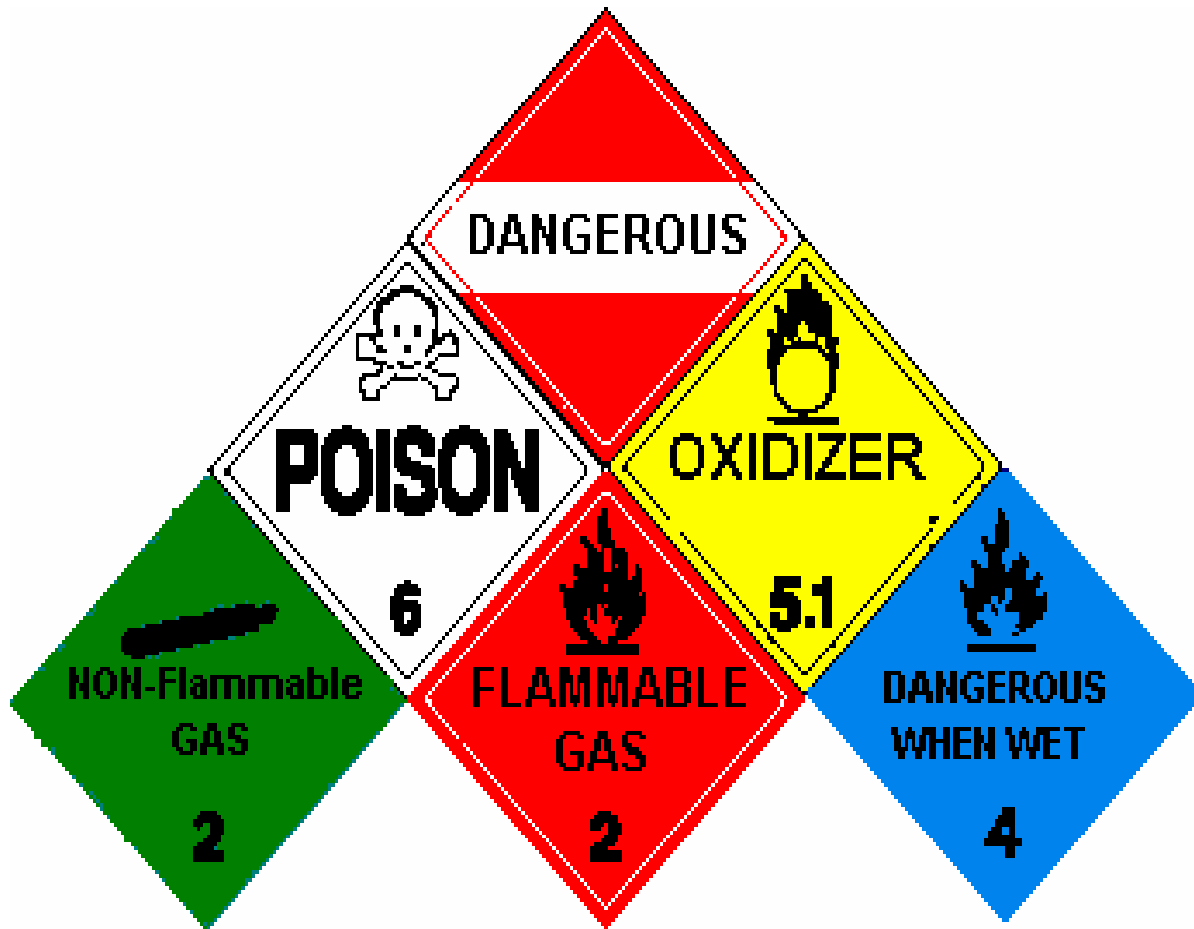


**UNIVERSITY OF HAWAI'I
COLLEGE OF TROPICAL AGRICULTURE AND
HUMAN RESOURCES**



**Hazardous Materials and Hazardous Waste
Management Program
for Off-Campus Facilities
November 25, 2002**

Dear Colleagues

The University of Hawaii, College of Tropical Agriculture and Human Resources (CTAHR) has a fundamental obligation to safeguard the health, safety, and welfare of our students, personnel, and the visiting public whenever they participate in an official University activity. It is the policy of the University to provide for and maintain, through implementation of environmental health and safety programs, conditions and practices that ensure a safe and healthful research environment. In keeping with this commitment, the CTAHR Hazardous Material and Hazardous Waste Management Program was developed and is updated annually.

The Hazardous Material and Hazardous Waste Management Program (HMMP) is designed to ensure the protection of University personnel and the environment from potential hazards associated with hazardous materials and hazardous waste. Also, it will assist the University to achieve compliance with applicable federal, state and county regulations. The HMMP is for your reference in managing hazardous materials and hazardous waste at the CTAHR off-campus facilities.

It is our responsibility as members of the University of Hawaii community to be committed to the environmental health and safety of our facilities. We are committed to follow and comply with the Hazardous Material and Hazardous Waste Management Program. This HMMP will be effective immediately.

Andrew Hashimoto
Dean, College of Tropical Agriculture and Human Resources
November 25, 2002

List of Abbreviations Used

CESQG – Conditionally Exempt Small Quantity Generator

CFR – Code of Federal Regulations

CTAHR – College of Tropical Agriculture and Human Resources

CTAHR-ARS – CTAHR Agriculture Research Stations

CTAHR-ESS – CTAHR Environmental Safety Specialist

DOH-SHWB – State of Hawaii Department of Health Solid and Hazardous Waste
Branch

EHSO – University of Hawaii at Manoa Environmental Health and Safety Office

EPA – Environmental Protection Agency

HawCC – Hawaii Community College

HMMP – Hazardous Materials and Hazardous Waste Management Program

Kg – Kilogram

LQG – Large Quantity Generator

MSDS – Material Safety Data Sheets

OSHA – Occupational Safety and Health Administration

PI – Principal Investigator

ppm – Parts per million

RCRA – Resource Conservation and Recovery Act

SQG – Small Quantity Generator

UHH – University of Hawaii at Hilo

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I. INTRODUCTION

A. Purpose

This program outlines requirements for the management of hazardous materials and the disposal of hazardous waste at University of Hawaii, College of Tropical Agriculture and Human Resources (CTAHR) off-campus facilities. (Note: CTAHR off-campus facilities are defined to be all facilities not on the main UH-Manoa Campus, including the Magoon Agricultural Facility.) These requirements are based on federal, state and county regulations. Adherence to this program will ensure the proper management of hazardous materials and hazardous wastes, reduce overall costs (by reducing disposal cost and minimizing the use of hazardous materials), and avoid potential civil and/or criminal liabilities. Revisions to this program require UH Environmental Health and Safety Office approval. This program is applicable only to the CTAHR off-campus facilities that are listed below.

