hoods that are used for highly toxic materials but are not connected to the Central Surveillance System are to be reviewed by the laboratory supervisor and the ER CHO to determine whether individual hood flow indicators and alarms are needed.

Special procedures for working in designated areas must be developed and approved by the ER CHO and the Argonne site CHO.

Designated work areas must be posted to indicate the potential hazards and any requirements for following the special work procedures established. Designated areas for the ER Division are in Appendix D.

4.7 Emergency Plan for Spill Control

The detailed Local Area Emergency Plans for ER Division spaces in Building 202 and Building 203 are maintained online by the Biosciences Division and the Physics Division, respectively. Also refer to the online *Comprehensive Emergency Management Plan*.

Report spills, accidents, explosions, fires, and similar incidents that have resulted in or could result in injury or significant property damage immediately by using Argonne's 911 emergency notification system.

Do not clean up spills yourself unless you have been trained to do so and proper supplies and PPE are already available. Non-emergency cleanup of identified materials can be requested from WMO (2-5865).

Chemical materials used or collected in a spill response incident must be retained for proper disposal through WMO. Spilled chemicals, contaminated glassware, and other containers may not be placed in trash receptacles.

5 TRAINING PROGRAM

All new Argonne employees receive basic orientation in Argonne's health and safety requirements and services.

All supervisors have the duty to see that each employee receives the necessary information and training about the specific hazards of the materials with which he/she may work. Laboratory supervisors have the responsibility for ensuring that individuals working in their laboratory areas have received the required training.

Each employee must further be aware of the location of MSDSs covering the materials he/she will encounter in the workplace. The MSDSs for chemicals are available on the Argonne intranet. The Laboratory maintains an electronic database that contains MSDS information for over nearly 33,000 chemicals. Contact the ER CHO (2-3924) for assistance if necessary. Laboratory workers must also be aware of provisions of the OSHA Laboratory Standard (available on the ER Division web site).

To provide all the necessary information, each laboratory worker is to have ready access to the following:

1. The OSHA Laboratory Standard, 29 CFR 1910.1450 (online)

2. The *Chemical Hygiene Plan* for the ER Division (online or printed upon request)

The EQO Training organization will provide basic training classes on provisions of the OSHA Laboratory Standard and applicable sitewide health and safety programs. The ER CHO and the laboratory supervisor will provide specific instructions regarding ER Division activities.

Written documentation of the instruction and information given to laboratory workers must be maintained by the ER CHO, to be held in an auditable file. Appendix A contains the form for documenting individual training given by the ER CHO or the laboratory supervisor.

6 MEDICAL CONSULTATION AND EVALUATION

Any employee who develops signs and symptoms indicating that he/she may have been overexposed to chemicals will receive medical attention. The employee is to report to his/her supervisor and to the Argonne Medical Department in Building 201.

When an unusual occurrence such as a spill results in a potentially significant exposure, a 911 call must be placed to ensure that exposed individuals receive prompt medical evaluation and attention.

When review by the ER CHO or EQO-IH staff indicates that significant exposure could occur, the Medical Department is to be consulted regarding the advisability or availability of monitoring for a biological exposure index for the toxic substance or its metabolites.

7 USE OF RESPIRATORS

The first level of protection against chemical hazards must be (1) engineering controls such as laboratory hoods and enclosed operations or (2) the use of substitute materials with lower toxicity. If engineering controls are not feasible, if operations are temporary, or if an additional level of protection is required, respiratory protective equipment can be used.

All training in the selection and use of respiratory protective equipment will be provided by EQO-IH staff (2-3310). Annual retraining is required. Respiratory protective equipment is recalled twice annually for inspection by EQO-IH.

Respiratory protective equipment may NOT be purchased without prior approval of EQO-IH. Approval from the Medical Department must be received before any respirator fitting and/or training occurs.

In emergency response situations and where approximate levels of contaminants are unknown, the use of self-contained breathing apparatus (SCBA) is required. Only persons who are currently trained in the use of SCBA are authorized to use such equipment.

For additional procedures relating to the use of respiratory protective equipment, refer to the *ANL ESH Manual,* Chapter 12.2.

8 PACKAGING AND TRANSPORTATION OF HAZARDOUS MATERIALS

The policy of Argonne and the ER Division is to transport hazardous materials, substances, and wastes in a manner that protects people, avoids environmental insult, and conforms to security requirements. Chapter 20.1 of the *ANL ESH Manual* provides guidance for persons originating the movement of hazardous materials. In general, the originator is responsible for identifying the material and its hazards, and a traffic specialist (2-2934) is responsible for assisting in packaging the material and for moving it.

All packaging, shipments, transfers, and movements of hazardous materials at Argonne-East are to comply with DOE Order 5480.3, regulations of the U.S. Department of Transportation, and other applicable regulations. The policy, responsibilities, and procedures are detailed in the Argonne *Policy Manual*, and in the Argonne *Hazardous Materials Transportation Safety Manual*. These documents are available online.

Movements of hazardous materials covered by Chapter 20.1 of the *ANL ESH Manual* include the following:

1. Transfers between locations at Argonne-East that require movement out of doors.

2. Transfers to off-site locations.

3. Indoor movements of radioactive and nuclear materials across the boundaries of material balance areas and accountability control areas. Other transfers of hazardous materials within a building are not subject to the requirements of this chapter, but they are to be administratively controlled by building supervisors.

Radioactive materials that are not waste and have specific activity equal to or less than 2 nCi/g are not defined as hazardous materials and are therefore not covered by this chapter.

Waste Management Operations (2-5865) assists in the packaging of radioactive, hazardous, and mixed waste for on-site transfer; transports radioactive, hazardous, and mixed waste from pickup points in various buildings to WMO facilities for temporary storage prior to shipment to off-site waste repositories; assists in the atmospheric release of gaseous radioactive, hazardous, and mixed wastes; and prepares solid and liquid radioactive, hazardous, and mixed waste for shipment off-site.

