



FOCUS ON PHENOL

FIRST AID AND PERSONAL PROTECTIVE EQUIPMENT UPDATE

Phenol is a common chemical used on campus for activities such as tissue preservation and DNA/RNA extraction. Phenol can be a component in a commercial reagent (e.g. QIAzol, TRIzol) or prepared as part of a mixture in the laboratory (e.g. chloroform:phenol). Because phenol solutions are an integral part of routine life science applications, their hazards may be taken for granted. Make no mistake about it, however. Phenol can be very dangerous and the hazards are not just those of a typical corrosive.

The hazards of phenol are 2 fold. It is both a corrosive (can cause severe burns) and toxic (absorbed phenol acts as a systemic toxin). In one case, death resulted from ingestion of as little as 15 mL. Liquid phenol can penetrate the skin with efficiency approximately equal to that of inhalation. Deaths have been reported for exposures of 25% or more of body surface area. Phenol has an anesthetic effect and can cause severe burns that may not be immediately painful or visible. The threshold concentration of human skin damage from phenol is 1.5%. It can cause permanent eye injury and blindness.

There have been a number of phenol splashes to the face that have occurred at Cornell. Most of the workers involved were not wearing appropriate personal protective equipment (such as the basics - lab coats, safety glasses or goggles, or suitable gloves), and it was just luck that the phenol did not splash in their eyes. While none of these exposures were significant enough to cause systemic effects, facial burns could have caused permanent scarring.

These incidents prompted EH&S and Gannett Health Services to review current recommendations for phenol personal protective equipment and first aid procedures. As a result, important changes have been made regarding first aid for dermal (skin) exposures. *Most notably, recommendations are that laboratories working with phenol use polyethylene glycol 300 or 400 (PEG-300 or PEG-400), rather than water, for immediate first aid treatment of dermal exposures.* In addition, all laboratory groups using phenol should take the need for appropriate personal protective equipment seriously and require its use as part of the laboratory's standard operating procedures.

SYMPTOMS OF PHENOL EXPOSURE

The most common route of occupational exposure for phenol is skin contact and absorption. Phenol does not readily form a vapor at room temperature and is unlikely to pose an inhalation hazard unless it is heated or misted. Additionally, it has a distinct, sweet, acrid, odor that is detected by most people at levels well below the OSHA airborne permissible exposure limit (PEL).

Phenol burns and intoxications can be life-threatening. Symptoms include:

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Eye Contact: Severe irritation, permanent damage, blindness.

Inhalation: Respiratory irritation, sore throat, headache, and shortness of breath.

Ingestion: Phenol is very toxic; death can occur rapidly following ingestion. Symptoms include irritation, swelling, burns and damage to the mouth, throat and stomach, internal bleeding, vomiting, diarrhea, decreased blood pressure, shock, collapse, coma and death.

Skin Contact: Initial exposure can cause numbness or slight tingling, so contact may not be immediately apparent. However, even minor contact can result in burns, blisters, permanent skin damage and gangrene. Absorption of phenol through skin can result in phenol toxicity with symptoms including muscle weakness, tremors, loss of coordination, shock, sudden collapse, coma, convulsions, organ damage and death. When phenol contacts the skin, a white covering of precipitated protein forms. It soon turns red and eventually sloughs off, leaving the surface stained slightly brown. If phenol is left on the skin, it will penetrate rapidly and lead to cell death and gangrene.

EXPOSURE CONTROL AND PERSONAL PROTECTIVE EQUIPMENT

Emergency Showers and Eyewashes: Any laboratory using phenol (or any corrosive/caustic chemical) must have an emergency eyewash station accessible within 10 seconds and located in the same room the hazard is being used. Emergency showers must be accessible within 10 seconds and can be located within the room or in the hall way.

Administrative Controls: Never work alone when using phenol. Procedures requiring the use of phenol should have written safety SOPs associated with them.

Engineering Controls: Phenol should be used in a fume hood when working with stock solutions and making formulations and dilutions. Even when working with small amounts of dilute phenol, the best practice is to work in a fume hood because of the splash protection the sash provides and the ability of the hood to contain emissions especially in the event of a spill.

Eye/Face Protection: Safety glasses should be worn if working with small quantities of phenol in a fume hood with the sash properly positioned to provide splash, spray and mist protection. Otherwise, chemical splash goggles should be worn. A face shield (in addition to goggles) may also be necessary. Consider that small facial burns caused by splatter may not be life threatening but can result in permanent disfiguration.