Island of Hawaii:

Komohana Extension Office
Beaumont Agricultural Research Center
Hamakua Research Station
Mealani Research Station
Kona Research Station
Waiakea Research Station
Volcano Research Station

Island of Maui:

Low-Elevation Demonstration Farm
Maui Agricultural Research Center (Kula)
NifTAL Project
Haleakala Station

Island of Molokai:

Molokai Applied Research Farm

Island of Oahu:

Pearl City Urban Garden Center
Poamoho Research Station
Whitmore Research Station
Waialea Research Farm
Waimanalo Research Station
Magoon Agricultural Facility

Island of Kauai:

Kauai Agricultural Research Center
Paddy Field

Failure to comply with these requirements may subject CTAHR and/or individuals to fines and civil or criminal prosecution.

The Environmental Protection Agency (EPA) is charged with the enforcement of hazardous waste regulations under the Resource Conservation and Recovery Act (RCRA). Locally, the State of Hawaii Department of Health – Solid and Hazardous Waste Branch (DOH-SHWB) enforces RCRA regulations. Under RCRA, facilities that generate hazardous waste are categorized according to the amount and type of waste they generate and/or accumulate. Facilities that generate less than 100 Kg/mo of hazardous waste or 1 Kg of acutely hazardous waste (as defined in 40 CFR 261.33e) are categorized as Conditionally Exempt Small Quantity Generators (CESQG). Facilities that generate between 100 Kg and 1000 Kg/mo of hazardous waste and less than 1 Kg of acutely hazardous waste are categorized as Small Quantity Generators (SQG). Facilities that generate more than 1000 Kg/mo of hazardous waste or accumulate more than 1 Kg of acutely hazardous waste at any time are categorized as Large Quantity Generators (LQG). Regulatory requirements vary according to a facility's generator status.

It is the intent of CTAHR to operate off-campus facilities as CESQGs. This will minimize the requirements and burden of CTAHR faculty and staff. As stated above, a CESQG is allowed to generate up to 100 Kg of hazardous waste or 1 Kg of acutely hazardous waste per calendar month. Additionally, a CESQG is allowed to accumulate up to 1000 Kg of hazardous waste and up to 1 Kg of acutely hazardous waste at any time. The following program outlines the requirements for operating as a CESQG.

B. Applicability

This program applies to all personnel that purchase, store, transport, manage, use, and dispose of hazardous materials and/or hazardous wastes. This plan applies to waste generated on CTAHR off-campus facilities.

C. Responsibilities

All applicable personnel must become familiar with the hazardous materials in their area and with the CTAHR Hazardous Materials and Hazardous Waste Management Program. Principal Investigators (PI) who conduct research at off-campus facilities are responsible for the materials and wastes related to their projects at those off-campus facilities. They will contact the CTAHR

Environmental Safety Specialist (CTAHR-ESS), Ph: (808) 956-7918 if in doubt about the requirements of this program or about how to properly dispose of waste.

II. RESPONSIBLE PERSONNEL

A. Personnel Responsibilities

All personnel must:

- Become familiar with the hazardous materials in their area and with this CTAHR Hazardous Material and Hazardous Waste Management Program.
- Use a Procurement Authorization for Hazardous Materials form (Attachment 1) to obtain approval for the purchase of specific hazardous materials.
- Submit an Authorization to Use Hazardous Material form (Attachment 2) for grant approval.
- Provide an annual inventory of hazardous materials (Attachment 3) and a monthly inventory of hazardous wastes (Attachment 4).
- Store and label waste properly.

B. Designated program coordinator

The CTAHR-ESS is responsible for overall coordination of the Hazardous Material and Hazardous Waste Management Program at the CTAHR-ARS facilities. However, it is the ultimate responsibility of each faculty or staff member to comply with all Federal, State, and local regulations. The CTAHR-ESS shall ensure that the appropriate faculty and staff have the current training.

County Administrators shall be responsible for implementing the HMMP for his or her County including submission of the monthly and annual inventories to the CTAHR-ESS. County Administrators may designate appropriate individuals such as farm managers and principal investigators to be responsible for implementing the HMMP for specific areas or locations in the County. Department Chairs shall be responsible for implementing the HMMP for areas in the Magoon Agricultural Facility (Magoon) that are assigned to their Departments including submission of the monthly and annual inventories to the CTAHR-ESS. Department Chairs may designate appropriate individuals to be responsible for implementing the HMMP for specific areas in Magoon.

All designated faculty and staff are required to attend the initial and annual refresher hazardous waste generator training. EHSO will provide the training and upon satisfactory completion of the training will issue training certificates.

This Hazardous Materials and Hazardous Waste Management Program is subject

to review annually to maintain current practices, methods, and regulatory requirements specified.

III. HAZARDOUS MATERIAL MANAGEMENT

A. Training Certificates.

Responsible faculty and staff must retain copies of their training certificates for their records as proof of training for purchasing or disposing of hazardous chemicals.

B. Authorization to Purchase Hazardous Materials.

CTAHR-ESS approval is required for the purchase or requisition of the specific chemicals on the list provided on the Procurement Authorization for Hazardous Material Form, Attachment (1). This form must be filled out and submitted to the CTAHR-ESS for approval prior to initiating a purchase order for any of the materials on the list. If approved, a copy of the form will be provided to you for attachment to your purchase order or requisition. The purpose of the approval is to enable the CTAHR-ESS to assist you in ensuring the safe storage, handling and disposal of the material while minimizing cost to the University. All requests should be submitted for approval for purchase two weeks prior to purchasing chemicals.

C. Approval to Use Hazardous Materials.

As part of the grant approval process (ORS Form 5, item 4 under PI certification), a specific form for the use of certain hazardous materials has been developed (Attachment 2). This form is similar to those already in place for the use of radioactive and biohazard materials.

D. Inventory Control Procedures.

1. Annual Inventory of Hazardous Materials.

CTAHR off-campus facilities that store hazardous materials are required to submit annual inventories to the CTAHR-ESS. The Annual Inventory form, Attachment 3, will help CTAHR manage existing hazardous materials, monitor on-going usage, and prevent unnecessary accumulation. As part of the inventory procedure, responsible personnel, as designated by the County Administrators or department chairpersons, are required to inspect the condition of all hazardous material containers in their area to ensure that hazardous materials are stored in containers which are in good condition and which are properly labeled.

2. Monthly Inventory of Hazardous Wastes.

CTAHR off-campus facilities that generate hazardous wastes are required to submit monthly waste inventories to the CTAHR-ESS. Waste Inventory forms (Attachment 4) shall be submitted to the CTAHR-ESS on or before the first Friday of every month. The waste inventories help CTAHR ensure that it does not exceed its accumulation limits, thus subjecting CTAHR to more stringent regulations. As part of the inventory procedure, designated personnel are required to inspect the condition of all hazardous waste containers to ensure that hazardous wastes are stored in containers which are in good condition and which are properly labeled. The CTAHR-ESS will complete columns 7 & 8 (DOT class and EPA waste code) of the Waste Inventory Form and return a copy to the designated faculty or staff person who submitted it. This record documents the hazardous waste determination required by EPA regulations.