The Special Materials and Property Group of Argonne's Office of Safeguards and Security (2-7388) assists in the packaging of radioactive materials, carries out on-site transfers of radioactive materials, and prepares and maintains the *Special Materials User's Guide*. This document is available online.

Individuals who initiate the movement of hazardous material must contact the appropriate support organization and fill out the required forms. It is the originator's responsibility to identify the material, the amount to be shipped, and the hazards associated with the material. A copy of the material's MSDS must accompany the material being transferred.

Hosts and sponsors of visitors who may wish to bring hazardous materials onto the Argonne-East site must inform the visitors of Argonne's requirements for on-site transfer of hazardous materials.

Additional information on transportation of hazardous materials is in the Argonne *Hazardous Materials Transportation Safety Manual* and Chapter 7.5 of the Argonne *Policy Manual*. For assistance, call the ER CHO, David Peterson (2-3924).

9 WASTE DISPOSAL AND WASTE MINIMIZATION

Serious air and water pollution problems and serious hazards to facility personnel can be caused by improper handling of waste, even the waste produced by small laboratory operations.

Laboratory workers in the ER Division are responsible to ensure that the materials generated in laboratory processes or chemical reactions are safely and properly discarded. Each laboratory supervisor has the responsibility to ensure that waste chemicals are safely collected, identified, and stored for disposal and that the Division is fully advised of any special materials, methods, or facilities required. Hazardous or radioactive materials may NOT be poured down any sink within ER Division facilities. These sinks are not connected to retention tanks but go directly to the Argonne water treatment facility . Hazardous materials introduced inappropriately to the water system may not be successfully treated before release to the environment.

Plans for waste minimization and safe disposal of wastes should be made during the planning stages of new experiments and projects. The quantity of a chemical ordered, the quantity required, and possible reuse of chemicals must be considered. DO NOT ORDER MORE THAN YOU NEED. Normally, disposal costs far outweigh the savings from purchasing bulk quantities.

Chemical or radioactive waste must be properly identified, stored, and packaged for pickup and disposal by WMO. Form WMO-197, “Chemical Waste Disposal Requisition,” or form WMO-195, “Radioactive and Mixed Waste Disposal Requisition” must be completed and given to the Building 203 or Building 202 health physics personnel. They will survey the waste and send the requisition to WMO to initiate the waste disposal process. Keep a copy of the waste requisition for your own files; environmental regulations assign “cradle-to-grave” responsibility.

For additional guidance on waste disposal procedures, refer to the *ANL WHPM* or contact the ER Division ECR, David Peterson (2-3924).

10 RECORD KEEPING

Written records of information and training provided under this *Chemical Hygiene Plan* must be provided to the ER CHO and to the ER Training Management System representative (2-3924).

The Argonne Medical Department maintains records of medical consultations and examinations for 30 years beyond employee-employer separation.

The ER CHO maintains a list of chemicals and chemical products used in the ER Division. This list is a subfile of the sitewide chemical inventory.

Current records of exposure limits specified by OSHA in 29 CFR 1910, Subpart Z, are maintained by the Argonne site CHO.

11 SOURCES OF FURTHER INFORMATION

11.1 Information on Laboratory Safety and Hazardous Chemicals

Useful sources of information about the health effects of exposure to chemicals are the following sources:

- *Safety in Academic Chemistry Laboratories*, published by the American Chemical Society, 1995 edition (copy available from your laboratory supervisor)
- OSHA, "Air Contaminants" (29 CFR 1910, Subpart Z) (Building 203 Library)
- OSHA, "Specifically Regulated Substances" (29 CFR 1910.1001-1101) (Building 203 Library)
- National Toxicology Program, latest *Report on Carcinogens* (Building 203 Library)
- International Agency for Research on Cancer, latest volume on human carcinogens (Classes 1, 2A, and 2B) (Building 202 Library)
- Teratogens identified in Thomas H. Shepard, *Catalog of Teratogenic Agents*, Sixth Edition, Johns Hopkins University Press, 1989 (Building 202 Library)
- National Institute of Occupational Safety and Health, *Registry of Toxic Effects of Chemical Substances*, 1985 (Room H102, Building 203; Building 202 Library)
- *Dangerous Properties of Industrial Materials*, N. Irving Sax, latest edition (Building 203 Library)
- *Protective Glove Selection Guide*, Argonne-East EQO-IH (Room H102, Building 203)

11.2 Chemical Inventory

A sitewide chemical inventory has been developed. Divisions receive area-specific lists for use by laboratory supervisors. These lists must be kept available for reference by laboratory workers.

11.3 Argonne Policies and Procedures

Argonne policies and procedures that are relevant to chemical hygiene are described in the following documents:

- *ANL ESH Manual* (online and in Room H102, Building 203)

- Argonne *Comprehensive Emergency Management Plan* (online)
- *ANL WHPM* (online and in Room H102, Building 203)
- Argonne *Waste Minimization and Pollution Prevention Strategic Plan*
- *ER SHE Manual* (online and printed upon request)

Appendix A:
OSHA Laboratory Standard Training Documentation Record

Detailed Information

_____ 1. The contents of the OSHA Laboratory Standard and its appendixes.

_____ 2. The location and availability of the *Chemical Hygiene Plan* for my laboratory.

_____ 3. Hazardous chemicals located in my laboratory:

_____ • The Permissible Exposure Limits for OSHA-regulated substances.

_____ • The recommended exposure limits for other hazardous chemicals that may be encountered.

_____ • Signs and symptoms associated with exposure to hazardous chemicals.

_____ • The location and availability of reference materials on the hazards, safe handling, storage, and disposal of hazardous chemicals, including Material Safety Data Sheets.

Required Training

_____ 4. The physical and health hazards of chemicals in my work area.

_____ 5. The methods and observations that may be used to detect the presence or release of a hazardous chemical.

_____ 6. Personal protective measures available to me.

_____ 7. Work practices, emergency procedures, and engineering controls that are available to reduce exposure.

_____ 8. The details of the chemical hygiene plan for my laboratory.

Optional Training

_____ 9. Training about designated areas in which I might work with particularly hazardous substances.

With my signature, I certify that I have been informed about and have received training in the areas indicated. I have been given the opportunity to ask questions pertaining to all of the above topics.

