**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

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| **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. |

| NOTE: This SOP does NOT cover Hydrofluoric Acid (HF) or Phenol | |
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| Standard (Safe) Operating Procedure: corrosives | |
| **Nature of Hazard** | Corrosive substances produce injury through contact with any internal or external part of the body, including skin, eyes, mucous membranes, mouth, throat, lungs, and digestive tract. Corrosive injury manifests at the site of contact. Some corrosives additionally possess toxic properties which can manifest remote from the point of absorption, and which may cause serious illness or death.  Corrosive injury may arise from two mechanisms, *direct-acting* and *acting via toxicity*, described below. Depending on the corrosive, one mechanism may be dominant, or both mechanisms may occur together. |
| **Direct-Acting Corrosives** | These materials cause corrosion and destruction of tissue through direct chemical attack. This is often the principal mechanism of highly chemically reactive corrosives. These substances literally eat away at human tissues.  Examples:   * Medium-strength and strong acids, e.g., sulfuric acid, nitric acid, formic acid, concentrated acetic acid. * Strong bases, e.g., sodium hydroxide, aqueous ammonia, amines (Note: Bases can be even more dangerous to eyes than acids.) * Powerful oxidants, e.g., bromine, 30% hydrogen peroxide * Highly water-reactive substances, particularly if they hydrolyze to strong acids or bases, e.g., aluminum chloride, titanium tetrachloride, phosphorus pentoxide, lithium aluminum hydride, sodium hydride, alkali metals. |
| **Direct-Acting +**  **Thermal Burns** | Some highly water-reactive chemicals create heat on reaction with skin. The temperature rise may be sufficient to produce thermal burn damage as well as chemical damage. However, immediate drenching with water (e.g., using a safety shower/eyewash) is still recommended for removing water reactive corrosives as sufficient water will overwhelm thermal effects. Any delay caused by trying to remove contamination using non-aqueous methods will likely result in more severe injury. |
| **Corrosives Acting via Toxicity** | These materials may penetrate the skin followed by a toxic effect which damages or kills cells. This is the principal mechanism of a number of exceptionally dangerous corrosive substances. These substances may not initially produce any visible effect on skin, as they do not cause external burning and corrosion.  These substances penetrate the skin (or other part of the body), then cause cellular death and damage in the underlying tissues, which can result in an extremely serious burn appearing, often after a misleading symptomless delay.  Burns by these substances may be accompanied by systemic (i.e., non-localized) poisoning, which may be fatal if sufficient material is absorbed.  Examples:   * Hydrogen fluoride (hydrofluoric acid), phenol, (di)alkylarsenic halides * Strong electrophiles, including: Simple alkylating agents, e.g., dimethyl sulfate, iodomethane; electrophiles which react by ring-opening, e.g. aziridines, epoxides, ethylene sulfide; mustards, i.e., compounds containing 2-chloroethylamine or 2-chloroethyl sulfide moieties; strong Michael acceptors, e.g., divinyl sulfone, ethyl vinyl ketone; reactive aldehydes, including formaldehyde, glutaraldehyde, phthaldialdehyde, glyoxal.   Many of these examples can maim or kill by systemic toxicity following skin contact. Acutely toxic corrosives also need to be covered by an SOP for acute toxicants. |
| **Toxic and Reactive Corrosives** | Several dangerously corrosive non-metal halides and oxyhalides likely act more-or-less equally through both the above mechanisms, e.g., thionyl chloride, disulfur dichloride, selenium oxychloride (seleninyl chloride), arsenic halides. |
| **Hazard Identification** | Refer to Section 6 (and Appendix G) of the [Chemical Hygiene Plan (CHP)](http://tiny.cc/chem-hygiene-plan) for details 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.**  For purchased chemicals, identification as a corrosive should be made by assessing the hazard information given in the safety data sheet (SDS).  For synthesized chemicals, assume that all the following are corrosive: Acids, bases, substances which hydrolyze to acids/bases, highly reactive substances, and substances which have chemical analogies to known corrosive materials (e.g. assume all strong alkylating agents are corrosive). |
| **Specific Substances** | [Add details of specific substances you will be using in the lab under this SOP.] |