3. Inventory of Special Wastes.

While certain wastes are not hazardous, they also cannot be disposed of in a sanitary landfill or down the drain, and may necessitate special disposal procedures. These non-hazardous wastes should be included in the Waste Inventory form for proper disposal.

E. Audit Program.

The audit program will assist in maintaining a safe working and academic environment. CTAHR-ESS and/or the EHSO will conduct periodic audits of the facilities to review the current operations with respect to all applicable safety, health and environmental policies and regulations. The following issues will be reviewed: hazardous material storage, hazardous and acutely hazardous waste accumulation, Material Safety Data Sheet availability, hazardous waste accumulation areas, and emergency plans. A report indicating any necessary corrective actions and suggestions for any improvements will be provided by the CTAHR-ESS or EHSO.

F. Storage of Material Safety Data Sheets (MSDS).

All chemical manufacturers and suppliers of hazardous chemicals must furnish an MSDS with each initial shipment and furnish new MSDS information upon request. An MSDS will generally contain information such as:

- Chemical composition
- Physical characteristics and chemical properties
- Fire, explosion and reactivity hazards
- Health hazard information and symptoms of overexposure

- Protective equipment recommendations
- Handling and storage precautions
- Cleanup and disposal procedures
- Emergency first aid procedures

Federal and state law requires that written MSDSs must be kept in proximity to the area where products are stored and must be readily available to all employees at any time. MSDSs must also be available for emergency personnel or any state or federal agency that requests them. It is the responsibility of the supervisor in each area to ensure that all MSDSs are kept in an accessible storage area and are updated. If an MSDS is missing or incomplete, it is likely that you can obtain a copy via the internet (see Table 1 for related links) or from the manufacturer. Requests for missing MSDSs should be made in writing and sent by fax, and a copy of the request should be kept in your file.

IV. HAZARDOUS WASTE MANAGEMENT

A. Waste Identification and Classification.

All waste must be identified and then classified as hazardous or non-hazardous according to specific federal and state definitions as summarized below. The CTAHR-ESS (808-956-7918) will assist you in making a determination of whether a waste is hazardous or not. Most facilities produce wastes consistent in character. Therefore, what is often the most confusing aspect of the regulations – characterization and classification – becomes a periodic verification function. The monthly Hazardous Waste Inventory , Attachment (4), documents the waste determination.

1. What is a waste?

A waste is:

- A useless by-product of an operation
- A material which is to be disposed
- Any material which can no longer be used
- A manufacturing or process by-product

2. How do I determine if a waste is hazardous?

a. Contact the CTAHR – Environmental Safety Specialist.

The CTAHR-ESS (808-956-7918) will assist you in making a determination of whether or not a waste is hazardous.

B. Accumulation of Wastes.

1. Limits on Waste Generation.

To maintain the status of conditionally exempt small quantity generator, CTAHR off-campus facilities may not generate more than 100 kilograms (approximately one half of a 55-gallon drum, 27 gallons, or 220 pounds) of hazardous waste in one month. CTAHR off-campus facilities may not generate more than 1 kilogram (2.2 pounds) of acute hazardous waste in one month.

2. Limits on Waste Accumulation.

To maintain the status of conditionally exempt small quantity generator, CTAHR off-campus facilities may not have more than 1000 kilograms (approximately five 55-gallon drums, or 275 gallons, or 2200 pounds) of total accumulated hazardous waste and no more than 1 kilogram (2.2 pounds) of accumulated acute hazardous waste at any time.

3. Designation of Waste Management Area.

CTAHR off-campus facilities generating hazardous waste should establish safe areas near the point of generation for the temporary storage of that waste before disposal by a licensed contractor. These areas should always be neat and orderly in appearance. Containers should not be stacked one on top of another and liquid containers should not be stored on their sides. The CTAHR-ESS will annually, or more frequently if necessary, hire a licensed hazardous waste contractor to transport the waste to an EPA permitted hazardous waste treatment, storage and disposal facility.

C. Storage of Hazardous Waste.

1. Waste Containers.

a. Labeling.

All hazardous waste containers must be labeled with the following:

- The words “**Waste _____.**” (example: Waste Methanol, Waste Hydrochloric Acid, etc.).
- An accurate description of the contents of the container. The manufacturer’s label or a label giving the chemical name and specific hazards (e.g., flammable, corrosive or poison) is acceptable.
- Generic names can be used if a separate list is maintained to indicate the chemical names and the approximate amounts (e.g., "waste chlorinated solvent bottle no. 1" with a separate list "Bottle no. 1 Chloroform 50%, Methyl Chloroform 40%, Methylene Chloride 10%).
- The accumulation start date.

b. Closed Containers.

All hazardous waste containers must remain closed except when waste is being added to them.

c. Containers in Good Condition.

Containers used for wastes must be in good condition (i.e., no rusting, cracks or structural defects). If a container is broken or begins to leak, the material must be transferred to a container in good condition. The container composition must be compatible with the material to be stored and incompatible materials must not be stored in proximity to one another. Package materials in sturdy cardboard boxes or plastic waste containers. Cushion the material in the containers to prevent breakage. If cardboard boxes, which originally held other chemicals, are used, the name of the chemical and any inappropriate hazard markings must be covered over or defaced. Failure to do so constitutes improper marking as to contents and is an EPA and OSHA violation.

d. Containment.

Secondary containment is required for containers with liquid waste under the following circumstances:

1. When the waste is stored in 55-gallon drums.
2. When the waste is stored on the floor.
3. When the waste is stored in a hood which has a drain.
4. When the waste is stored within four (4) feet of a sink.

5. When it necessary to separate incompatible or very high hazardous wastes.

Plastic tubs can be used for as secondary containments. The size secondary container must large big enough to hold the all of the liquid if the primary container breaks. Consult with the Environmental Health and Safety Office at the UH Manoa campus at (808) 956-8660 regarding appropriate containment when a 55-gallon drum is used to collect waste.

e. Separate Incompatible Materials/Waste.

Incompatible materials shall be segregated by HAZARD CLASS, i.e., Toxic-Reactive-Ignitable-Corrosive-Oxidizers. Examples of incompatible materials are: acids/bases, organics/oxidizers, and flammable liquids/oxidizers. Unknowns and high hazard materials such as cyanides, organic peroxides, pyrophorics, water reactives and explosives shall be packaged separately regardless of quantity. Training will be provided to assist in segregation of incompatible materials. If there are any questions, please call the CTAHR-ESS (808-956-7918) for assistance.