_____ _____

Employee's Name (please print) Badge No.

_____ _____

Employee's Signature Date Trainer's Signature Date

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Appendix B:
Memo from B.M. Lesht to ER Division Staff

ARGONNE
NATIONAL
LABORATORY

INTRA-LABORATORY MEMO

June 9, 2003

To: Distribution

From: B. M. Lesht — Acting Division Director/ER

Subject: Procedure for Purchase of Laboratory Chemicals

All purchase orders for chemicals must be processed through the division office and approved by Dave Peterson or me. A copy of the ER pre-purchase requisition form, properly completed, is attached. Printed copies and PDF files of the form are available from Karen Ley (2-3137).

On the pre-purchase requisition, specify the Material Safety Data Sheet (MSDS) number for each chemical you order. To find the number quickly, search Argonne's online MSDS database at the following secure location (https:// not http://):

https://www.cms.anl.gov/msds/msds2.asp

For assistance in locating an MSDS, contact Dave Peterson (2-3924). If no MSDS is available in the Argonne database, place a "U" in the column for the chemical MSDS number.

Argonne requires each division to maintain an accurate chemical inventory. We need your help to do that. If you obtain a chemical by a method other than procurement through the division office (e.g., by borrowing it from someone), do the following:

- Inform Dave Peterson of
  - The security code (staff member responsible for the chemicals),
  - The manufacturer,
  - The quantity received, and
  - The storage location.
- Find an MSDS for the chemical. Give Dave a copy if the MSDS is not in the Argonne database.

Also inform Dave when any chemical is removed from the ER Division inventory because it has been disposed of as waste or has been consumed. An accurate chemical inventory can save precious time waiting for an order if borrowing or trading is possible.

cc: D. Peterson
K. Ley

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Appendix C: Properly Completed Chemical Prepurchase Requisition

ENVIRONMENTAL RESARCH DIVISION PRE-PURCHASE REQUISITION FORM

ASTERISK AREAS MUST BE COMPLETED

Name	Badge #	Div.	Bldg	Room	Ext.	Today's Date
John Doe	99999	ER	203	Z101		12/20/2004
	Y/N		Y/N			
Sole source **	N	Inspect	N	Rush		
Off Site Delivery	N	Drawings	N			
Shipping Order Require	N	***Chem?**	Y	If a chemical, where stored?		Z102
Installation Required?	N	**MSDS**	Y	***INCLUDE WITH ITEM NUMBER***		
Suggested Vendor(s) **						

Sigma Chemical Company	Attn:	
	Phone:	(314)771-5765
	Fax:	
	Email:	

****All orders > $2,500 will be competed**

If this order is over $2500, and this is a **required** vendor, you **must** provide a justification for sole source (non-competitive) procurement. (ANL-410) Forms are available in the ER Division office

PARIS?	N	AMOS?	Y

Item	Noun Description	Primary Adjective	Model #	MSDS #	Qty	U/M	(1) Size	Delivery Date Req.	Estimated Unit Price	Total
1	Chloroform		C6038	20938	2	cf	200	12/22/04	$32.00	$64.00
2										
3										
4										
5										
6										
7										
8										
9										
									Total	$64.00

COST DISTRUBUTION

ITEM	COST CODE	%	COST CODE	%	COST CODE	%
1	14909-EX-149	100				

Special instructions or comments

Offsite Delivery Address and Phone Number

Supervisor Approval		Badge	

(1) Must provide chemical CONTAINER size. Use unit of measure: amp, ang, c, cc, cf, cm, cyl, ft, g, gal, in, kg, l, lb, m, ml, mm, mol, ozfl, ozwt, pt, qt, t, and um;

ER-161

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Appendix D:
Designated Areas for the Environmental Research Division

Building	Room Number	Description	Potential Function
203	A130	Hood A130-1	Highly toxic material use
203	A130	Hood A130-2	Highly toxic material use
203	A130	Hood A130-3	Highly toxic material use
203	A138	Hood A138-1	General chemical use
203	A138	Hood A138-2	Highly toxic material use
203	A138	Hood A138-3	Highly toxic material use
203	B122	Hood B122	Highly toxic material use
203	B130	Hood B130	Highly toxic material use
203	B134	Hood B134	Highly toxic chemical use
203	B138	Hood B-138	Highly toxic chemical use
203	C126	Hood C126-1	Highly toxic material use
203	C134	Hood C134-1	Highly toxic material use
203	C146	Hood C146-1	Highly toxic material use
203	C154	Hood C154-1	Highly toxic material use
203	E102	Hood E102-1	Highly toxic material use
203	E114	Hood E114-1	Highly toxic material use
203	E122	Hood E122-1	Highly toxic material use
203	E154	Hood E154-1	Highly toxic material use
203	E158	Hood E158-1	Highly toxic material use
203	E158	Hood E158-2	Highly toxic material use
203	E166	Hood E166-1	Highly toxic material use
203	E166	Hood E166-2	Highly toxic material use
203	E166	Hood E166 (west side)	Highly toxic material use
203	E178	Hood E178-1	Highly toxic material use
203	E178	Hood E178-2	Highly toxic material use
203	J040	Hood J040-1	Highly toxic material use
203	J072	Hood J072-1	Highly toxic material use
203	J072	Hood J072-2	Highly toxic material use
203	J076	Hood J076-1	Highly toxic material use
203	J076	Hood J076-2	Highly toxic material use
203	J001	Hood J001	Highly toxic material use
202[a]	B150	Hood	Highly toxic material use

[a] The use of this hood requires two-day advance notice to Lee Makowski, BIO Division Director, 2-3819.

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Appendix E: Argonne Class 1 and Class 2 Carcinogens

For updated list see the *ANL ESH Manual*, Chapter 4.5, Appendix A.

