Standard Operating Procedures

Strong Corrosives - Strong Acids (SA) & Strong Oxidizing Agents (SOA)

Perchloric Acid

Print a copy and insert into your laboratory SOP binder.

<table>
<thead>
<tr>
<th>Department:</th>
<th>Chemistry</th>
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<tbody>
<tr>
<td>Date SOP was written:</td>
<td>June 17, 2013</td>
</tr>
<tr>
<td>Date SOP was approved by PI/lab supervisor:</td>
<td>Name: Richmond Sarpong</td>
</tr>
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<tr>
<td>Signature:</td>
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<tr>
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<td>Name: Rebecca Murphy</td>
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<tr>
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<td>Lab Phone: 510-643-2485</td>
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<td></td>
<td>Phone Number: 626-644-2407</td>
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<tr>
<td>Location(s) covered by this SOP:</td>
<td>Latimer Hall: 834, 836, 837, 838, 839, 842, 847, 849, 907</td>
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1 - Purpose

This SOP covers the precautions and safe handling procedures for the use of Perchloric Acid in the Sarpong group, which include the following uses:

Chemical  Use
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Perchloric Acid  1. Preparation of dilute solutions (typically 1-5M).
                     2. Use as reactant.
                     3. Make standard HClO₄ solution for titration.
                     4. Washing of diamond samples.
                     5. Preparation of inorganic perchlorate salts by addition of dilute perchloric acid solutions to solutions of metal complexes.
                     6. Oxidation of organic compounds.
                     7. Disposal of perchloric acid.

2 - Physical & Chemical Properties/Definition of Chemical Group

CAS#: 7601-90-3
Molecular Formula: HClO₄
Form: liquid,
Color: colorless
Melting point/freezing point: -18 °C (0 °F)
Boiling point: 203 °C (397 °F)
Vapor pressure: 9.1 hPa (6.8 mmHg) at 25 °C (77 °F)
Density: 1.664 g/mL at 25 °C (77 °F)
Flash point: 113 °C (235 °F) - closed cup
Lower explosion limit: no data available
Upper explosion limit: no data available
Odor: no data available
Odor Threshold: no data available

3 - Potential Hazards/Toxicity

GHS Classification
Oxidizing liquids (Category 1)
Acute toxicity, Oral (Category 4)
Skin corrosion (Category 1A)
Serious eye damage (Category 1)

GHS Label elements, including precautionary statements

Pictogram
Signal word Danger

Hazard statement(s)
H271 May cause fire or explosion; strong oxidiser.
H302 Harmful if swallowed.
H314 Causes severe skin burns and eye damage.

Precautionary statement(s)
P220 Keep/Store away from clothing/ combustible materials.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 Immediately call a POISON CENTER or doctor/ physician.

Cal/OSHA Permissible Exposure Limits (PEL): None established

4 - Engineering Controls

Use the engineering controls listed below unless other lab-specific information is included in the Protocol/Procedure section.

- A laboratory type fume hood with the sash position closed as much as possible;
- A glove box for pyrophorics and water reactive chemicals. Glove boxes may also be required for other chemicals, such as regulated carcinogens and particularly hazardous substances;
- Supplemental protective equipment like a blast shield, where appropriate, to protect from explosions when using peroxide formers, pyrophorics, water reactives, and potentially explosive chemicals.

5 - Personal Protective Equipment
For additional information on PPE requirements, go to:
http://cehss.berkeley.edu/section5#Personnel_Protective_Equipment_Required_in_College_Laboratories

Use the PPE listed below unless other lab-specific information is included in the Protocol/Procedure section.

**Eye and Face Protection**

ANSI-approved safety glasses with side shields or chemical splash goggles must be worn at all times when handling chemicals in the lab.

**Skin and Body Protection**

1. Gloves are required when handling hazardous chemicals.
   a. [Specific glove type recommendations are provided in the Protocol/Procedure section.](http://cehss.berkeley.edu/section5#Personnel_Protective_Equipment_Required_in_College_Laboratories)
   b. Inspect gloves prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Wash and dry hands after handling chemicals, before breaks, and at the end of the workday.
   c. For additional information on glove selection, go to:

2. Lab coats are required when handling hazardous chemicals in the lab.
   a. Nomex 3A flame-resistant lab coats are required when working with pyrophorics (H250) and explosives (H200, H201, H202, H203)
   b. Flame resistant lab coats (Nomex or other material) should be worn when working with materials such as Category 1 or 2 flammable liquids (H224 and H225).

