**Administrative Information**

|  |  |  |  |
| --- | --- | --- | --- |
| 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. Sections that require additional information and customization are highlighted in yellow throughout the document. |

Standard (Safe) Operating Procedure: Formaldehyde, Formalin, and Paraformaldehyde

Nomenclature

For brevity, much of this document just refers to “formaldehyde”; however, it is to be understood that the hazards and safety precautions associated with paraformaldehyde are essentially identical to those associated with formaldehyde. All the safe working practices and regulatory requirements applicable to formaldehyde are generally equally applicable to paraformaldehyde, and vice versa.

Scope

This SOP is intended to cover “normal” laboratory uses of formaldehyde where appropriate work practices and safety controls limit exposure to negligible levels, well below the regulatory limits given in Table 1, below. By “normal” laboratory use is meant usage in accordance with this SOP, i.e. small-to-medium scale, typical laboratory procedures (tissue fixation, chemical synthesis, etc) and all usage to be in a chemical fume hood except under the very limited quantity/concentration/time exceptions given later in this SOP (Table 2).

**Any proposed usage for formaldehyde which has potential to cause non-negligible exposure needs to be assessed by EH&S Occupational Health (****injuryprevention@usc.edu****) before proceeding.** Such usage would include large-scale procedures like embalming, and also procedures which are proposed to be conducted outside of a chemical fume hood (except for the very limited quantity/concentration/time exceptions for non-fume-hood use of formaldehyde detailed later in this document (Table 2)). Note that non-fume-hood local exhaust ventilation like downdraft tables and snorkels do not give such assurance of protection as fume hoods, so proposed formaldehyde usage with such safety controls also needs to be assessed by Occupational Health before proceeding. Occupational Health assessments may include quantitative exposure monitoring and other Industrial Health risk assessments to ensure that the STEL and Action Level are not exceeded (Table 1), and if limits are exceeded, that the complex regulatory requirements which are thereby trigged are appropriately met.

|  |
| --- |
| Table 1. Formaldehyde regulatory exposure limits which shall NOT be exceeded in “normal” labs operating under this SOP. |
| **Formaldehyde Airborne Concentration and Type of Limit** | **Cal/OSHA Requirements** |
| 0.1 ppm (limit does not have a specific name) | [§5217](https://www.dir.ca.gov/title8/5217.html) (n)(1): “*...where the employer can show, using objective data, that employees are not exposed to formaldehyde at or above 0.1 ppm, the employer is not required to provide* [formaldehyde] *training*”At USC, everyone who works with formaldehyde shall at a minimum be trained on its safe use as part of lab-specific safety training provided by PIs and supervisors. (This is the same requirement as for all hazardous materials usage.) Individuals who do not work with formaldehyde, but who may spend time in a workspace where formaldehyde is present, do not need formaldehyde safety training if exposure levels are below 0.1 ppm (which should be the case in normal labs using appropriate safety controls).Individuals who may be exposed to formaldehyde concentrations above 0.1 ppm will require formaldehyde safety training, which may need a higher-level component in addition to the basic internal lab-specific training. Contact injuryprevention@usc.edu for more information. |
| Below:* 0.5 ppm Action Level (AL; 8 hour time weighted average (TWA))

AND below:* 2 ppm Short Term Exposure Limit (STEL; 15 min TWA)
 | If employee exposure is below both the AL and STEL then no special requirements apply (aside from the training requirements covered above). **For typical research lab operations there is no valid reason the AL or STEL should ever be exceeded provided lab personnel are properly trained and using appropriate safety controls (e.g. chemical fume hoods) in accordance with a satisfactory SOP.**USC occupational health will conduct formaldehyde exposure monitoring in representative labs conducting typical formaldehyde procedures to objectively determine that exposures are below the AL and STEL, in accordance with the CAL/OSHA regulation [*§5217. Formaldehyde*](https://www.dir.ca.gov/title8/5217.html). |

Supporting Document

The document [*Formaldehyde and Paraformaldehyde in Laboratories: Hazards, Regulations, and Safety*](http://tiny.cc/usc-formaldehyde-regs) provides a higher-level overview of the regulatory and safety environment in which this SOP resides. All users of this SOP shall familiarize themselves with *Formaldehyde and Paraformaldehyde in Laboratories*.