Chemical Carcinogens–includes OSHA Select Carcinogens

CHEMICAL	CAS[1]	IARC	NTP	OSHA	ACGIH	ANL
2-Acetylaminofluorene; "2-AAF"	53-96-3	-	RA	SC	-	1
Acrylamide	79-06-1	2A	RA	EL	-	1
Acrylonitrile	107-13-1	2B	RA	C	A2	1
Actinolite asbestos	77536-66-4	1	KC	C	A1	1
Adriamycin	23214-92-8	2A	RA	-	-	2
AF-2 "[2-(2-furyl)-3-(5-nitro-2-furyl)]-acrylamide"	3688-53-7	2B	-	-	-	2
Aflatoxin M1	6795-23-9	2B	-	-	-	2
Aflatoxins	1402-68-2	1	KC	-	-	1
1-Amino-2-methyl-anthraquinone	82-28-0	-	RA	-	-	2
2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole	712-68-5	2B	-	-	-	2
2-Amino-9H-pyrido(2,3-b)-indole; "Amino-alpha-carboline"; "Glob-P-2"	26148-68-5	2B	-	-	-	2
2-Aminoanthraquinone	117-79-3	-	RA	-	-	2
p-Aminoazobenzene	60-09-3	2B	-	-	-	2
o-Aminoazotoluene	97-56-3	2B	RA	-	-	2
4-Aminobiphenyl	92-67-1	1	KC	SC	A1	1
Amitrole	61-82-5	2B	RA	EL	-	1
Amosite asbestos	12172-73-5	1	KC	C	A1	1
Androgenic (anabolic) steroids	-	2A	-	-	-	2
o-Anisidine	90-04-0	2B	-	-	-	2
o-Anisidine hydrochloride	134-29-2	-	RA	-	-	2
Anthophyllite asbestos	77536-67-5	1	KC	C	A1	1
Antimony trioxide	1309-64-4	2B	-	-	-	2
Aramite	140-57-8	2B	-	-	-	2
Arsenic, inorganic (elemental and all inorganic except arsine)	7440-38-2	1	KC	C	A1	1
Asbestos (see also individual types)	1332-21-4	1	KC	C	A1	1
Auramine	492-80-8	2B	-	-	-	2
Azacitidine	320-67-2	2A	RA	-	-	2
Azaserine	115-02-6	2B	-	-	-	2
Azathioprine	446-86-6	1	KC	-	-	1
Aziridine	151-56-4	2B	-	-	-	2

[1] CAS #-Chemical Abstract System Number; IARC – International Agency for Research on Cancer: 1-carcinogenic to humans, 2A-probably carcinogenic to humans, 2B-possibly carcinogenic to humans; NTP-National Toxicology Program: KC-known to be carcinogenic, RA-reasonably anticipated to be carcinogenic; OSHA – Occupational Safety & Health Administration: C-carcinogen, SC-suspect carcinogen, EL-permissible exposure limit based on avoidance of cancer; ACGIH - American Conference of Governmental Industrial Hygienists: A1-confirmed human carcinogen, A2-suspected human carcinogen; ANL 1-Class 1; ANL 2-Class 2; **These chemicals are not OSHA Select Carcinogens, but are added to the ANL-E list of chemical carcinogens per DOE requirements or specific division request.

CHEMICAL	CAS[1]	IARC	NTP	OSHA	ACGIH	ANL
Tris(Aziridinyl)-phosphine sulfide	52-24-4	1	RA	-	-	1
Benzal chloride	98-87-3	2A	-	-	-	2
Benz[a]anthracene	56-55-3	2A	RA	-	A2	1**
Benzene	71-43-2	1	KC	C	A1	1
Benzidine	92-87-5	1	KC	SC	A1	1
Benzo[a]pyrene	50-32-8	2A	RA	-	A2	1**
Benzo[b]fluoranthene	205-99-2	2B	RA	-	A2	1**
Benzo[j]fluoranthene	205-82-3	2B	RA	-	-	2
Benzo[k]fluoranthene	207-08-9	2B	RA	-	-	2
Benzofuran	271-89-6	2B	-	-	-	2
Benzotrichloride	98-07-7	2B	RA	-	A2	1**
Benzoyl chloride	98-88-4	2A	-	-	-	2
Benzyl chloride	100-44-7	2A	-	-	-	2
Benzyl violet 4B	1694-09-3	2B	-	-	-	2
Beryllium & beryllium compounds	7440-41-7	1	RA	EL	A1	1
Bitumens, extracts of steam/air refined	8052-42-4	2B	-	-	-	2
Bleomycins	1105-60-7	2B	-	-	-	2
Bromodichloromethane	75-27-4	2B	RA	-	-	2
1,3-Butadiene	106-99-0	2A	KC	-	A2	1**
1,4-Butanediol dimethane sulphonate "Myleran"	5598-1	1	KC	-	-	1
Butylated hydroxyanisole "BHA"	25013-16-5	2B	RA	-	-	2
beta-Butyrolactone	3068-88-0	2B	-	-	-	2
C.I. Basic red 9 monohydrochloride	569-61-9	-	RA	-	-	2
Cadmium and Cadmium compounds	7440-43-9	1	KC	C	A2	1
Calcium chromate (based on chromate)	13765-19-0	-	-	-	A2	1**
Captafol	2425-06-1	2A	-	-	-	2
Carbon tetrachloride	56-23-5	2B	RA	EL	A2	1
Carrageenan, degraded	9000-07-1	2B	-	-	-	2
Catechol	120-80-9	2B	-	-	-	2
Chemotherapy for lymphomas "MOPP" & others	-	1	-	-	-1	
Chlorambucil	305-03-3	1	KC	-	-	1
Chloramphenicol	56-75-7	2A	-	-	-	2
Chlordane	57-74-9	2B	-	-	-	2
Chlorendic acid	115-28-6	2B	RA	-	-	2

[1] CAS #-Chemical Abstract System Number; IARC – International Agency for Research on Cancer: 1-carcinogenic to humans, 2A-probably carcinogenic to humans, 2B-possibly carcinogenic to humans; NTP-National Toxicology Program: KC-known to be carcinogenic, RA-reasonably anticipated to be carcinogenic; OSHA – Occupational Safety & Health Administration: C-carcinogen, SC-suspect carcinogen, EL-permissible exposure limit based on avoidance of cancer; ACGIH - American Conference of Governmental Industrial Hygienists: A1-confirmed human carcinogen, A2-suspected human carcinogen; ANL 1-Class 1; ANL 2-Class 2; **These chemicals are not OSHA Select Carcinogens, but are added to the ANL-E list of chemical carcinogens per DOE requirements or specific division request.