3. Cotton-based, non-synthetic clothing (including long pants; no skin exposed below the waist) should be worn.

4. Closed-toe and closed-heel shoes are required in the lab.

**Respiratory Protection**

Respiratory protection is normally not required for UC Berkeley laboratory activities. Any lab personnel considering the use of a respirator must contact EH&S for a workplace assessment. Respirator users will be provided with specific instructions if a respirator is deemed necessary by EH&S.

**6 - First Aid Procedures and Medical Emergencies**

Notify supervisor and EH&S immediately. Follow up with a call to 510-642-9090 to report the incident.

**Life Threatening Emergency, After Hours, Weekends and Holidays** – Call 911 or go to the nearest emergency room. **Note:** All serious injuries must be reported to EH&S within 8 hours. Follow up with a call to 510-642-9090 to report the incident.

Assess the extent of danger. If you cannot assess the conditions of the environment well enough to be sure of your own safety, do not enter the area. If possible, help contaminated or injured persons. Obtain medical attention for the individual as soon as possible by calling 911. Provide a copy of the appropriate SDS to the emergency responders or physician, as needed.

**If inhaled**

Move into fresh air. Go to the Occupational Health Facility (Tang Health Center) and after hours, go to the nearest emergency room. If person is not breathing, call 911 and give artificial respiration. If unconscious, call 911.

**In case of skin contact**

Immediately flush with flowing water for no less than 15 minutes; remove any jewelry or clothing as necessary to facilitate clearing of any residual materials. Wash off with soap and plenty of water for 15
minutes. If skin contact requires medical assistance, go to the Occupational Health Facility (Tang Health Center) and after hours, go to the nearest emergency room. If this is a large or serious injury, call 911.

**In case of eye contact**

Rinse thoroughly with plenty of water using an eyewash station for at least 15 minutes, occasionally lifting the upper and lower eyelids. Remove contact lenses if possible. Call 911.

**If swallowed**

Call 911. Do not induce vomiting unless directed otherwise by the SDS. Never give anything by mouth to an unconscious person. Rinse mouth with water. Go to the Occupational Health Facility (Tang Health Center) and after hours, go to the nearest emergency room.

**Needle stick/puncture exposure**

Wash the affected area with antiseptic soap and warm water for 15 minutes. For mucous membrane exposure such as eyes, mouth and/or nose, flush the affected area for 15 minutes using an eyewash station. Go to the Occupational Health Facility (Tang Health Center) and after hours, go to the nearest emergency room.

All needle stick/puncture exposures must be reported to EH&S within 8 hours. Follow up with a call to 510-642-9090 to report the incident.

**7 - Special Handling and Storage Requirements**

Lab-specific information on handling and storage may be included in the Protocol/Procedure section.

**Working alone** - Certain extremely hazardous operations should not be performed if the PI or Lab Safety Contact(s) are not present. Never work alone with extremely hazardous materials/operations. See the Protocol/Procedure section below for specific prohibitions (if any) on working alone.

**Precautions for safe handling**

- Avoid contact with skin and eyes. Avoid formation of vapors, dusts, mists and aerosols.
- Use appropriate exhaust ventilation.
- Use appropriate personal protective equipment.
- Remove incompatible chemicals from immediate work area.
- Keep flammable, pyrophoric, potentially explosive and water reactive chemicals away from sources of ignition
- Use care when preparing chemical solutions.

**Conditions for safe storage**

- Keep quantities to a minimum.
- Keep containers tightly closed and in a cool, dry and well-ventilated location.
- Keep in proper storage cabinets and shelving. Use lowest shelf possible.
- Assure chemicals are properly labeled.
- Segregate incompatible chemicals.
- Store carcinogens in a designated area.
- Provide secondary containment for chemicals in accordance with the ccEHS "Chemical Hygiene Plan": [http://ccejss.berkeley.edu/section5#Chemical_Handling_Storage_and_Transportation](http://ccejss.berkeley.edu/section5#Chemical_Handling_Storage_and_Transportation)
8 - Chemical Spill

Spill – Assess the extent of danger; if necessary request help by calling 911 and 510-642-9090. If you cannot assess the conditions of the environment well enough to be sure of your own safety, do not enter the area. If possible help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors from spill. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.).