D. Hazardous Waste Disposal.

The disposal of hazardous wastes requires that a licensed hazardous waste contractor be hired to dispose of the waste.

1. Drain disposal prohibited.

No hazardous materials/waste may be disposed of down the drain. All liquid (except known clean water) shall be reviewed prior to any drain disposal. In addition, County Ordinances prohibit disposal of certain items down the drain. For example, Hawaii County prohibits the following:

- Fats and greases, if their concentration and physical dispersion results in separation and adherence to sewer structures.
- Storm water, surface water, groundwater, roof runoff, subsurface drainage, cooling water, swimming pool water or other unpolluted drainage.
- Liquid or vapor having a temperature of >150 degrees Fahrenheit.

- Any water or waste containing >100 ppm, by weight, of fat, oil or grease.
- Gasoline, benzene, naphtha, fuel oil, or other flammable or explosive liquid, solid or gas.
- Garbage that has not been properly shredded. Garbage from commercial food establishments is prohibited.
- Ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, paunch manure or any other solid or viscous substance capable of causing obstruction to the flow in sewers.
- Water or wastes having a pH level lower than 5.5 or higher than 11.0 having any other corrosive property capable of causing damage to the sewage works or its personnel.
- Water or wastes containing a toxic or poisonous substance of sufficient quantity to injure or interfere with any sewage treatment process or cause a hazard to humans or animals.
- Noxious or malodorous gas or explosive liquids or substances capable of endangering public property and safety, or creating a public nuisance.

Please check with your local regulations or contact the CTAHR-ESS (808-956-7918) for specific information.

V. EMERGENCY SPILL PROCEDURES.

You must have a specific spill emergency plan and provide information and training to individuals working in your area regarding the plan. It is a good idea to post the emergency procedures and emergency phone numbers in the work area. Personnel working with hazardous chemicals should be able to answer the question: "What would I do if this material spilled?"

Spill kits with instructions, absorbents, reactants, and protective equipment should be available to clean up minor spills. A **minor spill** is one that does not spread rapidly, does not endanger people or property except by direct contact, or does not endanger the environment, and the workers in the area are capable of handling safely without the assistance of safety and emergency personnel. **All other chemical spills are considered major.**

The following are general procedures for the handling of spills.

1. In the event of a spill, attend to anyone who may have been contaminated or hurt, if it can be done without endangering yourself.
2. Turn on the fume hood(s) and open windows where this can be done without endangering yourself.
3. If flammable materials are spilled, de-energize electrical devices if it can be done without endangering yourself.

A. Minor Spills.

- If you have any questions regarding spill clean up requirements, please contact the CTAHR-ESS (808-956-7918), or the Environmental Health and Safety Office (EHSO) at the UH Manoa campus (808-956-8660).
- Ensure protective apparel is resistant to the spilled material. Neutralize acids and bases, if possible, using neutralizing agents such as sodium carbonate or sodium bisulfate.
- Control the spread of liquids by containing the spill. Absorb liquids by adding appropriate absorbent materials, such as vermiculite or sand, from the spill's outer edges toward the center. Paper towels and sponges may also be used as absorbent material, but this should be done cautiously considering the character of the spilled material.
- Collect and contain the cleanup residue and any materials used to clean up the spill by scooping them into a plastic bucket or other appropriate container and properly disposing of the waste as hazardous waste.
- Decontaminate the area and affected equipment. Ventilating the spill area may be necessary.
- Document what happened, why, what was done, and what was learned. Such documentation can be used to avoid similar instances in the future. Major incidents are almost always preceded by numerous near misses.

B. Major Spills.

- If the spill is major, evacuate and secure the area from all personnel.
- If flammable liquid is spilled, secure all ignition sources.
- If the spill is major contact the Fire Department (911), CTAHR-ESS (808-956-7918), or the EHSO at the UH Manoa Campus (808-956-8660).

C. Reporting Requirements.

- After the initial spill response, contact the CTAHR-ESS (808-956-7918) to determine whether there are any federal or state reporting requirements. Some reporting obligations are immediate, and must be made within 24 hours.

VI. SPECIFIC INFORMATION ON THE DISPOSAL OF VARIOUS MATERIALS/WASTE.

The individual possessing or generating the material/waste retains the primary responsibility for the material/waste. The CTAHR-ESS (808-956-7918) provides information on requirements and assistance in handling the materials. Specific information on various types of materials is given below.

BATTERIES: Lithium, nickel/cadmium or mercury batteries shall be stored at the hazardous waste accumulation site for contract disposal. Vehicle batteries are recyclable and arrangements with local vendors can be made. Operations and Maintenance handles disposal of batteries from State vehicles.

BIOLOGICAL MATERIALS: For biohazardous wastes, refer to the published University biohazardous waste disposal guidelines or contact the CTAHR-ESS (808-956-7918) or the EHSO Biological Safety Office (808-956-3197) for information concerning the handling and disposal of biological materials. Remains from dissections shall be properly disposed of.

COMPRESSED GASES: Compressed gas cylinders should be returned to the vendor. A return agreement with the vendor should be included in the contract. Without such an agreement, the return or disposal of the cylinders is difficult and very costly; contact the CTAHR-ESS (808-956-7918) for assistance.

CONTROLLED SUBSTANCES: The handling and disposal of controlled substances (i.e., drugs and other substances listed in 21 CFR 1308) are the responsibility of the permit holder.

FLUORESCENT LIGHT BALLASTS: Older ballasts may contain PCBs; contact the CTAHR-ESS (808-956-7918) for assistance concerning leaking ballast or any ballast known to contain PCBs.

FLUORESCENT LIGHT TUBES: Fluorescent light tubes may contain small amounts of mercury. Please contact the CTAHR-ESS (808-956-7918) for assistance concerning fluorescent light tubes.

HAZARDOUS CHEMICALS AND HAZARDOUS WASTE: The University will annually hire a contractor to dispose of hazardous wastes. Efforts should be made to determine if others could use excess hazardous chemicals in the department or facility prior to submitting for contract disposal. Chemicals considered non-hazardous waste (see "Non-hazardous Waste" below) could be disposed of in the municipal sanitary landfill or sanitary sewer.

MERCURY: Items containing functional mercury (e.g., light switches, barometers and thermometers) shall be stored at a hazardous waste accumulation site for contract disposal.

MIXED WASTE: Mixed waste is defined as materials that possess a radioactive or biological hazard as well as an unrelated chemical hazard (e.g., potassium dichromate solution contaminated with Carbon-14). Contact the CTAHR-ESS (808-956-7918) as applicable for assistance in the proper disposal of these materials.