CHEMICAL	CAS[1]	IARC	NTP	OSHA	ACGIH	ANL
Chlorinated paraffins (average 12 carbons, 60% chlorination)	63449-39-8	2B	RA	-	-	2
Chlornaphazine	494-03-1	1	-	-	-	1
p-Chloroaniline	106-47-8	2B	-	-	-	2
Chloromethyl methyl ether	107-30-2	1	KC	-	-	1
1-Chloro-2-methylpropene	513-37-1	2B	RA	-	-	2
3-Chloro-2-methylpropene	563-47-3	2B	RA	-	-	2
4-Chloro-o-phenylenediamine	95-83-0	2B	RA	-	-	2
para-Chloro-ortho-toluidine and its strong acid salts	95-69-2	2A	RA	-	-	2
bis-(chloroethyl)-nitrosourea (BCNU)	154-93-8	2A	RA	-	-	2
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea; "MeCCNU'	13909-09-6	1	KC	-	-	1
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea; "CCNU'	13010-47-4	2A	RA	-	-	2
Chloroform	67-66-3	2B	RA	EL	A2	1
bis-Chloromethyl ether; "BCME"	542-88-1	KC	SC	A1		
3-Chloro-2-methylpropene	563-47-3	-	RA	-		
Chlorophenols, various (occupational exposure)		2B	-	-	-	2
Chlorophenoxy herbicides		2B	-	-	-	2
Chloroprene	126-99-8	2B	RA	-	-	2
Chlorothalonil	1897-45-6	2B	-	-	-	2
Chlorotrianisene	569-57-3	2B	-	-	A1	1**
Chlorozotocin	54749-90-5	2A	RA	-	-	2
Chromic acid	7738-94-5	-	-	EL	-	1
Chromium (water soluble & insoluble hexavalent compounds)		1	KC	-	A1	1**
Chromyl chloride	14977-61-8	-	-	EL	-	1
Chrysotile asbestos	12001-29-5	1	KC	C	A1	1
CI acid red 114	6459-94-5	2B	-	-	-	2
Ciclosporin	59865-13-3	1	KC	-	-	1
CI direct blue 15	2429-74-5	2B	-	-	-	2
Cisplatin	15663-27-1	2A	RA	-	-	2
Citrus red no. 2	6358-53-8	2B	-	-	-	2
Coal tar pitch volatiles (benzene soluble)	65996-93-2	1	-	C	A1	1

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Cobalt and cobalt compounds	7440-48-4	2B	-	-	-	2
p-Cresidine	120-71-8	2B	RA	-	-	2
Cresotes	8001-58-9	2A	KC	-	-	1
Crocidolite asbestos	12001-28-4	1	KC	C	A1	1
Cupferron	135-20-6	-	RA	-	-	2
Cycasin	14901-08-7	2B	-	-	-	2
Cyclophosphamide	50-18-0	1	KC	-	-	1
Dacarbazine	4342-03-4	2B	RA	-	-	2
Dantron; "Chrysazin"; "1,8-dihydroxyanthraquinone"	117-10-2	2B	RA	-	-	2
Daunomycin	20830-81-3	2B	-	-	-	2
DDT; "Dichlorodiphenyltrichloroethane"	50-29-3	2B	RA	-	-	2
Di(2-ethylhexyl)phthalate	117-81-7	-	RA	-	-	2
N,N'-Diacetylbenzidine	613-35-4	2B	RA	-	-	2
2,4-Diaminoanisole	615-05-4	2B	-	-	-	2
2,4-Diaminoanisole Sulfate	39156-41-7	2B	RA	-	-	2
4,4'-Diaminodiphenyl ether (4,4'-Oxydianiline)	101-80-4	2B	RA	-	-	2
2,4-Diaminotoluene	95-80-7	2B	RA	-	-	2
Dibenz[a,h]acridine	226-36-8	2B	RA	-	-	2
Dibenz[a,h]anthracene	53-70-3	2A	RA	-	-	2
Dibenz[a,j]acridine	224-42-0	2B	RA	-	-	2
Dibenzo[a,e]pyrene	192-65-4	2B	RA	-	-	2
Dibenzo[a,h]pyrene	189-64-0	2B	RA	-	-	2
Dibenzo[a,i]pyrene	189-55-9	2B	RA	-	-	2
Dibenzo[a,l]pyrene	191-30-0	2B	RA	-	-	2
7H-Dibenzo[c,g]carbazole	194-59-2	2B	RA	-	-	2
1,2-Dibromo-3-chloropropane; "DBCP"	96-12-8	2B	RA	C	-	1
1,1-Dibromoethane	557-91-5	-	RA	-	-	2
Dibromoethane (Ethylene dibromide)	106-93-4	-	RA	-	-	2
1,4-Dichloro-2-butene	764-41-0	-	-	-	A2	1**
3,3'-Dichloro-4,4'-diaminodiphenyl ether	28434-86-8	2B	-	-	-	2
1,4-Dichlorobenzene	106-46-7	2B	RA	-	-	2
3,3'-Dichlorobenzidene	91-94-1	2B	RA	SC	-	1
3,3'-Dichlorobenzidene dihydrochloride	612-83-9	-	RA	-	-	2