Lab-Specific Training Requirements

Initial training New users should be trained on the contents of this SOP and should also receive hands-on training in the lab from an individual the PI deems suitably experienced, until the new user is deemed competent and is seen to follow safe working practices.

Annual refresher training Formaldehyde users shall receive annual refresher training which covers the contents of this SOP.

Special training Any individuals exposed or potentially exposed to ≥ 0.1 ppm formaldehyde need to be given specific initial and annual formaldehyde safety training to meet the requirements of [§5217(n)](https://www.dir.ca.gov/title8/5217.html). Please contact injuryprevention@usc.edu for details.

Properties and Hazards

Formaldehyde and formalin Formaldehyde is a colorless, irritant, pungent-smelling, highly water-soluble gas. Formaldehyde is often used as a tissue preservative in labs and typically supplied as a saturated solution known as formalin. Formalin consists of formaldehyde dissolved in water with a stabilizer; it is often found in the ratio of 37% formaldehyde and 6-13% methanol in water. (Methanol prevents formation and precipitation of insoluble paraformaldehyde.) If a protocol calls for 10% formalin, it is roughly equivalent to 4% formaldehyde.

Paraformaldehyde Paraformaldehyde is polymerized formaldehyde. It is a white flammable solid which is a common lab reagent. Paraformaldehyde readily depolymerizes to produce formaldehyde, meaning that paraformaldehyde and formaldehyde have essentially identical health hazards. Paraformaldehyde can release formaldehyde gas slowly during storage, and rapidly when heated or mixed with water.

Health hazards Formaldehyde/paraformaldehyde are moderately acutely toxic by all routes of exposure, but the more concerning health hazards in a workplace setting are the chronic health hazards arising from them being a carcinogen, mutagen, and potent sensitizer. Furthermore, because formaldehyde is a volatile small molecule, exposure via the gaseous route is all too easy. Formaldehyde vapor readily irritates the eyes and respiratory system at low concentrations. Higher concentrations cause intense irritation which may progress to injury via toxic and corrosive effects.

Carcinogens directly or indirectly damage DNA in cells, causing an increased probability of cancer. Carcinogens are primarily a chronic hazard with each exposure leading to compounding irreversible damage which may eventually progress to cancer after years or decades. Formaldehyde is a [Cal/OSHA Article 110](https://www.dir.ca.gov/title8/sb7g16a110.html) regulated carcinogen in the workplace. Repeated exposure can lead to cancers of the nose, throat, and sinuses as well as leukemia and lymphoma.

Sensitizers are materials to which susceptible individuals may develop an allergy after their immune system becomes sensitized to the material. Initial exposure is typically symptomless, but repeated exposures may develop the immune memory to a point whereby any subsequent exposure, even to miniscule traces, causes allergic (“hypersensitivity”) reactions which may be extremely severe. Symptoms may include eye irritation, skin inflammation, hives, dermatitis, and occupational asthma. Once an individual has become sensitized, that condition is likely to be permanent. Known potent sensitizers such as formaldehyde/ paraformaldehyde should be handled with the utmost care to minimize exposure.

Formaldehyde and paraformaldehyde are Category 2 Germ Cell Mutagens, meaning they have not been proven to cause heritable mutations in humans, but this possibility exists based on known properties.

Formaldehyde and paraformaldehyde are corrosive to skin, and especially to eyes. In the case of eyes, vapor exposure is also harmful and can result in severe eye irritation and possible eye damage.