| **Designated Work Areas/ Signage** | For low hazard work with corrosives (limited quantities, low concentrations, or weak corrosives), the lab may be considered the designated area provided the lab door signs include appropriate warning pictograms.  More hazardous work with corrosives should be done at designated areas within the lab where spillage can be easily contained (e.g., a fume hood) and which should be signed “Warning — Corrosive” (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.  **Corrosive work and storage areas shall be serviced by a regulatory-compliant safety shower/eyewash combination.** Corrosive materials shall NOT be handled or stored if this requirement is not met. Additionally, an eyewash shall be immediately adjacent to the hazard if a “strong acid or strong caustic” is used (ANSI Z385.1). Please refer to the CHP for more information on safety shower/eyewash requirements. Email [labsafety@usc.edu](mailto:labsafety@usc.edu) if further information is required.  [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** | Corrosive materials should be stored in cool, dry well-ventilated areas below eye level, away from sunlight in an upright and tightly closed manner. Concentrated acids and bases should be stored in dedicated cabinets in appropriate secondary containment (e.g. polypropylene trays). Separate cabinets should be used to segregate acids from bases, segregate organic from inorganic acids, segregate oxidizing acids from reducing/flammable/combustible acids, and segregate organic from inorganic bases. If there is lack of space, separate secondary containment within the same cabinet may separate incompatible materials provided excessive hazard is not thereby created; EH&S can advise on a case-by-case basis.  Avoid storing volatile acidic corrosives (e.g. hydrochloric acid) in metal cabinets as this may lead to corrosion. If this must be done, placing a container of activated carbon or calcium hydroxide in the cabinet will absorb vapor and reduce corrosion.  Do NOT store oxidizing acids (e.g. perchloric acid, nitric acid) with flammable/combustible organic acids (e.g. acetic acid); use separate cabinets. Oxidizing and reducing inorganic acids should NOT be stored in the same secondary containment (reducing acids include hydroiodic acid and hypophosphorus acid).  Refer to the [CHP](http://tiny.cc/chem-hygiene-plan) (Section 7) for further information on storage and inventory-keeping requirements. |
| **Labeling** | Hazardous materials not in active use shall be labelled to indicate the hazard. Corrosive storage areas (cupboards, shelves, or secondary containment) shall be labeled “corrosive” and either “acid” or “base”, as appropriate.  Label templates are available at the [Chemical Labeling and Signage](http://tiny.cc/usc-chm-lbl-sign) web page. Refer to [CHP](http://tiny.cc/chem-hygiene-plan) (Section 5) for detailed requirements on hazardous materials labeling. |
| **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). Refer to the [CHP](http://tiny.cc/chem-hygiene-plan) (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 (normally a fume hood) shall be used for all work which has the potential to release hazardous vapor or particulates (dust, powder, spray, or liquid/solid aerosol). Please consult the CHP (Section 8) for detailed information on engineering safety controls.  Regular chemical fume hoods are generally satisfactory for acid use, but they may contain metal fittings which can corrode if large quantities of acid vapor or spray are produced. Fume hoods specially designed for acid use are present in some labs. See the CHP and refer to manufacturer’s information for further guidance on fume hood applicability.  Note that special restrictions apply to the location of work which generates perchloric acid vapor. Regular fume hoods may NOT be used. Please refer to the CHP (Section 8) for detailed information on circumstances necessitating specially-engineered perchloric acid fume hoods.  Secondary containment (e.g. polypropylene trays) should be used for experiments wherever there is potential for significant spillage of corrosives. The depressed working surface of a fume hood constitutes acceptable secondary containment for most work. |
| **Decontamination** | Clean and decontaminate all work areas and equipment after use. Ensure that all drips from or on corrosive containers and bench tops are wiped up promptly. Ensure stock bottles are clean on the outside before putting away.  Potentially contaminated PPE shall be removed before entering clean areas. Hands shall be washed before entering clean areas and after completion of work.  [Add details of specific decontamination/cleaning procedures, if needed.] |
| **Work Practices** | Several concentrated acids generate significant heat when diluted with water. If water is added to the acid, the mixture can locally exceed 100 °C, causing undissolved water drops to boil and throw acid out of the container. Therefore, **when diluting acids, always *slowly* and carefully pour the concentrated acid into water with continual stirring. Do NOT pour water into the acid.** Note that a number of bases also produce large temperature rises on dissolving in water (sodium hydroxide, potassium hydroxide) or reacting with water (CaO, SrO, BaO). Add base to water with stirring and caution.  [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. Follow all EH&S directions ([hazmat webpages](http://tiny.cc/usc-hazmat), [fact sheets](https://tiny.cc/usc-ehs-fact-sheets), [CHP](http://tiny.cc/chem-hygiene-plan)) when disposing of hazardous chemical waste. 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** | 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**](http://tiny.cc/usc-spill-clnup) **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.**  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.  **Major spills outside a fume hood SHALL NOT be cleaned by lab personnel. Evacuate the area, restrict access, call DPS.** |
| **Emergency Response** | **Before starting work, review the** [**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 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)”, [**CHP Chapters 6 and 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. | | | |