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1,2-Dichloroethane	107-06-2	2B	RA	-	-	2
1,3-Dichloropropene; "Telone II"	542-75-6	2B	RA	-	-	2
Dichlovos	62-73-7	2B	-	-	-	2
Diepoxybutane	1464-53-5	2B	RA	-	-	2
Diethyl sulfate	64-67-5	2A	RA	-	-	2
1,2-Diethylhydrazine	1615-80-1	2B	-	-	-	2
Diethylstilbestrol	56-53-1	1	KC	-	-	1
Diglycidyl resorcinol ether	101-90-6	2B	RA	-	-	2
Dihydrosafrole	94-58-6	2B	-	-	-	2
Diisopropyl sulfate	2973-10-6	2B	-	-	-	2
3,3'-Dimethoxybenzidine	119-90-4	2B	RA	-	-	2
2,6-Dimethylaniline (2,6-xylidene)	87-62-7	2B	-	-	-	2
Dimethyl carbamoyl chloride	79-44-7	2A	RA	-	A2	1**
Dimethyl sulfate	77-78-1	2A	RA	EL	-	1
4,4'-bis(Dimethylamino)-benzophenone; "Michler's ketone"	90-94-8	-	RA	-	-	2
Trans-2-[(Dimethylamino)-methylimino)5-(2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole	25962-77-0	2B	-	-	-	2
4-Dimethylaminoazobenzene	60-11-7	2B	RA	-	-	2
3,3'-Dimethylbenzidine	612-82-8	-	RA	-	-	2
1,1-Dimethylhydrazine	57-14-7	2B	RA	-	A2	1**
1,2-Dimethylhydrazine	540-73-8	2B	-	-	-	2
Dimethylvinyl chloride	513-37-1	-	RA	-	-	2
3,7-Dinitrofluoranthene	105735-71-5	2B	-	-	-	2
3,9-Dinitrofluoranthene	22506-53-2	2B	-	-	-	2
1,6-Dinitropyrene	42397-64-8	2B	RA	-	-	2
1,8-Dinitropyrene	42397-65-9	2B	RA	-	-	2
2,4-Dinitrotoluene	121-14-2	2B	-	-	-	2
2,6-Dinitrotoluene	606-20-2	2B	-	-	-	2
1,4-Dioxane	123-91-1	-	RA	-	-	2
Direct black 38	1937-37-7	-	KC	-	-	1
Direct blue 6	2602-46-2	-	KC	-	-	1
Disperse blue 1	2475-45-8	2B	RA	-	-	2
Epichlorohydrin	106-89-8	2A	RA	-	-	2
1,2-Epoxybutane	106-88-7	2B	-	-	-	2
Erionite	12510-42-8	1	KC	-	-	1

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Estradiol 17B	50-28-2	-	RA	-	-	2
Estrogen & certain estrogen compounds (conjugated)	57-63-6	1	KC	-	-	1
Estrone	53-16-7	-	RA	-	-	2
Ethidium bromide	1239-45-8	-	-	-	-	1**
Ethinylestradiol	57-63-6	-	PA	-	-	2
Ethyl acrylate	140-88-5	2B	RA	-	-	2
Ethyl methanesulfonate	62-50-0	2B	RA	-	-	2
Ethylene dibromide	106-93-4	2A	RA	-	-	2
Ethylene oxide; "EtO"	75-21-8	1	KC	C	A2	1
Ethylene thiourea	96-45-7	2B	RA	-	-	2
Ethyleneimine	151-56-4	-	-	SC	-	1
Di(2-Ethylhexyl)phthalate; "DOP"	117-81-7	2B	RA	-	-	2
Formaldehyde	50-00-0	2A	RA	SC	A2	1
Furan	110-00-9	-	RA	-	-	2
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole	3570-75-0	2B	-	-	-	2
Glu-P-1 "(2-amino-6-methyl-dipyrido[1,2-a:3',2'-d]imidazole)"	67730-11-4	2B	-	-	-	2
Glu-P-2 "(2-aminodipyrido[1,2-a:3',2'-d]imidazole)"	67730-10-3	2B	-	-	-	2
Glycidaldehyde	765-34-4	2B	-	-	-	2
Glycidol	556-52-5	-	RA	-	-	2
Griseofulvin	126-07-8	2B	-	-	-	2
HC blue no. 1	2784-94-3	2B	-	-	-	2
Heptachlor and heptachlor epoxide	76-44-8	2B	-	-	-	2
Hexachlorobenzene	118-74-1	2B	RA	-	-	2
Hexachlorocyclohexane (mixed isomers)	608-73-1	2B	RA	-	-	2
Hexachloroethane	67-72-1	2B	RA	-	-	2
Hexamethylphosphoramide	680-31-9	2B	RA	-	-	2
Hydrazine	302-01-2	2B	RA	-	-	2
Hydrazine sulfate	10034-93-2	-	RA	-	-	2
Hydrazobenzene	122-66-7	-	RA	-	-	2
Indeno[1,2,3-cd]pyrene	193-39-5	2B	RA	-	-	2
Iron dextran complex "Inferon"	9004-66-4	2B	RA	-	-	2

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Isoprene	78-79-5	2B	RA	-	-	2
Kepone; "Chlordecone"	143-50-0	2B	RA	-	-	2
Lasiocarpine	303-34-4	2B	-	-	-	2
Lead chromate (based on chromate)	7758-97-6	-	-	-	A2	1**
Lindane	58-89-9	-	RA	-	-	2
Medroxyprogesterone acetate	71-58-9	2B	-	-	-	2
MeIQ (2-amino-3,4-dimethylimidazo[4,5-f]quinoline)	77094-11-2	2B	-	-	-	2
MeIQx (2-amino-3,8-dimethylimidazo[4,5-f]quinoxaline)	77500-04-0	2B	-	-	-	2
Melphalan	148-82-3	1	KC	-	-	1
Merphalan	531-76-0	2B	-	-	-	2
Mestranol	72-33-3	-	RA	-	-	2
8-Methoxypsoralen (+ UVA therapy) "PUVA"	298-81-7	1	KC	-	-	1
Methyl chloromethyl ether; "Chloromethyl methyl ether"	107-30-2	1	KC	SC	A2	1
4,4'-Methylenedianiline dihydrochloride	13552-44-8	-	RA	-	-	2
Methyl methanesulfonate	66-27-3	2A	RA	-	-	2
2-Methyl-1-nitroanthraquinone	129-15-7	2B	-	-	-	2
N-methyl-n'-nitro-N-nitrosoguanidine; "MNNG"	70-25-7	2A	RA	-	-	2
N-Methyl-N-nitrosourethane	615-53-2	2B	-	-	-	2
Methylazoxymethanol acetate	592-62-1	2B	-	-	-	2
5-Methylchrysene	3697-24-3	2B	RA	-	-	2
4,4'-Methylene bis(2-chloroaniline); "MBOCA", "MOCA"	101-14-4	2A	RA	-	A2	1**
4,4'-Methylene bis(2-methylaniline)	838-88-0	2B	-	-	-	2
Methylene chloride (dichloromethane)	75-09-2	2B	RA	SC	-	1
4,4'-Methylenebis(N,N-dimethyl)aniline	101-61-1	-	RA	-	-	2
4,4'-Methylenedianiline "4,4'-Methylenebis(benzeneamine)"	101-77-9	2B	RA	-	-	2
4,4'-Methylenedianiline dihydrochloride	13552-44-8	-	RA	-	-	2
Methylthiouracil	56-04-2	2B	-	-	-	2
Metronidazole	443-48-1	2B	RA	-	-	2