GHS hazard classification The GHS hazard classification for formalin and paraformaldehyde are given below; however, **personnel should also always review the specific SDS for the chemical they are using:**

**Formalin (37%)**Flammable liquids (Category 3)
Acute toxicity, Oral (Category 3)
Acute toxicity, Inhalation (Category 2)
Acute toxicity, Dermal (Category 3)
Skin corrosion (Category 1B)
Serious eye damage (Category 1)
Skin sensitization (Category 1)
Germ cell mutagenicity (Category 2)
Carcinogenicity (Category 1B)
Specific target organ toxicity - single exposure (Category 1), Eyes, Central nervous system
Specific target organ toxicity - single exposure (Category 3), Respiratory system
Short-term (acute) aquatic hazard (Category 2)

**Paraformaldehyde**
Flammable solids (Category 2)
Acute toxicity, Oral (Category 4)
Acute toxicity, Inhalation (Category 4)
Skin irritation (Category 2)
Serious eye damage (Category 1)
Skin sensitization (Category 1)
Germ cell mutagenicity (Category 2)
Carcinogenicity (Category 1B)
Specific target organ toxicity - single exposure (Category 3), Respiratory system
Short-term (acute) aquatic hazard (Category 3)

For more detailed information regarding the OSHA/GHS hazard classifications, please refer to Section 6 of the [Chemical Hygiene Plan (CHP)](http://tiny.cc/chem-hygiene-plan). **All personnel who agree to abide by this SOP are required to familiarize themselves with the contents of Section 6 of the CHP.**

PHS Formaldehyde’s status as a carcinogen classifies it as a *Particularly Hazardous Substance* (PHS) by Cal-OSHA ([8 CCR §5191 (e) (H)](https://www.dir.ca.gov/title8/5191.html)). PHS must be handled with special care. Refer to the [CHP](http://tiny.cc/chem-hygiene-plan) (Sections 6 and 8) for more information on the classification and identification of PHS, and safe practices for working with these materials. (Section 6 covers identification and Section 8 deals with safe working practices.)

Dangerous interactions! **Formaldehyde/paraformaldehyde can react with hydrogen chloride to produce bis(chloromethyl) ether which is very volatile, extremely toxic by inhalation, and an exceptionally potent known carcinogen in humans and animals. Hydrogen bromide may react similarly.** **NEVER mix formaldehyde with hydrochloric acid or hydrobromic acid, or allow formaldehyde vapor to interact with HCl or HBr vapor/gas. Furthermore, do NOT react formaldehyde with materials which readily hydrolyze to HCl or HBr, e.g. thionyl chloride, aluminum chloride.**

This [reference](https://www.atsdr.cdc.gov/ToxProfiles/tp128.pdf) details the toxicology of bis(chloromethyl) ether.

Formaldehyde may interact hazardously with hypochlorites, with potential production of bis(chloromethyl) ether. **Do NOT mix formaldehyde/paraformaldehyde with bleach.**

Safety Controls and Safe Working Practices

Specific substances [Add details of specific substances you will be using in the lab under this SOP.]

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 Formaldehyde containing materials should be stored in labeled secondary containment (e.g., polypropylene trays). They shall not be stored under sinks. They should be stored below eye level and upright in a well-ventilated area out of direct sunlight. Keep them segregated from incompatible materials (e.g., paraformaldehyde is flammable and shall therefore not be stored with oxidizers, water reactive materials, or pyrophorics).

Labeling As a PHS, all secondary containers and cabinets housing formaldehyde shall be labeled with the words “Carcinogen". 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.

 [Add details of any lab specific labeling requirements, if necessary.]

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, and [fact sheets](https://tiny.cc/usc-ehs-fact-sheets). Most commonly, research lab PPE consists of a lab coat, eye protection, and chemical protective gloves. Lab-specific PPE requirements should be developed based on the type of work being done with formaldehyde. Please refer to Table 2, below, for basic guidelines on PPE appropriate for various formaldehyde operations.

PPE: Gloves Formaldehyde may penetrate gloves, especially disposable gloves, and especially in the presence of organic solvents. Please consult glove manufacturer’s chemical resistance guides for authoritative data on the suitability of specific gloves. If specific gloves are recommended for specific procedures in your lab, please add details into the SOP.

Additional glove information may also be found by consulting SDSs from a reputable vendor, e.g. Sigma Aldrich. When specific glove resistance information is provided in SDSs, it will be found in Section 8.

What follows in the subsections below and in Table 2 are some general guidelines to assist glove selection, but not to supersede information provided by glove manufacturers.

