Administrative Information

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| School |  | Department |  |
| PI name |  | PI email |  |
| Lab manager name (if applicable) |  | Lab manager email (if applicable) |  |
| Locations covered by this SOP (buildings/rooms) |  | | |
| SOP version number |  | SOP approval date |  |
| Reviewed and approved by (name) |  | Reviewed and approved by (initials) |  |
| **Emergency contact name** |  | **Emergency contact phone\*** |  |
| Secondary emergency contact name |  | Secondary emergency contact phone\* |  |
| \* Provide emergency contact phone numbers that will be active both during normal work hours and after hours, e.g., personal mobile phone. Alternatively, give separate daytime and after-hours numbers for both contacts. | | | |

SOP Requirements

Instructions document You are responsible for reading the [SOP Instructions](https://tiny.cc/usc-sop-instructions) outlining roles, responsibilities, and other important safety information. In addition, you must include that document as part of your records.

Recordkeeping Acknowledgement forms for this SOP and any associated training are included at the end of this document. Additional copies of the forms are available online ([SOP Acknowledgement](https://tiny.cc/usc-sop-acknowledgement), [Internal Training Record](https://tiny.cc/usc-sop-training)).

Customization It is intended that personnel add lab-specific information to the SOP template to produce a finished and functional SOP. Suggested places to add customization are highlighted in yellow throughout the document.

Standard (Safe) Operating Procedure: CYANIDES

Scope This SOP covers substances which produce cyanide ion in solution and which display the high acute toxicity characteristics of cyanide. Organic cyano compounds which do not dissociate into cyanide ion (e.g. nitriles such as acetonitrile) and inorganic thiocyanates and cyanates exhibit much lower toxicity and do not need to be handled under this SOP.

Hexacyanoferrates (II or III) are virtually non-toxic and do not need to be handled with the same precautions as acutely toxic cyanides. That is, however, with one exception: Addition of strong acids to hexacyanoferrates may liberate highly toxic hydrogen cyanide gas and thus, this must be avoided at all costs.

Background: Cyanide Toxicity Cyanide ion strongly complexes the active metal site in a number of enzyme systems which are essential for life, most notably, cytochrome c oxidase which is necessary for cells to use oxygen and produce energy. Exposure of cells to cyanide causes rapid dysfunction and death. In the human body, the effects of cyanide poisoning manifest most severely in those organs that have the highest energy and oxygen requirements, especially the central nervous system.

As a poison, cyanide has some unusual characteristics. The rapidity of the toxic effect of a sizeable dose of cyanide is extraordinarily fast, much quicker than almost all other poisons. Substantial cyanide exposure can cause almost immediate collapse and unconsciousness, rapidly followed by convulsions, with death ensuing within a few minutes. As illustrated above, the acute toxicity of cyanide is extremely high. For example, a fatal dose of hydrogen cyanide is 50 mg or less.

Cyanides are highly acutely toxic by all routes of absorption (inhalation, ingestion, skin or eye contact, injection under the skin). The main difference between the routes is the speed of absorption and thus, the speed with which symptoms may appear. Inhalation of hydrogen cyanide (a highly volatile liquid or gas) may cause life threatening symptoms within seconds. Ingestion can cause symptoms within 30 seconds to a few minutes depending on the quantity of cyanide. Symptoms from skin contact are generally the slowest to appear. Substantial spillage of cyanide solution on the skin may result in a fatal dose of cyanide being absorbed within minutes, although symptoms may be further delayed as the cyanide slowly diffuses into the body.

Symptoms of poisoning may include severe pain, skin burns, and deep ulcers from skin contact with solutions, irritation to the nose, throat, and lungs from breathing solid cyanide dust, and may also result in headache, dizziness, fast heartbeat, nausea and vomiting, sudden collapse, unconsciousness, convulsion, and death.

Despite the extreme acute toxicity, the chronic toxicity of cyanide is low on account of the human body having an inbuilt detoxification mechanism. The body oxidizes cyanide to low toxicity thiocyanate which is excreted. The detoxification mechanism is an evolutionary adaptation to naturally occurring cyanides in foods (e.g. apple pips) and cyanide produced within the body as a byproduct of biochemical processes. Chronic exposure is not, however, without effects. Long-term exposure to sodium cyanide, for example, may lead to cancer, possible teratogenic effects, thyroid gland enlargement, changes in blood cell count, and nose discharge, bleeds and sores.

[Cal-OSHA permissible exposure limit](https://www.dir.ca.gov/title8/5155table_ac1.html) (PEL) for contained cyanides is 5 mg/m3. Per this definition, cyanide exposure should be virtually zero but should never exceed an average value of 5 mg/m3 over an 8 hour work day. The Cal-OSHA PEL and ceiling limit for hydrogen cyanide is 5 mg/m3.