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Mineral oil mist—ONLY untreated and mildly-treated (excludes refined oils)		1	KC	-	-	1
Mirex	2385-85-5	2B	RA	-	-	2
Mitomycin C	50-07-7	2B	-	-	-	2
Monocrotaline	315-22-0	2B	-	-	-	2
5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene) amino]-2-oxazolidinone (I form)	3796-8-8	2B	-	-	-	2
Mustard gas "bis(2-chloroethyl)sulfide"	505-60-2	1	KC	-	-	1
Nafenopin	3771-19-5	2B	-	-	-	2
Alpha-Naphthylamine	134-32-7	-	-	SC	-	1
Beta-Naphthylamine	91-59-8	1	KC	SC	A1	1
Nickel (insoluble compounds only)	7440-02-0	2B	RA	EL	A1	1
Niridazole	61-57-4	2B	-	-	-	2
Nitrilotriacetic acid and its salts	139-13-9	2B	RA	-	-	2
N(4-(5-Nitro-2-furyl)-2-thiazolyl)acetamide	531-82-8	2B	-	-	-	2
5-Nitroacenaphthene	602-87-9	2B	-	-	-	2
2-Nitroanisole	91-23-6	2B	RA	-	-	2
o-Nitroanisole	91-23-6	-	RA	-	-	2
Nitrobenzene	98-95-3	2B	-	-	-	2
4-Nitrobiphenyl "4-Nitrodiphenyl"	92-93-3	-	-	SC	A2	1
6-Nitrochrysene	7496-02-8	2B	RA	-	-	2
Nitrofen	1836-75-5	2B	RA	-	-	2
2-Nitrofluorene	607-57-8	2B	-	-	-	2
1-((5-Nitrofurfurylidene)amino)-2-imidazolidinone	555-84-0	2B	-	-	-	2
N-[4-(5-nitro-2-furyl)-2-thiazoly]acetamide	531-82-8	2B	-	-	-	2
Nitrogen mustard "bis(B-chloroethyl) methylamine"	51-75-2	2A	RA	-	-	2
Nitrogen mustard hydrochloride	55-86-7	-	RA	-	-	2
Nitrogen mustard N-oxide	126-85-2	2B	-	-	-	2
2-Nitropropane	79-46-9	2B	RA	EL	-	1
1-Nitropyrene	5522-43-0	2B	RA	-	-	2
4-Nitropyrene	57835-92-4	2B	RA	-	-	2
N-Nitroso-N-ethylurea	759-73-9	2A	RA	-	-	2

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N-Nitroso-N-methylurea	684-93-5	2A	RA	-	-	2
N-Nitrosodi-n-butylamine	924-16-3	2B	RA	-	-	2
N-Nitrosodi-n-propylamine	621-64-7	2B	RA	-	-	2
N-Nitrosodiethanolamine	1116-54-7	2B	RA	-	-	2
N-Nitrosodiethylamine	55-18-5	2A	RA	-	-	2
N-Nitrosodimethylamine	62-75-9	2A	RA	SC	-	1
4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanonE; "NNK"	64091-91-4	2B	RA	-	-	2
3-(N-Nitrosomethylamino)-propionitrile	60153-49-3	2B	-	-	-	2
N-Nitrosomethylethylamine	10595-95-6	2B	-	-	-	2
N-Nitrosomethylvinylamine	4549-40-0	2B	RA	-	-	2
N-Nitrosomorpholine	59-89-2	2B	RA	-	-	2
N-Nitrosonornicotine	16543-55-8	2B	RA	-	-	2
N-Nitrosopiperidine	100-75-4	2B	RA	-	-	2
N-Nitrosopyrrolidine	930-55-2	2B	RA	-	-	2
N-Nitrososarcosine	13256-22-9	2B	RA	-	-	2
Norethisterone	68-22-4	-	RA	-	-	2
Ochratoxin A	303-47-9	2B	RA	-	-	2
Oil Orange SS	2646-17-5	2B	-	-	-	2
Oxazepam	604-75-1	2B	-	-	-	2
4,4'-Oxydianiline	101-80-4	-	RA	-	-	2
Oxymetholone	434-07-1	2A	RA	-	-	2
Panfuran S	794-93-4	2B	-	-	-	2
Phenazopyridine hydrochloride	136-40-3	2B	RA	-	-	2
Phenobarbital	50-06-6	2B	-	-	-	2
Phenoxybenzamine hydrochloride	63-92-3	2B	RA	-	-	2
Phenyl glycidyl ether	122-60-1	2B	-	-	-	2
Phenytoin	57-41-0	2B	RA	-	-	2
PhIP (2-amino-1-methyl)-6-phenylimidazo[4,5-b]pyridine	105650-23-5	2B	-	-	-	2
Polybrominated biphenyls	36355-01-8	2B	RA	-	-	2
Polychlorinated biphenyls	1336-36-3	2A	RA	-	-	2
Ponceau 3R	3564-09-8	2B	-	-	-	2
Ponceau MX	3761-53-3	2B	-	-	-	2
Potassium bromate	7758-01-2	2B	-	-	-	2