NON-HAZARDOUS WASTE: Listed in Table 1 below are typical laboratory chemicals which are not considered hazardous wastes by the US Environmental Protection Agency. If the facility refuse contract permits the disposal of the solid chemicals in Table 1, then they can be disposed of as ordinary trash. The containers should be labeled and marked “non-hazardous” to mitigate any concern by the refuse collectors. Alternatively, the materials can be collected for disposal as non-hazardous waste in the periodic waste disposal shipments. Liquid chemicals or chemical solutions can be disposed of to sanitary sewer if the requirements of the applicable country ordinances of the facility industrial waste water discharge permit are met. Alternatively, the materials can be collected for disposal as non-hazardous waste in the periodic waste disposal shipments.

TABLE 1: Non-Hazardous Waste

Sugars (e.g., sucrose, glucose, mannose)	Silica Gel
Starch	Alumina (aluminum oxide)
Naturally occurring Amino Acids	Calcium Fluoride
Citric Acid and its Sodium, Potassium, Magnesium, Calcium and Ammonium Salts	Lactic Acid and its Sodium, Potassium, Magnesium, Calcium and Ammonium Salts
Sodium, Potassium, Calcium, Strontium, and Ammonium Sulfates	Sodium, Potassium, Calcium, Magnesium, Strontium, and Ammonium Phosphates
Sodium, Potassium, Magnesium and Ammonium Chlorides	Sodium, Potassium, Magnesium and Calcium Borates
Silicon Dioxide	Sodium, Potassium, Ammonium Acetates
Boron, Magnesium, Copper Oxides	Sodium, Potassium, Magnesium, Calcium and Ammonium Carbonates

OILS AND TRANSFORMER FLUID: The CTAHR-ESS will assist with disposal of used pump oil. Used motor oil is recyclable through local vendors. Operations and Maintenance handle used motor oil from University vehicles.

Transformer fluid will be handled on a case-by-case basis, contact the CTAHR-ESS (808-956-7918) for assistance.

The following requirements apply to used oil:

- Used oil may only be stored in containers that are in good condition and not leaking.
- Containers, aboveground storage tanks, and fill pipes must be labeled or marked clearly with the words “**Used Oil.**”
- Upon detection of a release of used oil, a generator must stop the release, contain the used oil, clean up and manage properly the used oil and other materials, and if necessary, repair or replace any leaking used oil storage containers. If a release of used oil occurs, contact the CTAHR-ESS (808-956-7918) for information regarding cleanup, and special regulatory reporting requirements that may apply.

PESTICIDES: Pesticides, Herbicides, Insecticides, Fungicides, etc. are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Please attempt to buy only amounts needed and not in large containers if only a few ounces are needed. Expired pesticides, those with invalid registrations, or expired experimental use formulations are expensive to dispose. Arrangements should be made with the manufacturer to return the unused materials if possible. Restricted Use pesticides may only be used under the direct supervision of Faculty or Staff with valid Restricted Use licenses.

PHOTOGRAPHIC CHEMICALS: Photographic fixer must be stored in capped container and labeled, “Fixer for Recycling”. Photographic fixer solution may contain silver salts after use. Silver is an EPA toxic characteristic waste and must be recycled or disposed of as a hazardous waste. If your facility has a silver recovery unit, it should be used to process the used fixer in accordance with the manufacturing instructions. This would include ensuring that the effluent from the unit meets the requirements for safe drain disposal and that the unit filter, when full, is sent for recycling. If your facility does not have a silver recovery unit, there are contractors who will furnish one for a fee or for the value of the silver recovered. Alternatively, the used fixer solution can be handled and disposed of as a hazardous waste.

RADIOACTIVE MATERIALS: Refer to the University Radiation Safety Manual or contact the CTAHR-ESS (808-956-7918) or the EHSO Radiation Safety Office (808-956-6475) for information concerning the proper handling and disposal of radioactive material.

SHARPS AND GLASSWARE: Glassware not contaminated with radiological, biological or hazardous chemical material shall be placed in a puncture resistant container labeled "glass" or "broken glass". Refer to the published University biohazardous waste disposal guidelines or contact the CTAHR-ESS (808-956-7918) for information on the handling and disposal of sharps or glassware contaminated with biological or infectious material. Refer to the University Radiation Safety Manual or contact the CTAHR-ESS (808-956-7918) for information on the proper handling and disposal of sharps or glassware contaminated with radioactive material. Glassware or sharps contaminated with hazardous chemicals should be rinsed to decontaminate them and then disposed of as non-contaminated glassware or sharps (i.e., placed in a sharps container). Broken glassware contaminated with hazardous chemicals should be placed in a puncture resistant container (e.g., bottle, plastic container or can overpack), labeled with the name of the chemical and disposed of as hazardous chemical waste.

VII. HAZARDOUS WASTE MINIMIZATION.

A. Buying Chemicals in Smaller Amounts.

The "large economy size" may cost less to buy, but disposal costs, in most cases, are several times the initial cost of the material. Many of the bottles of excess or waste chemicals sent for disposal are full or 3/4 full. Everyone needs to try to accurately estimate the amount of a chemical they expect to use.

B. Recycling and Redistribution.

Efforts should be made to find someone in the laboratory or department who can use the hazardous material before it is submitted to the CTAHR-ESS as waste for contract disposal.

C. Use of Less Hazardous or Non-hazardous Materials.

The following provides some examples of the use of less hazardous or non-hazardous materials; everyone is encouraged to think of some others which may be applicable to their research or instructional materials.

1. Cleaning Solutions. Chromerge, chromic acid and dichromate cleaning solutions are not desirable from a waste disposal prospective, as they cannot be made non-hazardous and are expensive to dispose of. There are many non-toxic biodegradable cleaning solutions that can be used instead of chromic acid. For extremely dirty glassware a product called Nochromix, which uses sulfuric acid and an organic oxidizer in place of chromium can be used. While this requires neutralization of the acid for ordinary disposal, it is far less costly to dispose of than chromium solutions. A number of alternative cleaning solutions are listed below. These are all available from Fisher Scientific, who has the University

contract for laboratory supplies. NoChromix, Alconox, Liquinox liquid detergent, Citranox, Fisherbrand sparkleen, and FL-70 Concentrate.

2. Drying Agents. The safest common drying agents are calcium chloride, silica gel, molecular sieves and calcium sulfate (Drierite). These are recommended because of their low toxicity and stability. Drying agents that pose varying degrees of hazard and disposal problems include:

- Phosphorus pentoxide, which generates highly corrosive phosphoric acid and heat on contact with water. This material also has to be disposed of as a hazardous waste.
- Magnesium perchlorate (Dehydrite) is a strong oxidizer, which may cause fires or explosions on contact with organic materials. This material has to be disposed of as a hazardous waste.