Please note: Hydrogen cyanide is readily produced in small amounts when working with cyanide solutions and solids. When these same materials are used in conjunction with acids, large amounts of hydrogen cyanide will be released.

Hazard identification Common ionic cyanides are white crystalline solids or powders (e.g. NaCN) or colorless gases (e.g. HCN). As previously stated, such compounds will readily produce hydrogen cyanide gas upon contact with acids. According to the Centers for Disease Control and Prevention (CDC), hydrogen cyanides may have an almond-like odor but do not always give off a smell and not everyone can detect this odor as 1 in 4 people are genetically predisposed not to. According to California Proposition 65, hydrogen cyanide and cyanide salts are also regulated as reproductive toxicants. (<https://oehha.ca.gov/proposition-65/proposition-65-list>)

Taking sodium cyanide as an example, within the OSHA/GHS hazard classification system (used in supplier’s labelling and safety data sheets (SDSs)), this material is classified as:

Acute toxicity, Oral (Category 1)

Acute toxicity, Inhalation (Category 1)

Acute toxicity, Dermal (Category 1)

Specific target organ toxicity- repeated exposure (Category 1)

With category 1 representing the most severe hazard category, sodium cyanide is highly acutely toxic by oral, inhalation, and dermal exposure and for specific target organ toxicity through prolonged or repeated exposure.

Please refer to Section 6 of the [CHP](http://tiny.cc/chem-hygiene-plan) for a detailed explanation of the OSHA/GHS hazard classification system. **All personnel who agree to abide by this SOP are required to familiarize themselves with the contents of Section 6 of the CHP.**

PHS Cyanides fall under the Cal-OSHA definition of *Particularly Hazardous Substances* (PHS) which require additional precautions in use ([8 CCR §5191](https://www.dir.ca.gov/title8/5191.html); also see *SOP Instructions* document). Please refer to the [CHP](http://tiny.cc/chem-hygiene-plan) (Sections 6 and 8[[1]](#footnote-1)) for more information on the classification and identification of PHS, and safe practices for working with these materials.

Specific substances [Add details of specific substances you will be using in the lab under this SOP, e.g. Sodium cyanide.]

Designated work areas/signage Work with cyanides should be done at designated areas within the lab (e.g. a chemical fume hood) which should be signed “Warning—Highly Acute Toxicant area” (or equivalent wording). If highly hazardous work is being performed, additional signage giving the name of the responsible individual and contact number is also recommended.

Cyanides shall NOT be used in areas which do not have ready access to a safety shower/eyewash. For more detailed information about eye wash and safety shower requirements please reference the CHP (Section 4, Subsection *Emergency Equipment and Supplies*).

[Add lab-specific work area and signage information here, if needed.]

Unattended experiments Unattended hazardous experiments should be signed according to the requirements of the [Unattended Experiments Fact Sheet](https://tiny.cc/usc-unattended-operations).

Storage Requirements Cyanides should be stored under conditions of satisfactory physical security, preferably in a locked cabinet in a restricted access room. **Unauthorized personnel shall not have access to cyanides**. An access and usage log is highly recommended.

Acute toxicants, like cyanides, should be stored in labelled secondary containment, preferably enclosed by a tight fitting lid. Acute toxicants shall not be stored under a sink and segregation of acute toxicants within a dedicated poisons cabinet may also be appropriate.

Acute toxicants should be stored upright, below eye level and in a well-ventilated area. **Keep acute toxicants segregated from incompatibles (e.g. acids, strong oxidizing agents, carbon dioxide)**.

Inventories of very highly health hazardous chemicals should be kept to a minimum. Unused inventory should be disposed of as hazardous waste at the end of research projects, unless there is reasonable probability that the material will be required again within the next 6-12 months.

Please refer to the CHP (Section 7) for further information on storage and inventory-keeping requirements.

Labelling Cyanides not in active use shall be labelled to indicate the hazard. Acute toxicant storage areas (cupboards, shelves, or secondary containment) shall be labelled “Danger! Acute Toxicants” (printable labels are available from the EH&S website).

Please note: Hydrogen cyanide and cyanide salts are also regulated as reproductive toxicants per Proposition 65. Thus, these materials shall also be labelled “Danger! Reproductive Toxicants” (printable labels are available from the EH&S website).

Please refer to the CHP (Section 5) for detailed requirements for hazardous materials labelling.