Gloves: Performance standard EN ISO 374-1:2016 is an internationally-recognized standard on the performance of chemical-protective gloves. When selecting gloves for the highest resistance to formaldehyde (i.e. when requiring protection from continual contact rather than just splashes) look out for gloves which are certified to EN ISO 374-1:2016 with the additional designators “Type A” or “Type B” (meaning breakthrough time of at least 30 minutes for least six or three, respectively, of the standard test chemicals applied individually) and “T”. This standard includes testing with 18 standard chemicals denoted by a letter A to T, with T being 37% formaldehyde. The appropriate letters are applied to the glove according to which chemical resistance tests it passes. An internet search will readily disclose the meaning of the various letters, for example [here](https://guidegloves.com/en/knowledge/our-products/standards/en-iso-374-1-2016).

Type C gloves have a breakthrough time of only 10 minutes against a minimum of one test chemical and are not recommended.

Grainger allows for gloves to be searched based on EN ISO 374 Type A/B/C and chemicals tested, for example, disposable gloves Type B tested against formaldehyde (“T”) can be found [here](https://www.grainger.com/category/safety/hand-arm-protection/safety-gloves/disposable-gloves/chemical-resistant-disposable-gloves?attrs=EN+ISO+374+Chemicals+Tested%7CT+-+Formaldehyde+37%25~~EN+ISO+374+Type%7CType+B&filters=attrs).

Gloves: Reusable Reusable gloves can provide superior resistance to formaldehyde compared to disposable gloves. When using reusable gloves, users shall:

Carefully check for pin holes and damage before each use.

Thoroughly decontaminate the exterior of gloves by washing before removal.

Store gloves in a cool, clean, dark location, away from hazardous contamination and sharp objects.

Mark reusable gloves with the name of the user and do not share gloves.

Many reusable gloves are thick and may not be practical for laboratory operations requiring good dexterity. Examples of reusable gloves with sufficient dexterity for lab use and which have been tested against formaldehyde:

Reusable relatively thin butyl gloves: [Ansell® AlphaTec® 38-514](https://www.ansell.com/us/en/products/alphatec-38-514) ([available from Grainger](https://www.grainger.com/search?catalogGrpExist=Yes&searchQuery=J2998); available in sizes 7-11, see [manufacturer’s size guide](https://www.ansell.com/-/media/projects/ansell/website/pim/product-assets/sizing-chart/glove-size-chart.ashx?rev=b71b2b5f11064f87ba70e8d694743da1).) According to the manufacturer, they are rated *EN ISO 374-1:2016 Type A ABCIKMPST*. (Butyl is known for exceptional permeation resistance to high polarity materials so formaldehyde resistance would be expected to be excellent.)

Reusable nitrile gloves with good dexterity (at the thinnest end of reusable gloves) and low cost: [Ansell® AlphaTec® 37-200](https://www.ansell.com/us/en/products/alphatec-37-200). According to the manufacturer, they are rated *EN ISO 374-1:2016 Type B JKT*.

Gloves: Disposable Disposable nitrile gloves are a minimum standard of protection and (unless specifically tested by the manufacturer against formaldehyde permeation) should be assumed to offer limited resistance to formaldehyde/paraformaldehyde solutions. They are mainly suitable for short-term splash protection from dilute solutions; they are not suitable for protection from continuous contact, especially if solutions are concentrated.

Please refer to Table 2, below, for information on what formaldehyde operations require a single pair of disposable nitrile gloves as minimum hand protection, and what require a minimum of double-gloving if generic disposable nitrile gloves are used. Note that generic nitrile gloves only provide temporary protection from splash hazards and should be changed immediately once contaminated, especially if the formaldehyde solutions are not dilute. Disposable gloves shall also be changed after each use, or when torn or punctured. Chemically contaminated gloves shall be disposed as solid chemical waste; they may NOT be disposed as bio waste.

Disposable gloves are available which are tested by the manufacturer against formaldehyde penetration, and/or provide extra protection by virtue of being thicker or using neoprene in the construction. The thicker versions of these gloves (e.g. [Ansell® MICROFLEX® 93-260](https://www.ansell.com/us/en/products/microflex-93-260), covered below) may be a satisfactory alternative to double-gloving, and may approach reusable gloves in the degree of protection afforded.