Minor Spill – In the event of a minor spill, if there is no potential for hazardous chemical exposure, report the spill to 510-642-9090 and proceed to clean it, if you are trained. Use appropriate personal protective equipment and clean-up material for chemical spilled. Double bag spill waste in clear plastic bags, label and take to the next chemical waste pick-up location.

Call 510-642-9090 to report the spill to ccEHSS and for assistance.

Major Spill – Any hazardous chemical spill that involves chemical exposure, any chemical spill that due to size and/or hazard requires capabilities beyond your training, or any chemical spill that gives the perception (because of odor, for example) that there has been a hazardous release

Call 911 and 510-642-9090 to report the spill to ccEHSS and for assistance.

9 - Cleaning and Decontamination

Lab-specific information on decontamination may be included in the Protocol/Procedure section.

- Wearing proper PPE, laboratory work surfaces should be cleaned at the end of each work day.
- Dispose of contaminated materials in accordance with hazardous waste disposal guidelines referenced below.
- Decontaminate all equipment before removing from a designated area.

10 - Hazardous Waste Disposal

Label Waste

Label all containers with the label provided at:

See the EH&S Fact Sheet, “Hazardous Waste Management” for general instructions on procedures for disposing of hazardous waste.

Dispose of Waste

- Dispose of regularly generated chemical waste within 6 months.
- Call EH&S with questions.

11 - Safety Data Sheet (SDS) Location

SDS can be accessed online at http://ucmsds.com
12 - Protocol/Procedure – Perchloric Acid

| Preparation | Wear proper PPE.  
|             | Prepare the experiment in the hood if possible.  
|             | Use spark-proof tools and explosion proof equipment. Perchloric acid mist and vapor can condense in ventilation systems to form metallic perchlorates, which can be explosive. Inform laundry personnel of contaminant's hazards.  
|             | Be aware of the location of the fire extinguisher, eyewash, and safety shower. |
| Chemical Storage and Disposal | Stability: Unstable.  
|             | **Conditions of Instability:** Perchloric acid itself is unstable (volatile) in concentrated form. It may undergo spontaneous and explosive decomposition. It is also unstable if heated and in contact with incompatible materials, and moisture.  
|             | **Incompatibility with various substances:** Highly reactive with combustible materials, organic materials, acids, alkalis. Reactive with reducing agents, metals. Detonable compounds are often formed from mixtures of perchloric acid and organic materials, especially nitrogenous bases.  
|             | Consult Bretherick's Handbook of Reactive Chemical Hazards, Vol 2, p 312 to 315, 7th Edition (2007) for descriptions of organic perchlorate salt accidents and explosions. This text provides an excellent entry point into the literature for this class of compounds.  
|             | **Corrosivity:** Extremely corrosive in presence of aluminum, of copper. Highly corrosive in presence of stainless steel, of stainless steel. Non-corrosive in presence of glass.  
|             | **Special Remarks on Reactivity:** Incompatible with acids, acetic anhydride, alcohols, aniline and formaldehyde, alkaline materials, organic materials, combustible materials (cellulose, paper, wood), Antimony III compounds, bismuth, charcoal, dibutyl sulfoxide, diethyl ether, dimethyl sulfoxide, fluorine, glycine and lead oxide, glycol ethers, hydriodic acid, hydrogen, hypophosphites, ketones, methyl alcohol, nitrogen iodide, nitrosophenol, phosphorous pentoxide, phosphorus pentoxide and chloroform, sodium iodide, steel, sulfoxides, sulfur trioxide. May react violently or explosively with many of these compounds. Reaction with fuels may be violent. Mixtures of acetic acid, perchloric, and acetic anhydride have varying degrees of sensitivity to shock. Addition of acetic anhydride to aqueous solution of perchloric acid causes formation of acetic acid which can react violently with perchloric acid. Perchloric acid is very hygroscopic and combines vigorously with water with evolution of heat.  
|             | **Special Remarks on Corrosivity:** The aqueous is very corrosive. Minor corrosive effect on bronze.  
|             | Perchloric acid should be stored segregated from all other chemicals & inside secondary containment (such as pyrex baking dish).  
|             | Do not store near combustible materials.  
|             | Store in a tightly closed container.  
|             | Store in a cool, dry, well-ventilated area away from incompatible substances. |
| Avoid storage on wood floors.  
| It must not be stored near organic acids, near bases, or near other organic or flammable material.  
| Shelves and floor material should be non-combustible and acid-resistant.  
| Protect from freezing.  
| Avoid contact with strong dehydrating agents (sulfuric acid, phosphorous pentoxide etc)  