Skin Protection: Lab coat, long sleeves, closed toe shoes, long pants at a minimum. If body splash potential exists, wear a butyl rubber or neoprene apron.

Hand Protection: Hand protection needs to be selected based on projected use (concentration and exposure). For working with phenol at concentrations >70%, butyl rubber, Viton, Barrier and Silver Shield gloves provide good resistance. Neoprene and polyvinyl alcohol are suitable for

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short term work (resistance to breakthrough within 1-4 hours) but should be thicker than 0.3 mm (11.8 mil).

Thin disposable gloves are generally for splash protection only and should immediately be removed if phenol gets on them. Ansell (<http://www.ansellpro.com/index.asp>) recommends “NeoTouch®”(neoprene) or DermaShield (proprietary poly-chloroprene blend) for splash protection when working with 10% phenol solutions. A good practice is to use a heavy weight disposable (0.2 mm; 8 mil) and double glove. In general, nitrile is not recommended as a material of choice when working with phenol.

Ansell has a useful interactive site for choosing gloves based on phenol concentration (10% or 90%) and exposure (splash or immersion): <http://www.ansellpro.com/specware/guide.asp>.

Chloroform and Phenol Mixtures. Phenol is often used in combination with chloroform in nucleic acid purification procedures. Unfortunately, chloroform rapidly degrades both neoprene and nitrile. Ansell has recently developed a relative thin glove (ChemTek® 380214T) consisting of a 4 mil outer layer of Viton® rubber over a 4 mil layer of butyl rubber which provides >90 minutes breakthrough resistance to chloroform/phenol solutions. The request to develop this glove was initiated by University of California, San Francisco as a result of a phenol/chloroform laboratory accident: <http://or.ucsf.edu/ehs/8082-DSY/version/default/part/4/data/> http://www.ansellpro.com/main/pressRoom_pressReleases_details.asp?rId=97.

These gloves (Viton Butyl) may be purchased from VWR, and although they are more expensive than nitrile, they may be reused after incidental contact (always inspect them before use and discard if holes are evident or contamination is apparent):

Size	VWR Catalog #	Price per Pair (approximate)
Small 6.5	89128-804	\$43.27
Medium 7	89128-806	\$43.27
Large 8	89128-808	\$43.27
X-Large 9	89128-809	\$43.27



FIRST AID

Eye: **Rapid and immediate decontamination is critical.** Flush with copious amounts of water for at least 15 minutes, lifting eyelids occasionally. Remove contact lenses if easily removable without additional trauma to the eye. Do not interrupt flushing. Get medical attention immediately.

Inhalation: Remove to fresh air. Get medical attention immediately.

Ingestion: Do not induce vomiting. If victim is conscious and able to swallow, give 4-8 oz (1 c) of milk or water. Get medical attention immediately. Never give anything by mouth to an unconscious person.

Skin Contact: **Rapid and immediate skin decontamination is critical** to minimize phenol absorption. Anyone assisting the victim should wear protective clothing and gloves.

Small Exposures. Rapidly remove contaminated clothing (including anything leather like belts or watchbands) and either irrigate or wipe exposed areas immediately and repeatedly with low-molecular-weight polyethylene glycol (PEG 300 or PEG 400). Treatment should be continued until there is no detectable odor of phenol. If PEG is not available, a glycerine solution can be used instead. If neither of these are available, irrigation with a source of high-density drenching water (such as an emergency shower) will reduce phenol uptake, but lesser amounts of water will merely dilute the phenol and expand the area of exposures. If using the shower or other, shower for at least 15 min.

Large Exposures. First aid treatment is similar to as that for small exposures except the amount of surface area to be decontaminated must be considered. If the amount of phenol on the skin is more than can be quickly removed by swabbing or irrigating with PEG, then an emergency shower should be used and 911 should be called immediately. A high density shower is preferable to reduce phenol uptake. Lesser amounts of water will merely dilute the phenol and expand the area of exposure. If possible, use PEG after the initial decontamination. Otherwise, the victim should stay in the shower until the emergency responders arrive to provide assistance.

For any exposure, double-bag contaminated clothing and personal belongings. Get medical attention. Even if the exposure is small, it is still important to be evaluated by a medical professional to determine if follow-up treatment is necessary. Contact Gannett Health Services at 255-5155.