An example of disposable nitrile gloves which have been tested for formaldehyde permeation are [Ansell® MICROFLEX® 93-850](https://www.ansell.com/us/en/campaigns/microflex-93-850) According to the [manufacturer’s test results](https://www.ansell.com/-/media/projects/ansell/website/pdf/single-use/microflex/microflex-93-850/product-literature/en-us/microflex-93-850-chemical-permeation-chart.ashx) (ASTM F739 test for chemical permeation of protective clothing), formaldehyde breakthrough time is >480 minutes (formaldehyde concentration was not specified in the published results).

Disposable nitrile/neoprene double layer gloves with much superior chemical protection than regular disposable gloves: [Ansell® MICROFLEX® 93-260](https://www.ansell.com/us/en/products/microflex-93-260) ([available from Grainger](https://www.grainger.com/product/MICROFLEX-Chemical-Resistant-Gloves-52RW12)). According to the manufacturer, they are rated *EN ISO 374-1:2016 Type A JKLOPST*.

Neoprene generally has better permeation resistance to high-polarity molecules than nitrile; therefore, neoprene disposable gloves would be expected to provide generally better formaldehyde resistance than disposable nitrile gloves. An example of disposable neoprene gloves, relatively thick compared to most disposable gloves, but with still excellent dexterity due to the elasticity of neoprene: [Ansell® MICROFLEX® NeoPro® NEC-288](https://www.ansell.com/us/en/products/microflex-neopro-ec-nec-288) ([available from Grainger](https://www.grainger.com/product/MICROFLEX-11-1-2-Powder-Free-Unlined-3NET4)). Note: These gloves are not specifically rated by the manufacturer as to formaldehyde resistance, so should not be relied upon to provide protection from continuous contact with concentrated formaldehyde solutions.

Eye protection Wear safety glasses with side shields are the minimum standard of eye protection in the absence of any splash hazard present e.g. when weighing solid paraformaldehyde.

Chemical splash goggles (i.e. not directly vented) are required when working with any amount of formaldehyde or paraformaldehyde solutions due to the splash hazard.

If severe splash/splatter possible, wear face shield over safety goggles to provide both eye and face protection.

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

Body protection A lab coat shall always be worn when working with formaldehyde (100% cotton, FR cotton, Nomex, or polyester barrier coat). The lab coat shall be appropriately matched to the hazards present (especially the fire hazard) and to the work being done.

If severe splash/splatter possible, wear a chemical resistant apron with sleeves.

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

Respiratory Protection **Any formaldehyde work which requires respiratory protection is outside the scope of this SOP.** Atmospheric concentrations which require respiratory protection by definition trigger numerous regulatory requirements under [§5203](https://www.dir.ca.gov/title8/5203.html), including State reporting, exposure monitoring, medical surveillance, establishment of authorized areas, signage, etc. Furthermore, respirators shall NOT be used except as part of the [USC Respiratory Protection Program](https://tiny.cc/usc-ehs-RPP-fs), which incorporates regulatory requirements, including medical clearance, fit testing, and training.

Formaldehyde work which generates atmospheric concentrations requiring respiratory protection (or exceeding the 0.5 ppm Action Level) shall ONLY be conducted when specifically approved by EH&S Occupational Health under their Formaldehyde Program, and after assessment by the Industrial Hygienist; please contact injuryprevention@usc.edu for more details.

For typical lab operations, safe working practices and engineering safety controls (e.g. consistent fume hood use) should reliably keep exposure levels at a negligible valve, well below 0.1 ppm.

A small minority of people are predisposed to develop hypersensitivity reaction to formaldehyde. Such individuals may need to use respiratory protection in order to continue working in rooms where formaldehyde is used, even though formaldehyde exposure is well below levels at which respiratory protection is mandatory as per Cal-OSHA. In these cases, respiratory protection under the voluntary regime may be applicable, please contact injuryprevention@usc.edu for details.

Please note, surgical masks or dust masks do not provide protection, and shall not be used in lieu of appropriate respiratory protection.

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 for detailed information on engineering safety controls.