**Disposal:**  
Don't dispose of chemicals down the drain!  
Don't dispose of chemicals via trashcans.  
Don't use hoods to intentionally evaporate chemicals  
Quench reaction by diluting with water, then adding mild base to neutral pH. Check pH before disposal as aqueous waste.  

| **Lab-specific Information**  
| **WARNING:** Take extra care to minimize evaporation of perchloric acid solutions or the concentrated acid; oxidizers can accumulate in the fume hood ductwork and create dangerously explosive perchlorates. If ANY reasonable alternative exists (e.g. a perchlorate salt instead of the acid, a different acid, or a different anion) use it.  
| Many perchlorate salts are explosive. Evaporate perchlorate products only with the utmost care and oversight from the PI.  
| NEVER WORK ALONE.  
| Obtain explicit PI approval for the reaction in question if you intend to evaporate product.  
| Only purchase the minimum amount of perchloric acid needed  
| Do not touch bottles that have turned brown or contain solids (pose explosion hazard)  
| Never heat perchloric acid in a standard hood. If heating is necessary, it must be in a hood designed for perchloric acid use and equipped with wash down facilities.  


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<tr>
<td>1. Preparation of dilute solutions (typically 1-5M)</td>
<td>Up to 10 ml concentrated perchloric acid per dilution</td>
<td>All work using perchloric acid must be performed in a ventilated fume hood with a chemical resistant surface. Never heat perchloric acid in a standard hood. If heating is necessary, it must be in a hood designed for perchloric acid use.</td>
<td><strong>Eye protection</strong>: Wear ANSI approved tight-fitting safety goggles or safety glasses with side shields. <strong>Face protection</strong>: Wear a face shield when not protected by a lab hood sash. <strong>Gloves</strong>: Wear rubber, PVC, Viton or nitrile gloves. Remove gloves as soon as contaminated. <strong>Clothing</strong>: Wear fire/flame resistant lab coat (100% cotton based); cotton based clothing/attire; full length pants or equivalent; and close-toed and close-heeled shoes. Wear acid resistant apron when pouring concentrated perchloric acid.</td>
<td>Always add acid slowly to the bulk water component. Do not add the water to the acid. Avoid contact with strong dehydrating agents (sulfuric acid, phosphorous pentoxide etc) Avoid contact with organic materials (wood, cotton, paper) could result in fire or explosion. Store the diluted solution in the same cabinet with the concentrated solutions. Wash down hood and work area after use. Wipe the work area with a 10% sodium carbonate solution. Quench solutions for disposal by diluting with water, then adding mild base to neutral pH. Check pH before disposal as aqueous waste.</td>
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**Notes**: Any deviation from this SOP requires approval from PI.
<p>| 2. Use as reactant | Up to 1mL (concentrated solution) or 10mL (diluted solution) | Keep away from heat or sources of ignition. No heating is allowed unless the hood is specially designed. Because hot perchloric acid solution is a strong oxidizing agent. Avoid reactions with organic matters as they will explode, unless the solution is very diluted. Clean the work area and potential spill area to make sure that no flammable and/or organic materials present. | Eyes: Wear ANSI approved chemical goggles. Use chemical splash and impact-rated goggles. <strong>Face protection</strong>: If hood sash is up, a face shield should be worn in addition to the goggles. <strong>Gloves</strong>: Wear rubber, PVC, Viton or nitrile gloves. Remove gloves as soon as contaminated. <strong>Clothing</strong>: Wear fire/flame resistant lab coat (100% cotton based); cotton based