Personal Protective Equipment Appropriate PPE shall be worn for all work with hazardous materials, in accordance with the USC [Minimum Standard](https://tiny.cc/usc-ppe-standard), [CHP](http://tiny.cc/chem-hygiene-plan), and [fact sheets](https://tiny.cc/usc-ehs-fact-sheets). Most commonly, research lab PPE consists of a lab coat, eye protection (safety glasses; goggles required if there is a splash hazard) and chemical protective gloves. A face shield may be needed in addition to goggles for severe splash hazards. Note that for reasons of safety and regulatory compliance, respirator usage is NOT permitted outside of the [USC Respiratory Protection Program](https://tiny.cc/usc-ehs-RPP-fs). Please refer to the CHP (Section 8) and [EH&S Fact Sheets](https://tiny.cc/usc-ehs-fact-sheets) for additional information about PPE requirements.

[Add details of any lab- or procedure-specific PPE rules/requirements.]

Exposure control To prevent exposure of personnel, appropriate engineering safety controls (e.g. a chemical fume hood) shall be used for all work with cyanide powders, concentrated solutions or any situation when hydrogen cyanide or other volatile gases are produced. Keep acids out of the chemical fume hood unless needed for the experiment. If needed, keep quantity to a minimum.

Please consult the CHP (Section 8) for detailed information on engineering safety controls.

Decontamination All work areas and equipment is to be cleaned and decontaminated after use, first with use of a pH 10 buffer solution, followed by cleaning with a freshly prepared 10% bleach solution. Cleaning activities should be completed only within the chemical fume hood.

Potentially contaminated PPE shall be removed before entering clean areas. Hands shall be washed before entering clean areas and after completion of work.

[If specific decontamination/cleaning procedures are required please enter details here.]

Work practices **Cyanides should not be handled while working alone**. Cyanides should be kept secured with a lock and access to the work and storage areas should be restricted. Purchasing, working and storage quantities should be kept as small as possible. Any unused materials should be immediately and appropriately disposed of as hazardous chemical waste.

Cyanide powders shall NOT be weighed in the open lab. Use a balance in a fume hood if possible. When preparing solutions, it is important to add small volumes of cyanide powder to large volumes of water (as opposed to adding small volumes of water to cyanide powder).

[Add details of specific work practices you will be using in the lab under this SOP. Work practices are rules which personnel are required to follow to be safe, for example, that certain procedures may not be done out-of-hours or alone. Work practices can also be a defined way of doing things, for example, diluting concentrated acids by pouring the acid slowly into water while stirring, with a prohibition on pouring water into the acid.]

Experimental procedures [Add details of specific experimental procedures/protocols you will be using in the lab under this SOP]

Waste disposal Contaminated materials shall be disposed as hazardous chemical waste. Please follow all EH&S directions ([hazmat webpages](https://ehs.usc.edu/hazmat/), [fact sheets](https://tiny.cc/usc-ehs-fact-sheets), [CHP](http://tiny.cc/chem-hygiene-plan)). Please email [hazmat@usc.edu](mailto:hazmat@usc.edu) if you have questions that are not answered by EH&S online resources.

[Add details of any lab-specific waste disposal rules.]

Spill response **The high toxicity posed by cyanide compounds makes it inadvisable for lab personnel to attempt to clean up any substantial cyanide spill.** If properly trained, lab personnel should not attempt to clean up more than a few drops. Call DPS and request Hazmat. If safe to do so, place absorbent on and around the spill to prevent it from spreading — this will make subsequent clean-up by Hazmat quicker and safer.

**Any significant cyanide spill outside of a chemical fume hood should be cause for immediate evacuation.**

Chemical spill clean-up shall not be attempted if lab personnel do not have proper training and experience, necessary spill kit supplies, and/or appropriate personal protective equipment. **Before starting work, review the** [**Spill Response and Clean-Up**](https://ehs.usc.edu/hazmat/spill-cleanup/) **web page and Section 10 of the** [**CHP**](http://tiny.cc/chem-hygiene-plan)**. All personnel operating under this SOP shall familiarize themselves with this information and shall re-review these references at least annually.**

Please refer to the EH&S [Chemical Spill Kit Guide Sheet](https://tiny.cc/usc-ehs-chmSplkit-gs) for guidance on appropriate spill kit materials.

**Call DPS for all spills, even if they get cleaned up by lab personnel.** DPS will pass information to the EH&S and Hazmat on-call system. If needed, trained staff will be sent to the lab to clean and decontaminate the spill. If lab personnel clean the spill themselves, notification should still be made as lab safety specialists may wish to follow up with a routine safety investigation.

**Spills posing a respiratory hazard SHALL NOT be cleaned by lab personnel. Evacuate the area, restrict access, call DPS.**

Cyanide first aid: Skin exposure **Speedy and thorough decontamination is essential! Immediately remove all contaminated clothing — do not worry about modesty, cyanide exposure can kill you!** **Immediately wash all contaminated areas with lots of water— use safety shower/drench hose.**

If the face/head is contaminated, goggles are worn, and there is nothing in the eyes, use the following procedure: Close the eyes tightly, wash face/head under safety shower, remove goggles (still keeping eyes closed and face under safety shower), wash face and head again thoroughly before opening eyes.