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Potassium zinc chromate; "Zinc Yellow" (based on chromate)	11103-86-9	1	-	-	A1	1**
Procarbazine hydrochloride	366-70-1	-	RA	-	-	2
Progesterone	57-83-0	2B	RA	-	-	2
1,3-Propane sultone	1120-71-4	2B	RA	-	-	2
beta-Propiolactone	57-57-8	2B	RA	SC	-	1
Propylene imine "2-Methylaziridine"	5-55-8	2B	RA	-	-	2
Propylene oxide	75-56-9	2B	RA	-	-	2
Propylthiouracil	51-52-5	2B	RA	-	-	2
Reserpine	50-55-5	-	RA	-	-	2
p-Rosaniline "Basic Red 9"	569-61-9	-	RA	-	-	2
Safrole	94-59-7	2B	RA	-	-	2
Selenium sulfide	7446-34-6	-	RA	-	-	2
Shale oils, crude	68308-34-9	1	-	-	-	1
Sodium ortho-phenylphenate	132-27-4	2B	-	-	-	2
Solvent orange 2	2646-17-5	2B	-	-	-	2
Sterigmatocystin	10048-13-2	2B	-	-	-	2
Streptozotocin	18883-66-4	2B	RA	-	-	2
Strontium chromate (based on chromate)	7789-06-2	-	-	-	A2	1**
Styrene (monomer only)	100-42-5	2B	-	EL	-	1
Styrene-7,8-oxide	96-09-3	2A	-	-	-	2
Sulfallate	95-06-7	2B	RA	-	-	2
Talc (ONLY containing asbestiform fibers)	14807-96-6	1	KC	-	A1	1**
Tamoxifen	10540-29-1	1	KC	-	-	1
2,3,7,8-Tetrachlorodibenzo-p-dioxin; "TCDD", "Dioxin"	1746-01-6	1	RA	-	-	1
Tetrachloroethylene (perchloroethylene)	127-18-4	2A	RA	-	-	2
Tetrafluoroethylene	116-14-3	2B	RA	-	-	2
Tetranitromethane	509-14-8	2B	RA	-	-	2
Thioacetamide	62-55-5	2B	RA	-	-	2
4,4'-Thiodianiline	139-65-1	2B	-	-	-	2
Thiotepa [tris(1-aziridinyl)phosphine sulfide	52-24-1	1	KC	-	-	1
Thiourea	62-56-6	2B	RA	-	-	2
Thorium dioxide	1314-20-1	-	KC	-	-	1

[1] CAS #-Chemical Abstract System Number; IARC – International Agency for Research on Cancer: 1-carcinogenic to humans, 2A-probably carcinogenic to humans, 2B-possibly carcinogenic to humans; NTP-National Toxicology Program: KC-known to be carcinogenic, RA-reasonably anticipated to be carcinogenic; OSHA – Occupational Safety & Health Administration: C-carcinogen, SC-suspect carcinogen, EL-permissible exposure limit based on avoidance of cancer; ACGIH - American Conference of Governmental Industrial Hygienists: A1-confirmed human carcinogen, A2-suspected human carcinogen; ANL 1-Class 1; ANL 2-Class 2; **These chemicals are not OSHA Select Carcinogens, but are added to the ANL-E list of chemical carcinogens per DOE requirements or specific division request.

CHEMICAL	CAS[1]	IARC	NTP	OSHA	ACGIH	ANL
Tobacco smoke; smokeless tobacco products	-	1	-	-	-	1
o-Tolidine	119-93-7	2B	-	-	-	2
Toluene diisocyanate	26471-62-5	2B	RA	-	-	2
o-Toluidine	95-53-4	2B	RA	EL	-	1
o-Toluidine hydrochloride	3165-93-3 & 636-21-5	-	RA	-	-	2
p-Toluidine	106-49-0	-	-	EL	-	1
o-Toluidine hydrochloride	636-21-5	-	RA	-	-	2
Toxaphene "Chlorinated camphene"	8001-35-2	2B	RA	-	-	2
Tremolite asbestos	77536-68-6	1	KC	C	A1	1
Treosulphan	299-75-2	1	-	-	-	1
Trichloromethine; "Trimustine hydrochloride"	817-09-4	2B	-	-	-	2
Trichloroethylene	79-01-6	2A	RA	-	-	2
2,4,6-Trichlorophenol	88-06-2	-	RA	-	-	2
1,2,3-Trichloropropane	96-18-4	2A	RA	-	-	2
Tris(2,3-dibromopropyl) phosphate "TRIS"	126-72-7	2A	RA	-	-	2
Trp-P-1(3-amino-1,4-dimethyl-5H-pyriol[4,3-b]indole; "Tryptophan P1"	62450-06-0	2B	-	-	-	2
Trp-P-2(3-amino-1-methyl-5H-pyrido[4,3-b]indole); "Tryptophan P2"	62450-07-1	2B	-	-	-	2
Trypan blue "C.I-Direct blue 14"	72-57-1	2B	-	-	-	2
Uracil mustard	66-75-1	2B	-	-	-	2
Valentinite	1317-98-2	2B	-	-	-	2
Vinyl acetate	105-05-4	2B	-	-	-	2
Vinyl bromide	593-60-2	2A	-	EL	A2	1
Vinyl chloride	75-01-4	1	KC	SC	A1	1
4-Vinyl cyclohexene	100-40-3	2B	-	-	-	2
Vinyl cyclohexene diepoxide	106-87-6	2B	RA	EL	-	1
Vinyl fluoride	75-002-5	2A	-	-	-	2
Xylidine (mixed isomers) "Dimethylaminobenzene"	1300-73-8	-	-	SC	-	1
Zinc chromate (based on chromate)	13530-65-9	1	-	EL	A1	1

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