clothing/attire; full length pants or equivalent; and close-toed and close-heeled shoes. Wear acid resistant apron when pouring concentrated perchloric acid. | Clean the work area and set up the experiments. Check the chemical compatibility before beginning experiments. If heating is needed, please consult with internal lab safety coordinator first. Transfer volume of perchloric acid solution to the reaction with a pipette. Put the perchloric acid bottle back in its storage cabinet ASAP. Once work with perchloric acid is complete, wipe the work area with a 10% sodium carbonate solution. |
|---|---|---|---|
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<tr>
<td>3. Make standard HClO₄ solution for titration</td>
<td>Up to 2000 mL (diluted solution)</td>
<td>Keep away from heat or sources of ignition. No heating is allowed unless the hood is specially designed. Because hot perchloric acid solution is a strong oxidizing agent. Avoid reactions with organic matters as they will explode, unless the solution is very diluted. Clean the work area and potential spill area to make sure that no flammable and/or organic materials present.</td>
<td><strong>Eyes:</strong> Wear ANSI approved chemical goggles. Use chemical splash and impact-rated goggles. <strong>Face protection:</strong> If hood sash is up, a face shield should be worn in addition to the goggles. <strong>Gloves:</strong> Wear rubber, PVC, Viton or nitrile gloves. Remove gloves as soon as contaminated. <strong>Clothing:</strong> Wear fire/flame resistant lab coat (100% cotton based); cotton based clothing/attire; full length pants or equivalent; and close-toed and close-heeled shoes.. Wear acid resistant apron when pouring concentrated perchloric acid.</td>
<td>Purchase the standard 1M HClO₄ solution from J. T. Baker. Boil Millipore water while bubble Ar through to remove CO₂. Pre-rinse the 1L volumetric flask, add standard HClO₄ solution as instructed on the package, rinse HClO₄ tube 3 times with CO₂ free water and fill the flask to the line. (Note: if DMSO needs to be add to the solution, add after the prerinse.) Rinse the 1L bottle for Dosimat 3 times with standard solution, then pour the standard solution into it.</td>
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| 4. Washing of diamond samples | Up to 10 mL concentrated perchloric acid per dilution | All work using Perchloric acid must be performed in a ventilated fume hood with a chemical resistant surface.  
Keep away from heat or sources of ignition.  
No heating is allowed unless the hood is specially designed.  
Because hot perchloric acid solution is a strong oxidizing agent.  
Avoid reactions with organic matters as they will explode, unless the solution is very diluted.  
Clean the work area and potential spill area to make sure that no flammable and/or organic materials present. | **Eye protection**: Wear ANSI approved tight-fitting safety goggles or safety glasses with side shields.  
**Face protection**: Wear a face shield when not protected by a lab hood sash.  
**Gloves**: Wear rubber, PVC, Viton or nitrile gloves. Remove gloves as soon as contaminated.  
**Clothing**: Wear fire/flame resistant lab coat (100% cotton based); cotton based clothing/attire; full length pants or equivalent; and close-toed and close-heeled shoes. Wear acid resistant apron when pouring concentrated perchloric acid. | Always add acid slowly to the bulk water component. Do not add the water to the acid.  
Avoid contact with strong dehydrating agents (sulfuric acid, phosphorous pentoxide etc)  
Avoid contact with organic materials (wood, cotton, paper) could result in fire or explosion.  
Put the perchloric acid bottle back in its storage cabinet ASAP.  
Once work with perchloric acid is complete, wipe the work area with a 10% sodium carbonate solution. |