3. Thermometers. Mercury thermometers should be replaced with non-mercury thermometers whenever possible. Broken mercury thermometers create spills that are a potential health hazard, time consuming to clean up, and are one of the most expensive hazardous wastes we handle. Non mercury thermometers with equivalent accuracy are available for temperature ranges of -20 to 250 degrees Centigrade. Contact EHSO or check your laboratory supply catalog for more information. **If mercury-containing equipment is used, then a mercury spill kit and personnel knowledgeable about its use is required in the laboratory or facility.**

• **TABLE 1. INTERNET MSDS SITES**

Where to Find MSDS on the Internet from the University of Kentucky	http://www.ilpi.com/msds/index.html
Vermont SIRI--Safety Information Resources on the Internet	http://hazard.com/
Fisher Scientific	http://www.fisher1.com
University of Georgia, MSDS Database	http://www.esd.uga.edu/rtk/msds.htm
University of Oklahoma Glossary of MSDS Terms	http://www.pp.okstate.edu/ehs/hazcom
Oregon State University MSDS Database	http://www.property.orst.edu/Property/msds/msds.htm
Stanford University MSDS Database	http://goddard.stanford.edu/msds/

ATTACHMENTS

**COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES
PROCUREMENT AUTHORIZATION FOR HAZARDOUS MATERIALS**

An approved (signed) copy of this form must accompany any *request*, purchase order or requisition for the procurement of the hazardous materials listed on pages 2 to 8 of "Attachment (1)."

.....
NAME: _____
 (Requestor/Requisitioner)

DEPARTMENT/UNIT: _____ PHONE NO.: _____
 LOCATION: _____ PURCHASE ORDER NO.: _____

Chemical Name	Solid/Liquid/Gas	Amount (gallon, lbs)	Usage Plan	Estimated Usage Period

Requestor/Requisitioner: _____ **DATE:** _____
 (Signature)

PLEASE SEND THE COMPLETED FORM TO: CTAHR – Environmental Safety Specialist
 (CTAHR-ESS), 2040 E-W Road, Honolulu, HI 96822.

FOR CTAHR-ESS USE ONLY

CTAHR-ESS APPROVAL: _____ DATE: _____

APPROVAL NO.: _____

LIST OF CHEMICALS REQUIRING CTAHR ENVIRONMENTAL SAFETY SPECIALIST APPROVAL TO PURCHASE

Because the following chemicals are highly toxic, explosive, water reactive or for other reasons very difficult and expensive to dispose of (disposal costs can be more than \$1,000 per container) their use needs to be minimized and monitored. Contact the CTAHR-ESS (808) 956-7918 for further information.

All Restricted Use Pesticides

Arsine
Boron Trichloride
Boron Trifluoride
Bromine Chloride
Butyl Lithium
Carbon Monoxide
Carbonyl Sulfide
Cesium
Calcium Hydride
Chlorine
Chlorine Trifluoride
Chloropicrin
Cyanogen
Cyanogen Chloride
Diborane
3,5-Dinitrophenol
2,4-Dinitrophenylhydrazine
3,5-Dinitrosalicylic Acid
Ethylene Oxide
Fluorine
Hydrogen Bromide
Hydrogen Chloride
Hydrogen Cyanide
Hydrogen Fluoride
Hydrogen Sulfide
Lithium
Lithium Aluminum Hydride
Lithium Hydride

Methyl Amine
Methyl Bromide
Methyl Chloride
Methyl Lithium
Nitric Oxide
Nitrogen Dioxide
Nitrogen Trifluoride
Phosgene
Phosphine
Phosphorus
Picfume
Picric Acid
Picryl Sulfonic Acid
Picramide
Potassium
Rubidium
Silane
Silane Dichloride
Sodium
Sulfur Dioxide
Trinitroaniline
Trinitrobenzene
Trinitrocresol
Trinitronaphthalene
Trinitrophenol
Trinitrotoluene
Urea Nitrate
Vinyl Chloride

Acetaldehyde, chloro-
Acetamide, N-(aminothioxomethyl)-
Acetamide, 2-fluoro-
Acetic acid, fluoro-, sodium salt
1-Acetyl-2-thiourea
Acrolein
Aldicarb
Aldicarb sulfone.
Aldrin
Allyl alcohol
Aluminum phosphide (R,T)
5-(Aminomethyl)-3-isoxazolol
4-Aminopyridine
Ammonium picrate (R)
Ammonium vanadate
Argentate(1-), bis(cyano-C)-,potassium
Arsenic acid H_3AsO_4
Arsenic oxide As_2O_3
Arsenic oxide As_2O_5
Arsenic pentoxide
Arsenic trioxide
Arsine, diethyl-
Arsonous dichloride, phenyl-
Aziridine
Aziridine, 2-methyl-
Barium cyanide
Benzenamine, 4-chloro-
Benzenamine, 4-nitro-
Benzene, (chloromethyl)-
1,2-Benzenediol, 4-[1-hydroxy-2- (methylamino)ethyl]-, (R)-
Benzeneethanamine, alpha,alpha-dimethyl-
Benzenethiol
7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate.
Benzoic acid, 2-hydroxy-, compd. with (3aS-cis)-1,2,3,3a,8,8a- 1,3a,8-trimethylpyrrolo[2,3-
b]indol-5- yl methylcarbamate ester (1:1).
2H-1-Benzopyran-2-one, 4-hydroxy-3-(3- oxo-1-phenylbutyl)-, & salts, present at concentrations
greater than 0.3%
Benzyl chloride
Beryllium powder
Bromoacetone
Brucine
2-Butanone, 3,3-dimethyl-1- (methylthioO-[methylamino]carbonyl] oxime
Calcium cyanide
Calcium cyanide $\text{Ca}(\text{CN})_2$
Carbamic acid, [(dibutylamino)- thio]methyl-, 2,3-dihydro-2,2- dimethyl- 7-benzofuranyl ester.