**Work with formaldehyde or paraformaldehyde shall be conducted in a properly operating and certified chemical fume hood or fume hood equivalent (i.e., fully exhausted biosafety cabinet (BSC)).** Do NOT use laminar flow clean benches, non-exhausted biosafety cabinets, or non-ducted fume hoods. [Note 1 – The great majority of USC biosafety cabinets are not externally exhausted, but simply recirculate vapors back into the room. Note 2 – Non-ducted fume hoods are generally disallowed at USC.]

There are limited exceptions whereby dilute formaldehyde/ paraformaldehyde solutions may be handled outside of a fume hood for a limited maximum time, provided the specified maximum volume is not exceeded; please refer to Table 2 (including footnotes), below, for details.

In general, a chemical fume hood is always the preferred type of local exhaust ventilation to control formaldehyde exposure, as their enclosed nature and well-defined airflow patterns provide the most reliable separation of the user from the hazard.

Other types of local exhaust ventilation such as downdraft tables and snorkels provide less assurance of protection and therefore shall NOT be used with formaldehyde unless assessed and approved for the specific application by the USC Industrial Hygienist; please email injuryprevention@usc.edu. Such assessment may include smoke tests and quantitative exposure monitoring.

[Please provide lab-specific information on exposure control, including safe work practices with any special local exhaust devices.]

**Table 2.** Minimum Ventilation and PPE Requirements for Common Procedures using Formaldehyde

| **Procedure** | **Formaldehyde containing chemical** | **Ventilation** | **PPE (minimum)** |
| --- | --- | --- | --- |
| Handling solid paraformaldehyde (e.g. weighing) | Solid paraformaldehyde | Fume hood or equivalent | Chemical splash goggles or safety glasses, nitrile gloves,† lab coat |
| Preparation of solutions | Formaldehyde or paraformaldehyde | Fume hood or equivalent | Chemical splash goggles, double nitrile gloves,† lab coat |
| Formaldehyde or paraformaldehyde solutions in pressurized systems | All | Local exhaust ventilation (fume hood, downdraft table, etc) at locations where formaldehyde may escape the system | Chemical splash goggles, nitrile gloves,† lab coat. If high splash hazard, add face shield, impervious apron with sleeves |
| Fixing tissues or cells | ≤ 4% formaldehyde solution (equivalent to ≤ 10% neutral buffered formalin) or ≤ 4% paraformaldehyde soln | Fume hood or equivalent; or well-ventilated area if small amounts and short task time\* | Chemical splash goggles, nitrile gloves,† lab coat |
| Placing sample in prefilled screw cap containers | Less than or equal to 4% formaldehyde or paraformaldehyde(≤10% neutral buffered formalin) | Fume hood or equivalent; or well-ventilated area if small amounts and short task time\* | Chemical splash goggles, nitrile gloves,† lab coat |
| Gross examination of fixed tissues | Less than or equal to 4% formaldehyde or paraformaldehyde(≤10% neutral buffered formalin) | Fume hood or equivalent, well ventilated area if small amounts and short task time\* | Chemical splash goggles, nitrile gloves,† lab coat |
| Microscopic examination of fixed tissues or cells | Less than or equal to 4% formaldehyde or paraformaldehyde(≤10% neutral buffered formalin) | Fume hood or equivalent, well ventilated area if small amounts and short task time\* | Chemical splash goggles, disposable nitrile gloves,† lab coat.Safety glasses permissible when samples present no splash hazard (i.e. no liquid is present).After sample is placed in microscope, provided no eye hazards are in the vicinity, eye protection may be removed if needed to look into the microscope. |
| Blot assays | 37% formaldehyde and diluted solutions | Fume hood or equivalent | Chemical splash goggles, double-glove (disposable nitrile gloves),† lab coat |
| Animal perfusions | Varies, but whenever possible use ≤4% formaldehyde or paraformaldehyde(≤10% neutral buffered formalin) | Fume hood or equivalent\*\*\* | Chemical splash goggles, disposable nitrile gloves,† lab coat |
| Embalming | Varies, but whenever possible use ≤4% formaldehyde or paraformaldehyde(≤10% neutral buffered formalin) | Fume hood or equivalent\*\*\* | Chemical splash goggles, disposable nitrile gloves,† lab coat |
| Specimen discard, waste chemical handling  | All | Fume hood or equivalent | Chemical splash goggles, disposable nitrile gloves,† lab coat. If high splash hazard, add face shield, impervious apron with sleeves |
| Spill cleanup (minor spill)\*\* | All | Fume hood or well-ventilated area | Goggles, double-glove with disposable nitrile gloves, or preferably use Silver Shield™ or other suitable non-disposable chemical protective gloves,† lab coat. |
| Spill cleanup (major spill)\*\* | Cleaning major spills requires special training and respiratory protection and shall NOT be attempted by lab personnel. Cover the spill with absorbent (only if safe to do so without hazardous exposure), evacuate the lab, call DPS.\*\* |
| † Disposable nitrile gloves are a minimum standard of protection and offer limited resistance to formaldehyde/paraformaldehyde solutions. They are mainly suitable for short-term splash protection from dilute solutions; they are not suitable for protection from continuous contact, especially if solutions are concentrated. Appropriate glove selection for formaldehyde protection is covered in detail in the EH&S formaldehyde SOP.\*Permissible outside of a fume hood only if ALL the following are adhered to:1. Well ventilated area
2. Small quantities (a few mL; 50 mL absolute maximum)
3. All liquid surfaces to be covered as far as practical
4. Short task time (≤5 mins)
5. Task not frequently repeated (average of once a day or less; not more than three times in any single day)
6. Fume hood is not easily available or is not practical
7. Safety protocol is written into a lab-specific SOP