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<td>5. Preparation of inorganic perchlorate salts by addition of dilute perchloric acid solutions to solutions of metal complexes.</td>
<td>No more than 100 mL total reaction volume.</td>
<td>All work using perchloric acid must be performed in a ventilated fume hood. (SEE WARNING IN PROCEDURE) If the acid is to be heated or if the reaction is exothermic, the procedure must be performed in a perchloric acid specific fume hood.</td>
<td><strong>Eye protection:</strong> Wear ANSI approved tight-fitting safety goggles or safety glasses with side shields. <strong>Face protection:</strong> Wear a face shield when not protected by a lab hood sash. <strong>Gloves:</strong> Wear neoprene, Viton, PVC, or nitrile (NOT butyl) gloves when handling perchloric acid. Inspect gloves prior to use. Remove gloves as soon as contaminated. <strong>Clothing:</strong> Wear fire/flame resistant lab coat (100% cotton based); cotton based clothing/attire; full length pants or equivalent; and close-toed and close-heeled shoes. Wear acid resistant apron when pouring concentrated perchloric acid.</td>
<td>Many perchlorate salts are explosive. Evaporate perchlorate products only with the utmost care and oversight from the PI. NEVER WORK ALONE. Obtain explicit PI approval for the reaction in question if you intend to evaporate product. Use dilute solutions to dissipate heat and reduce risk of fire, explosion, or evaporation. Avoid contact with any easily oxidized or incompatible substances (see list in chemical storage above). If following a literature procedure, do not modify it without approval from PI. Consult PI on process before beginning. Add slowly, monitoring heat generation.</td>
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| 6. Oxidation of organic compounds and/or preparation of organic perchlorate salts. | No more than 100 mL total reaction volume. | All work using perchloric acid must be performed in a ventilated fume hood. (SEE WARNING IN PROCEDURE) If the acid is to be heated or if the reaction is exothermic, the procedure must be performed in a perchloric acid specific fume hood. | **Eye protection:** Wear ANSI approved tight-fitting safety goggles or safety glasses with side shields.  
**Face protection:** Wear a face shield when not protected by a lab hood sash.  
**Gloves:** Wear neoprene, Viton, PVC, or nitrile (NOT butyl) gloves when handling perchloric acid.  
Inspect gloves prior to use. Remove gloves as soon as contaminated.  
**Clothing:** Wear fire/flame resistant lab coat (100% cotton based); cotton based clothing/attire; full length pants or equivalent; and close-toed and close-heeled shoes. Wear acid resistant apron when pouring concentrated perchloric acid. | Organic perchlorates are EXTREMELY HAZARDOUS. Evaporation of organic perchlorate mixtures can lead to violent explosions. All work with organic perchlorates must be done in solution.  
NEVER WORK ALONE.  
Obtain explicit approval for each reaction from the PI.  
Consult Bretherick’s Handbook of Reactive Chemical Hazards, Vol 2, p 312 to 315, 7th Edition (2007) for descriptions of organic perchlorate salt accidents and explosions. This text provides an excellent entry point into the literature for this class of compounds.  
Use dilute solutions to dissipate heat and reduce risk of fire, explosion, or evaporation.  
Avoid contact with any easily oxidized or incompatible substances (see list in chemical storage above). If following a literature procedure, do not modify it without approval from PI. |

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| 7. Disposal of perchloric acid / perchlorate waste | No more than 1 L total waste, but waste must be submitted for pick up the same day it is generated. | All work using perchloric acid must be performed in a ventilated fume hood. (SEE WARNING IN PROCEDURE) | Eye protection: Wear ANSI approved tight-fitting safety goggles or safety glasses with side shields.  
Face protection: Wear a face shield when not protected by a lab hood sash.  
Gloves: Wear neoprene, Viton, PVC, or nitrile (NOT butyl) gloves when handling perchloric acid. Inspect gloves prior to use. Remove gloves as soon as contaminated.  
Clothing: Wear fire/flame resistant lab coat (100% cotton based); cotton based clothing/attire; full length pants or equivalent; and close-toed and close-heeled shoes. Wear acid resistant apron when pouring concentrated perchloric acid. | WARNING: Take extra care to minimize evaporation of perchloric acid solutions or the concentrated acid; oxidizers can accumulate in the fume hood ductwork and create dangerously explosive perchlorates. If ANY reasonable alternative exists (e.g. a perchlorate salt instead of the acid, a different acid, or a different anion) use it instead.  
See warnings in procedures above about dry organic or inorganic perchlorate salts.  
NEVER WORK ALONE.  
Avoid contact with any easily oxidized or incompatible substances (see list in chemical storage above).  
Submit all perchloric acid and perchlorate waste for pick up the same day it is generated. |