While safety equipment is being utilized, colleagues should **phone DPS requesting emergency medical assistance.** Give a copy of the SDS to medical responders.

Cyanide first aid: Eye exposure **Immediately use eyewash for at least 15 min, holding eyelids open, wash underneath eyelids, and roll eyes around in all directions.**

While eyes are being washed, colleagues should **phone DPS requesting emergency medical assistance.** Give a copy of the SDS to medical responders.

Emergency response **Before starting work, review the** [**Non-Life-Threatening Workplace Injury or Illness webpage**](https://ehs.usc.edu/occhealth/non-life-threatening-workplace-injury-or-illness/)**,** [**EH&S emergency webpage**](https://tiny.cc/usc-injury)**, and the** [**1-2-3 poster**](https://tiny.cc/usc-123)**. Ensure that the 1-2-3 poster is posted in the lab.** **All personnel operating under this SOP shall familiarize themselves with these documents and webpage.**

**All personnel operating under this SOP shall have downloaded and read Section 10 of the** [**CHP**](http://tiny.cc/chem-hygiene-plan) (“*Emergency Response / Injury and Illness Reporting*”). This section provides information on chemical exposure response, spill response, and injury reporting.

**The non-life threatening workplace Injury or Illness web page, 1-2-3 poster, CHP Section 10, and the EH&S emergency webpage are hereby incorporated into this SOP by reference.**

**All personnel operating under this SOP shall have the DPS emergency number programed into their phone** (UPC 213-740-4321; HSC 323-442-1000).

**Phone the DPS emergency line in an emergency!!** DPS have 24 h/day immediate communication access to primary and backup personnel on the EH&S and Hazmat on-call rota. **Do NOT call the EH&S general phone line or individual EH&S personnel in an emergency as access is not guaranteed.**

SOP Acknowledgement

The undersigned acknowledge by their signature that they:

1. Have read, understood, have access to, and agree to abide by this SOP, AND;
2. Have read and understood the emergency response resources incorporated into this SOP by reference (“[**1-2-3 poster**](https://tiny.cc/usc-123)”, [**Non-Life-Threatening Workplace Injury or Illness webpage**](https://ehs.usc.edu/occhealth/non-life-threatening-workplace-injury-or-illness/), [**CHP Chapter 10**](http://tiny.cc/chem-hygiene-plan), and [**EH&S emergency webpage**](https://tiny.cc/usc-injury)), AND;
3. Will download, store, read, and thoroughly familiarize themselves with safety data sheets (SDSs) for all the hazardous materials they intend to use within the scope of this SOP.

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| **Name** | **USC ID** | **Email** | **Signature** | **Date** |
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Internal Training Record

If hazards are high or complex, or personnel have limited prior experience or training, then hands-on training should be provided on the contents of this SOP. For convenience, the training may be documented using this form, although PIs are free to keep internal training records in other formats if desired. Training may be conducted by the PI, or the PI may delegate a suitably experienced and knowledgeable lab member (e.g. lab manager or senior postdoc) as the trainer. If delegated, the PI still retains management responsibility for the quality and adequacy of the safety training.

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| --- | --- | --- | --- |
| Trainer name |  | Trainer position |  |
| Trainer USC ID |  | Trainer email |  |
| Trainee #1 name |  | Trainee #1 USC ID |  |
| Trainee #1 email |  | Trainee #1 signature |  |
| Trainee #2 name |  | Trainee #2 USC ID |  |
| Trainee #2 email |  | Trainee #2 signature |  |
| Trainee #3 name |  | Trainee #3 USC ID |  |
| Trainee #3 email |  | Trainee #3 signature |  |
| Trainee #4 name\* |  | Trainee #4 signature |  |
| Trainee #4 email |  | Trainee #4 USC ID |  |
| Date training started |  | Date training completed |  |
| Type of training (delete as appropriate) | **Initial training**  **Refresher training** | Type of training (delete as appropriate) | **Classroom training**  **Hands-on laboratory training** |
| If refresher training, provide date of initial training |  | If refresher training, was the initial training hands-on in the lab? | **YES 🞏 NO 🞏** |
| Signature of trainer confirming the above named trainees have successfully completed safety training on the contents of this SOP (and any additional subjects listed below) | |  | |
| Date of signing by trainer | |  | |
| Additional subjects covered by safety training |  | | |
| \* If there are more than four trainees, please append an additional sign-in sheet. | | | |

1. Section 6 for identification and Section 8 for safe working practices. [↑](#footnote-ref-1)