\*\*See Spill response section, below.\*\*\*Embalming and animal perfusion may be conducted outside of a chemical fume hood (or fume hood equivalent such as a totally exhausted biosafety cabinet) ONLY if assessed and approved by EH&S Occupational Health. Exposure monitoring may be required as a part of the approval process. Limitations may be required on the maximum formaldehyde or paraformaldehyde concentration in the embalming/perfusion solution. Note that suitable local exhaust ventilation is likely to be required, e.g. downdraft table. Please contact injuryprevention@usc.edu before starting embalming/perfusion work if intending to conduct the procedure outside of a fume hood. |

Decontamination All work areas and equipment is to be cleaned and decontaminated after use: wipe down area with detergent and water solution.

Contaminated or potentially contaminated PPE shall be removed before entering clean areas. Contaminated PPE shall be treated as hazardous waste, and shall be disposed of properly. 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 practice [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.]

Preparation of formaldehyde solutions shall be performed in a chemical fume hood. It is best practice to prepare solutions over plastic backed absorbent pads to reduce spill hazards. The pads should be disposed of once they are no longer in use.

If large volume of formalin solution must be used (e.g. more than a liter), determine the best location, setup, and procedures to prevent exposure and spills. Evaluate all handling operations, training and procedures for use, change-out and refilling of containers. Consider using pump dispensing to obviate the need to lift large containers. Use spill containment trays of adequate volume. Annotate this SOP with all safety procedures and safe working practices.

Consider purchasing pre-made paraformaldehyde solution. If solution is to be made from solid paraformaldehyde, all steps (including weighing the paraformaldehyde) shall be conducted in a chemical fume hood. Use safe practices for making the solution, particularly if heating is employed (which obviously greatly increases evolution of formaldehyde vapor); see [this reference](https://www.cambridge.org/core/journals/microscopy-today/article/fast-simple-and-safe-way-to-prepare-paraformaldehyde-solutions/130CEB355F44FA758435C600B398A3AF) for a satisfactory method. Annotate this SOP with specific protocols used.

Work with formaldehyde shall take place in a fume hood or other approved exhausted enclosure except under the limited exceptions detailed in Table 2, above. Examples of work which a fume hood or other exhausted device are required include the following:

* Mixing or transferring solutions
* Working with high concentrations or large volumes in open containers
* Aerosolizing solutions
* Heating solutions
* Working with solution under pressure
* Spreading solutions over a large surface area

**Any work with formaldehyde shall be conducted in an area where safety shower and emergency eyewash stations are easily accessible and within the immediate work environment.**

Hand-transportation of formaldehyde-containing materaisl shall be conducted with the utmost safety in mind. Use leak/spill proof, non-breakable secondary containers with a secure liquid-tight lid. Additionally, use a hand cart for transporting significant quantities, or for transportation between non-adjacent buildings.