Notes | Any deviation from this SOP requires approval from PI.
Sarpong Group Notes for Perchloric Acid

Perchloric acid is the inorganic compound with the formula HClO4. Usually encountered as an aqueous solution, this colorless compound is a strong acid comparable in strength to sulfuric acid and nitric acid. It is a powerful oxidizer, but its aqueous solutions up to 70% are remarkably inert, only showing strong acid properties and no other oxidizing properties. Above concentrations of approx. 70% the speed of oxidizing reactions rapidly increases with increasing acid concentration. The oxidizing power also greatly increases as the temperature is increased. It is useful for preparing perchlorate salts, especially ammonium perchlorate, an important rocket fuel. Perchloric acid is also dangerously corrosive and readily forms explosive mixtures.

Perchloric acid is mainly produced as a precursor to ammonium perchlorate, which is used as rocket fuel. The growth in rocketry has led to increased production of perchloric acid. Several million kilograms are produced annually. It is one of the strongest Brønsted-Lowry acids. Despite hazards associated with the explosiveness of its salts, the acid is often preferred in certain syntheses.

EMERGENCY OVERVIEW: Appearance: clear, colorless liquid. Causes digestive and respiratory tract burns. Causes eye and skin burns. Strong oxidizer. Contact with other material may cause a fire. Heating may cause an explosion. Contact with other material may cause explosion. Corrosive to metal.

Highly important danger information!

In addition to being a corrosive liquid, while not combustible, under some circumstances perchloric acid may act as an oxidizer and/or present an explosion hazard. Perchloric crystals, or perchloric acid in crystalline form, are an extremely dangerous inorganic material. The crystals are sometimes formed due to condensation inside of ventilation hoods in chemical labs or in bottles stored for extended periods in the lab. Among the principle hazards are that the perchlorite crystals are subject to exploding on impact. Perchlorate salts are shock sensitive.

Organic materials are especially susceptible to spontaneous combustion if mixed or contacted with perchloric acid. Under some circumstances, perchloric acid vapors form perchlorates in duct work, which are shock sensitive.

Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Any procedure involving heating of perchloric acid must be conducted in a perchloric acid fume hood, with the sash down. No organic materials should be stored in the perchloric acid hood.

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use spark-proof tools and explosion proof equipment. Avoid contact with clothing and other combustible materials. Do not get on skin or in eyes. Do not ingest or inhale. Use only with adequate ventilation. Do not allow perchloric acid to come into contact with strong dehydrating agents (concentrated sulfuric acid, anhydrous phosphorous pentoxide, etc.). Keep the quantities of perchloric acid handled at the bare minimum for safety. Perchloric acid should be handled in a masonry building with concrete or tile floors. Handling acid on wooden floors is dangerous, especially after the acid has dried. The wooden floor will
then become sensitive to ignition by friction. Perchloric acid mist and vapor can condense in ventilation systems to form metallic perchlorates, which can be explosive. Inform laundry personnel of contaminant’s hazards.

**Storage:** Do not store near combustible materials. Store in a tightly closed container. Keep container closed when not in use. Store in a cool, dry, well-ventilated area away from incompatible substances (e.g. strong dehydrating agents). Avoid storage on wood floors. Perchloric acid should be stored segregated from all other chemicals & inside secondary containment (such as pyrex baking dish). It must not be stored near organic acids, near bases, or near other organic or flammable material. Shelves and floor material should be non-combustible and acid-resistant. Protect from freezing. Do not store for long periods of time or allow solids to form (water to evaporate).

**Spill** – Assess the extent of danger. Clean up perchloric acid spills immediately. Remove all sources of ignition. Absorb spill using an absorbent, non-combustible material such as earth, sand, or vermiculite. Do not use combustible materials such as sawdust. Flush spill area with water. Wet area to prevent drying out. Provide ventilation. Keep combustibles (wood, paper, oil, etc.,) away from spilled material. Keep unnecessary and unprotected personnel away. Use only non-sparking tools and equipment. Spill may be carefully neutralized with soda ash (sodium carbonate).
13 - Documentation of Training (signature of all users is required)

✓ Prior to conducting any work with perchloric acid, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.

✓ The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.

I have read and understand the content of this SOP:

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