Carbamic acid, dimethyl-, 1-[(dimethyl- amino)carbonyl]- 5-methyl-1H- pyrazol- 3-yl ester.
 Carbamic acid, dimethyl-, 3-methyl-1- (1-methylethyl)-1H- pyrazol-5-yl ester.
 Carbamic acid, methyl-, 3-methylphenyl ester.
 Carbofuran.
 Carbon disulfide
 Carbonic dichloride
 Carbosulfan.
 Chloroacetaldehyde
 p-Chloroaniline
 1-(o-Chlorophenyl)thiourea
 3-Chloropropionitrile
 Copper cyanide
 Copper cyanide Cu(CN)
 m-Cumenyl methylcarbamate.
 Cyanides (soluble cyanide salts), not otherwise specified
 Cyanogen
 Cyanogen chloride
 Cyanogen chloride (CN)Cl
 2-Cyclohexyl-4,6-dinitrophenol
 Dichloromethyl ether
 Dichlorophenylarsine
 Dieldrin
 Diethylarsine
 Diethyl-p-nitrophenyl phosphate
 O,O-Diethyl O-pyrazinyl phosphorothioate
 Diisopropylfluorophosphate (DFP)
 1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro-1,4,4a,5,8,8a,-hexahydro-,
 (1alpha,4alpha,4abeta,5alpha,8alpha,8abeta)-
 1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro1,4,4a,5,8,8a-hexahydro-,
 (1alpha,4alpha,4abeta,5beta,8beta,8abeta)-
 2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro1a,2,2a,3,6,6a,7,7a-octahydro-,
 (1aalpha,2beta,2aalpha,3beta,6beta,6a alpha,7beta, 7aalpha)-
 2,7:3,6-Dimethanonaphth [2,3- b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-,
 (1aalpha,2beta,2abeta,3alpha,6alpha,6 abeta,7beta, 7aalpha)-, & metabolites
 Dimethoate
 alpha,alpha-Dimethylphenethylamine
 Dimetilan.
 4,6-Dinitro-o-cresol, & salts
 2,4-Dinitrophenol
 Dinoseb
 Diphosphoramidate, octamethyl-
 Diphosphoric acid, tetraethyl ester
 Disulfoton
 Dithiobiuret
 1,3-Dithiolane-2-carboxaldehyde, 2,4- dimethyl-, O- [(methylamino)- carbonyl]oxime.

Endosulfan
Endothall
Endrin
Endrin, & metabolites
Epinephrine
Ethanedinitrile
Ethanimidithioc acid, 2- (dimethylamino)-N-[[[(methylamino) carbonyl]oxy]-2-oxo-, methyl ester.
Ethanimidithioic acid, N-[[[(methylamino)carbonyl]oxy]-, methyl ester
Ethyl cyanide
Ethyleneimine
Famphur
Fluorine
Fluoroacetamide
Fluoroacetic acid, sodium salt
Formetanate hydrochloride.
Formparanate.
Fulminic acid, mercury(2+) salt (R,T)
Heptachlor
Hexaethyl tetraphosphate
Hydrazinecarbothioamide
Hydrazine, methyl-
Hydrocyanic acid
Hydrogen cyanide
Hydrogen phosphide
Isodrin
Isolan.
3-Isopropylphenyl N-methylcarbamate.
3(2H)-Isoxazolone, 5-(aminomethyl)-
Manganese bis(dimethylcarbomodithioato-S,S')-,
Manganese dimethyldithiocarbamate.
Mercury, (acetato-O)phenyl-
Mercury fulminate (R,T)
Methanamine, N-methyl-N-nitroso-
Methane, isocyanato-
Methane, oxybis[chloro-
Methane, tetranitro- (R)
Methanethiol, trichloro-
Methanimidamide, N,N-dimethyl-N'-[3- [[[(methylamino)-carbonyl]oxy]phenyl]- ,
monohydrochloride.
Methanimidamide, N,N-dimethyl-N'-[2- methyl-4- [[[(methylamino)carbonyl]oxy]phenyl]-
6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-,3-
oxide
4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
Methiocarb.

Methomyl
Methyl hydrazine
Methyl isocyanate
2-Methylactonitrile
Methyl parathion
Metolcarb.
Mexacarbate.
alpha-Naphthylthiourea
Nickel carbonyl
Nickel carbonyl Ni(CO)₄, (T-4)-
Nickel cyanide
Nickel cyanide Ni(CN)₂
Nicotine, & salts
Nitric oxide
p-Nitroaniline
Nitrogen dioxide
Nitrogen oxide NO
Nitrogen oxide NO₂
Nitroglycerine (R)
N-Nitrosodimethylamine
N-Nitrosomethylvinylamine
Octamethylpyrophosphoramidate
Osmium oxide OsO₄, (T-4)-
Osmium tetroxide
7-Oxabicyclo[2.2.1]heptane-2,3- dicarboxylic acid
Oxamyl.
Parathion
Phenol, 2-cyclohexyl-4,6-dinitro-
Phenol, 2,4-dinitro-
Phenol, 2-methyl-4,6-dinitro-, & salts
Phenol, 2-(1-methylpropyl)-4,6-dinitro-
Phenol, 2,4,6-trinitro-, ammonium salt (R)
Phenol, 4-(dimethylamino)-3,5-dimethyl-, methylcarbamate (ester).
Phenol, (3,5-dimethyl-4-(methylthio)-, methylcarbamate
Phenol, 3-(1-methylethyl)-, methyl carbamate.
Phenol, 3-methyl-5-(1-methylethyl)-, methyl carbamate.
Phenylmercury acetate
Phenylthiourea
Phorate
Phosgene
Phosphine
Phosphoric acid, diethyl 4-nitrophenyl ester
Phosphorodithioic acid, O,O-diethylS-[2-(ethylthio)ethyl] ester
Phosphorodithioic acid, O,O-diethylS-[(ethylthio)methyl] ester
Phosphorodithioic acid, O,O-dimethyl S- [2-(methylamino)-2-oxoethyl] ester

Phosphorofluoridic acid, bis(1- methylethyl) ester
Phosphorothioic acid, O,O-diethyl O-(4- nitrophenyl) ester
Phosphorothioic acid, O,O-diethyl O- pyrazinyl ester
Phosphorothioic acid, O-[4- [(dimethylamino)sulfonyl]phenyl] O,O- dimethyl ester
Phosphorothioic acid, O,O,-dimethyl O- (4-nitrophenyl) ester
Physostigmine.
Physostigmine salicylate.
Plumbane, tetraethyl-
Potassium cyanide
Potassium cyanide K(CN)
Potassium silver cyanide
Promecarb
Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime
Propanal, 2-methyl-2-(methyl-sulfonyl)- , O-[(methylamino)carbonyl] oxime.
Propanenitrile
Propanenitrile, 3-chloro-
Propanenitrile, 2-hydroxy-2-methyl-
1,2,3-Propanetriol, trinitrate (R)
2-Propanone, 1-bromo-
Propargyl alcohol
2-Propenal
2-Propen-1-ol
1,2-Propylenimine
2-Propyn-1-ol
4-Pyridinamine
Pyridine, 3-(1-methyl-2-pyrrolidinyl)- , (S)-, & salts
Pyrrolo[2,3-b]indol-5-ol, 1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethyl-,methylcarbamate (ester), (3aS-cis)-.
Selenious acid, dithallium(1+) salt
Selenourea
Silver cyanide
Silver cyanide Ag(CN)
Sodium azide
Sodium cyanide
Sodium cyanide Na(CN)
Strychnidin-10-one, & salts
Strychnidin-10-one, 2,3-dimethoxy-
Strychnine, & salts
Sulfuric acid, dithallium(1+) salt
Tetraethyldithiopyrophosphate
Tetraethyl lead
Tetraethyl pyrophosphate
Tetranitromethane (R)
Tetraphosphoric acid, hexaethyl ester
Thallic oxide