PHENOL FIRST AID KIT

Laboratories that use phenol are advised to assemble a kit for first aid treatment of dermal exposure. The kit should be located in a visible area where the phenol work is being done (for instance, in the fume hood), or nearby with the location clearly posted. The principal

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investigator or laboratory manager should train all persons working with phenol on how to respond to a phenol exposure and how to use the kit.

EH&S has designed a simple kit that can fit in a plastic zip-lock bag that laboratories can assemble themselves. Included in the kit is a 500 mL bottle of PEG 300 or PEG 400. Pharmaceutical grade (USP or NF) PEG is recommended and available from most chemical suppliers. A 500 mL bottle is meant to treat small areas of exposure, such as might occur when using DNA/RNA extraction kits. For work involving larger amounts of phenol, contact EH&S for help designing a kit and a response plan suitable for the amount of phenol being used.

The recommended contents of the kit and instructions for use are listed below (the list of the contents of the kit can be taped to the outside of the large zip lock bag while the instructions for use should be kept in the bag). Date the bag with the expiration date of the PEG and replace the bottle when it expires (use the opportunity to inspect the integrity of the other items in the kit, such as the gloves, and replace as necessary).

Contents	
Phenol Skin (Dermal) Exposure First Aid Kit	
1	Pre-packaged gauze pads, 4" x 4" (~10) <i>Example: VWR catalog #: 82030-642</i>
2	Polyethylene Glycol 300 or 400, 500 mL (~ 1 pint) USP or NF <i>Example: VWR catalog #: 700012-594</i>
3	Silver Shield gloves (1-2 pairs) <i>Example: VWR catalog #:11000-646</i>
4	Instructions for use
5	Small plastic bag (for collecting waste gauze pads)
6	Large plastic zip lock bag big enough to hold items above



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Instructions

Phenol Skin (Dermal) Exposure First Aid

Emergency Number: 911 (campus phone)
255-1111 (cell phone)

NOTE: This procedure is NOT for eye exposure. For eye exposure, flush with water in an eyewash station for at least 15 minutes and call 911 immediately.

1. Remove contaminated clothing, including any leather items such as watch bands or belts.
2. Put on safety glasses and silver shield gloves (but don't put on the gloves if you are treating yourself and your hands are contaminated with phenol).
3. Open up a few packages of gauze pads.
4. Pour polyethylene glycol liberally on to one of the gauze pads.
5. Gently wipe off excessive phenol on exposed area. Discard the gauze pad in the small plastic bag in the kit.
6. Take a new gauze pad, add polyethylene glycol, and continue to clean off exposed area. Discard the pad. Repeat with a new gauze pad and application of polyethylene glycol until all visible traces of phenol have been removed from the skin.
7. Continue to gently wipe skin (do not scrape or irritate the effected skin area) with polyethylene glycol soaked gauze pads until no odor of phenol remains, changing the gauze pad frequently.

Follow-up:

8. Even if you feel it unnecessary to call 911 and get emergency help, please go to **Gannett Health Services (255-5155)** for evaluation to determine if follow-up treatment is necessary. Don't forget to fill out an on-line accident report! (<http://cfp-rmps.coldfusion.cornell.edu/accinj>)
9. Double bag any contaminated clothing. Label both the bag and the small zip-lock bag used to collect the used gauze wipes as "Hazardous Waste – Phenol Contamination". Contact **EH&S (255-8200)** regarding disposal.
10. Replace the contents of the kit with new, unused items

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REFERENCES

Canadian Centre for Occupational Health and Safety. CHEMINFO: Phenol.
<http://ccinfoweb2.ccohs.ca/cheminfo/Action.lasso?-database=cheminfo&-layout=Display&-response=detail.html&-op=eq&CHEMINFO+RECORD+NUMBER=29E&-search>

Agency for Toxic Substances and Disease Registry. Medical Management Guidelines for Phenol. <http://www.atsdr.cdc.gov/MHMI/mmg115.html>

MSDS. Note that most MSDS have not incorporated the use of PEG into their first aid recommendations. Here is an exception: <http://www.caledonlabs.com/upload/msds/5523-1e.pdf>

Monteiro-Riviere, N. A., A. O. Inman, H. Jackson, B. Dunn and S. Dimond. 2001. Efficacy of topical phenol decontamination strategies on severity of acute phenol chemical burns and dermal absorption: *in vitro* and *in vivo* studies in pig skin and Industrial Health. Toxicology and Industrial Health. 17:95-104

Ruth A Lawrence Poison and Drug Information Center (serving the Finger Lakes Region): 1-800-222-1222 (or 1-585-275-3232). www.fingerlakespoison.org.