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

Waste disposal Formaldehyde-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 if you have questions that are not answered by EH&S online resources.

Waste shall be suitably packaged to prevent escape of formaldehyde vapor. For example, solid hazardous waste should be placed in a closed airtight plastic container, or double-bagged in sealed polyethylene bags (e.g. Ziplock™-style)) before removal from a fume hood.

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

Emergency Response

Spill response A *minor spill* has no inhalation hazard, is limited in volume (<500 mL), and is in an accessible location. “No inhalation hazard” is taken to mean a spill inside a fume hood, or a spill outside a hood of a formaldehyde concentration less than 5% (unless it is only a few drops).

A *major spill* has one or more of the following characteristics:

* Inhalation hazard (i.e. any spill outside of a fume hood with a formaldehyde concentration greater than 5% (unless it is only a few drops).
* Large in volume (>500 mL of any concentration).
* Inaccessible location (e.g. running under a cabinet).

Only minor spills should be cleaned up by lab personnel. However, 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.

For major spills, notify lab personnel and quickly throw absorbent onto spill only if safe to do so, before exiting the area and securing against reentry. Besides this, clean up shall NOT be attempted by lab personnel. Call DPS and request Hazmat.

**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.**

Sensitization reaction Any individual suspected of being sensitized to formaldehyde should cease working in locations where formaldehyde exposure is possible and should contact EH&S Occupational Health and Safety at injuryprevention@usc.edu, as well as notifying their PI/supervisor. Hypersensitivity reactions have similar symptoms to allergies, including eye irritation, skin inflammation, hives, dermatitis, and asthma-like symptoms (chest tightness, wheezing, difficulty breathing).

**Any individual suffering acute symptoms of a potential hypersensitivity reaction should seek urgent medical attention. If symptoms include difficulty breathing, throat constriction, or any other condition which may become life threatening, call DPS (213-740-4321) and request emergency medical attention.**

Eye/skin splash All users of this SOP shall read and understand the emergency response section in the [CHP](http://tiny.cc/chem-hygiene-plan) (Section 10), including information on how to respond to eye and skin splashes. In brief:

It is ESSENTIAL to IMMEDIATELY employ the eyewash in the event of being splashed in the eye with formaldehyde/paraformaldehyde. (Permanent eye damage is possible if response is delayed, and is a likely outcome if additionally the concentration is high.) Wash the eye for a minimum of 15 minutes while a colleague calls DPS (213-740-4321) and requests emergency medical attention.

Minor skin splashes may be washed off at the sink for a minimum of 15 minutes. It is recommended to seek medical evaluation (e.g. urgent care center), and essential to seek medical attention if any symptoms are present.

In the case of a major skin exposure (e.g. formalin spilled on the body), immediately get under a safety shower. Contaminated clothing MUST be removed under the shower even though that may be embarrassing. Wash for a minimum of 15 minutes while a colleague calls DPS (213-740-4321) and requests emergency medical attention.

Contaminated lab coats If a lab coat is splashed with formaldehyde or paraformaldehyde, it should immediately be removed. If the splash is a small one, the user should thoroughly rinse the splash at a sink to remove the hazard before allowing the lab coat to dry in a well-ventilated area. The coat may then be placed in a laundry locker.

 If a lab coat or personal clothing is contaminated by a significant splash of formaldehyde or paraformaldehyde, the coat/clothing should immediately be removed and placed in a fume hood, and ultimately disposed as hazardous waste. If the individual’s skin is also splashed, the immediate priority is for them to get under a safety shower. It is NOT safe for lab personnel to attempt decontamination of clothing or lab coats which are significantly contaminated; furthermore, items which are contaminated with any amount of formaldehyde/paraformaldehyde shall NOT be taken home or placed in a laundry locker.

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 rotation. **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.

|  |  |  |  |
| --- | --- | --- | --- |
| 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. |