Thallium oxide Tl_2O_3
Thallium(I) selenite
Thallium(I) sulfate
Thiodiphosphoric acid, tetraethyl ester
Thiofanox
Thioimidodicarbonic diamide $[(H_2N)C(S)]_2NH$
Thiophenol
Thiosemicarbazide
Thiourea, (2-chlorophenyl)-
Thiourea, 1-naphthalenyl-
Thiourea, phenyl-
Tirpate.
Toxaphene
Trichloromethanethiol
Vanadic acid, ammonium salt
Vanadium oxide V_2O_5
Vanadium pentoxide
Vinylamine, N-methyl-N-nitroso-
Warfarin, & salts, when present at concentrations greater than 0.3%
Zinc, bis(dimethylcarbamo-dithioato- S,S')-,
Zinc cyanide
Zinc cyanide $Zn(CN)_2$
Zinc phosphide Zn_3P_2 , when present at concentrations greater than 10% (R,T)
Ziram

**UNIVERSITY OF HAWAII
ENVIRONMENTAL HEALTH & SAFETY OFFICE
HAZARDOUS MATERIAL MANAGEMENT PROGRAM
APPROVAL FOR THE USE OF HAZARDOUS MATERIAL**

1. **Principal Investigator:** _____
2. **Project Title:** _____
3. If your project will involve any of the types of hazardous materials listed below, please provide a list of the chemical name(s) and approximate amounts of the materials to be used, information on how the material will be used and stored, also information on any special safety measures that will be taken. The information is needed to ensure the materials are stored, used and disposed of in accordance with the applicable Federal and State regulations.
 - a) **Explosive materials** (e.g., ammonium perchlorate, picric acid or picrates, azides, acetylides or fulminates of heavy metals, aromatic di or tri nitro compounds such as dinitrophenol or trinitrotoluene, nitroglycerine, RDX and tetrazene).
 - b) **Water reactive chemicals** (e.g., alkali metals such as sodium, potassium or lithium; metal hydrides such as lithium aluminum hydride, sodium borohydride or lithium hydride; calcium carbide, ethyldichlorosilane and phosphides).
 - c) **Flammable or poison gases** (e.g. methane, ethylene, chlorine, phosgene and hydrogen sulfide).
 - d) **Organic peroxides** (e.g., methyl ethyl ketone peroxide or peracetic acid).
 - e) **Highly toxic materials** (e.g., cyanides, osmium tetroxide, phosphorus, strychnine, pentaborane, or any material with a LD₅₀ [oral rat] of 50mg/kg or less).
 - f) **Flammable liquids** (i.e., materials with a flash point of 140 degrees Fahrenheit or less) in quantities of 60 gallons or more at any one time.
4. If your project will involve the use of controlled substances (i.e., materials listed in 21 CFR 1308 by the U.S. Drug Enforcement Agency such as cocaine, chloral hydrate, morphine, and sodium barbital), provide the number of the required Federal or State permit for possession and use of these materials.
5. I agree to: (1) comply with the University of Hawaii at Manoa Hazardous Material Management Program (HMMP) requirements and any additional requirements provided by the Environmental Health and Safety Office that are necessary to ensure compliance with Federal and State regulations, (2) inform the Environmental Health and Safety Office if there are any amendments to the project which affect the types of hazardous material listed above, and (3) transfer or properly dispose of all my hazardous material as specified in the HMMP prior to leaving the University or transferring to a different laboratory. I believe the above information is accurate and complete.

PRINCIPAL INVESTIGATOR (Signature)

DATE

DEPARTMENT CHAIRPERSON (Signature)

DATE

PLEASE SEND THE COMPLETED FORM TO: EHSO 2040 East-West Road Attention: Hazardous Materials Management Officer. The Hazardous Materials Management Officer may be contacted at 956-3198 or Fax 956-3205, if you have questions.

6. The use of the hazardous materials listed above is approved subject to the special requirements listed below.

HAZARDOUS MATERIALS MANAGEMENT OFFICER (Signature)

DATE

SPECIAL REQUIREMENTS (To Be Completed by Hazardous Materials Management Officer): _____

**COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES
HAZARDOUS WASTE INVENTORY FORM (MONTHLY)**

This form assists the CTAHR with proper management of our hazardous waste. If you have any hazardous or non-hazardous waste being stored for disposal, please provide the information requested. If additional space is needed, you may use an attached sheet using the same format. If at a later date you generate wastes not previously listed, please submit an amended form. **The CTAHR-ESS or EHSO will complete columns 7 and 8, DOT Class and EPA Waste Code.**

Chemical Name/Product (Chemical constituents)	Physical State (solid, liquid or solution)	Amount (gal, lbs)	Container Size	Container Type	Hazard Category	DOT Class (EHSO only)	EPA Waste Code (EHSO only)

DESIGNATED FACULTY/STAFF:

_____ **PHONE NO.:** _____ **LOCATION:** _____
(Printed Name)

_____ **Date:** _____
(Signature)

PLEASE SEND THE COMPLETED FORM TO: CTAHR Environmental Safety Specialist. The CTAHR-ESS may be contacted at (808) 956-7918, if you have any questions.

Weight and Volume Conversion Tables

The following tables are provided for convenience to those using the waste turn in form. Numbers are approximations and have been rounded off.

I. Weights: grams to pounds 1 gram = 0.0022 pounds

<5 grams = 0.01 pounds (per instructions all weights less than 5 grams or 0.01 pounds are to be reported as 0.01 pounds)

5 grams = 0.01 pounds

10 grams = 0.02 pounds

20 grams = 0.04 pounds

30 grams = 0.07 pounds

40 grams = 0.09 pounds

50 grams = 0.11 pounds

100 grams = 0.22 pounds

500 grams = 1.10 pounds

II. Volumes: liters to gallons 1 liter = 0.2642 gallons

≤ 40 ml = 0.01 gal (per instructions all volumes ≤ 40 ml are reported as 0.01 gal.)

50 ml = 0.01

60 ml = 0.02

100 ml = 0.03

150 ml = 0.04

200 ml = 0.05

300 ml = 0.08

400 ml = 0.11

500 ml = 0.13

600 ml = 0.16

700 ml = 0.18

800 ml = 0.21

900 ml = 0.24

1 liter = 0.26

1.5 liters = 0.40

2 liters = 0.53

2.5 liters = 0.66

3 liters = 0.79

4 liters = 1.06

0.5 pints (8 oz) = 0.06 gallons

1 pint (16 oz) = 0.13 gallons

1 quart (32 oz) = 0.25 gallon