Standard Operating Procedure

**Phosphine**

*This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and   
3) SOP has been signed and dated by the PI and relevant lab personnel.*

Print a copy and insert into your   
*Laboratory Safety Manual* and *Chemical Hygiene Plan*.   
Refer to instructions for assistance.

|  |  |
| --- | --- |
| **Department:** | Click here to enter text. |
| **Date SOP was written:** | Click here to enter a date. |
| **Date SOP was approved by PI/lab supervisor:** | Click here to enter a date. |
| **Principal Investigator:** | Click here to enter text. |
| **Internal Lab Safety Coordinator/Lab Manager:** | Click here to enter text. |
| **Lab Phone:** | Click here to enter text. |
| **Office Phone:** | Click here to enter text. |
| **Emergency Contact:** | Click here to enter text. |
| *(Name and Phone Number)* |
| **Location(s) covered by this SOP:** | Click here to enter text. |
| *(Building/Room Number)* |

**Type of SOP:**  Process Hazardous Gas  Hazardous Class

**Purpose**

Phosphineis pyrophoric, highly toxic and a highly flammable gas. It can form explosive mixtures with air and also self-ignite. When phosphine burns, it produces a dense white cloud of phosphorous pentoxide, a severe respiratory irritant. Phosphine gas is denser than air and hence may collect in low-lying areas. If not stored and handled properly, phosphine can pose a serious threat to the health and safety of laboratory personnel and emergency responders. It is important to thoroughly understand the properties of phosphine and follow safety protocols to properly store and handle. Small amounts of phosphine are used as dopant in the semiconductor industry, and a precursor for the deposition of compound semiconductors. Phosphine is mainly consumed as an intermediate in organophosphorus chemistry.

**Physical & Chemical Properties/Definition of Chemical Group**

CAS#: 7803-51-2

Class: **Pyrophoric**, **Toxic Gas**

Molecular Formula: H3-P

Form (physical state): Gas

Odor: Phosphine is often reported as having a disagreeable, garlic-like odor; like the odor of decaying

fish. Pure phosphine is odorless at concentrations up to 200 ppm, a highly toxic level. The characteristic garlic-like odor often attributed to phosphine is actually due to the presence of impurities.

Color: Colorless

Flammable Limits: Lower: 1.6% Upper: 98%

Vapor Density: 1.2 (Air = 1)

Synonyms: Hydrogen phosphide, phosphorus hydride & phosphorus trihydride.

**Potential Hazards/Toxicity**

Emergency Overview:

DANGER!

FLAMMABLE GAS.

POISONOUS

PYROPHORIC.

MAY CAUSE FLASH FIRE.

MAY BE FATAL IF INHALED.

May cause damage to the following organs: lungs, heart, upper respiratory tract, central

nervous system (CNS).

Short-Term Exposure Limit (STEL or ST): 1 ppm (1.4 mg/m3)

8-Hour Time Weighted Average (TWA): 0.3 ppm (0.4 mg/m3)

10-Hour Time Weighted Average (TWA): 0.3 ppm (0.4 mg/m3)

Immediately Dangerous to Life & Health (IDLH): 50 ppm (70 mg/m3)

**Personal Protective Equipment (PPE)**

**Respirator Protection**

Respirators should be used only under any of the following circumstances:

* As a last line of defense (i.e., after engineering and administrative controls have been exhausted).
* When Permissible Exposure Limit (PEL) has exceeded or when there is a possibility that PEL will be exceeded.
* Regulations require the use of a respirator.
* An employer requires the use of a respirator.
* There is potential for harmful exposure due to an atmospheric contaminant (in the absence of PEL)
* As PPE in the event of a chemical spill clean-up process

Lab personnel intending to use/wear a respirator mask must be trained and fit-tested by ORS and should contact occhealt@uga.edu. This is a UGA requirement described in more detail in the [UGA Respiratory Protection Plan](https://esd.uga.edu/sites/default/files/respiratoryprotection.pdf) and supported by the [Office of Research Occupational Health and Safety Program](https://research.uga.edu/ohsp/).

**Hand Protection**

Neoprene gloves or fire gloves is recommended for Phosphine.

NOTE: Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with Phosphine.

Refer to glove selection chart from the links below:

<http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf>

OR

<http://www.allsafetyproducts.biz/page/74172>

OR

<http://www.showabestglove.com/site/default.aspx>

OR

<http://www.mapaglove.com/>

**Eye Protection**

Safety glasses/goggles & Face shield (ANSI Approved).

**Skin and Body Protection**

Nomex suit & Nomex hood (clean room gown/attire)

**Engineering Controls**

Always to be stored and used inside a gas cabinet.

**First Aid Procedures**

**If inhaled**

Call medical doctor or poison control center immediately. Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

**In case of skin contact**

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately. During frostbite: Try to warm up the frozen tissues and seek medical attention.

**In case of eye contact**

Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.

**If swallowed**

As this product is a gas, refer to the inhalation section.

**Special Handling and Storage Requirements**

**Handling:** Use only with adequate ventilation. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. High pressure gas. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Keep container closed. Keep away from heat, sparks and flame. To avoid fire, eliminate ignition sources. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement. **Storage:** Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Segregate from oxidizing materials. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F). **Materials to avoid:** Phosphine reacts with many metals, including copper, silver, gold, and the salts of these metals. It reacts violently with oxygen, oxidizers (e.g., nitric acid and nitrogen oxides), metal nitrates, halogens (fluorine, chlorine, bromine and iodine) causing a fire and explosion hazard.

**Salient Points to Remember**

In case of fire, use water spray (fog), foam or dry chemical.

**Fire-fighting measures**

In case of fire, allow gas to burn if flow cannot be shut off immediately. Apply water from a safe distance to cool container and protect surrounding area. If involved in fire, shut off flow immediately if it can be done without risk. Contains gas under pressure. Flammable gas. In a fire or if heated, a pressure

increase will occur and the container may burst, with the risk of a subsequent explosion. Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

**Prerequisites for Phosphine Use**

**NOTE:** Only experienced and well trained lab personnel must handle Phosphine gas cylinder. \*There may be other requirements based on fire codes, depending on the quantity & concentration of Phosphine and other highly flammable gases used and/or stored in the lab.

1. Phosphine Gas Cabinet must be in place.
2. Auto purge system must be in place.
3. Gas cabinet exhaust with minimum face velocity of 200 cfm must be in place.
4. Excess flow valve and nitrogen aspirator must be in place (need nitrogen source and excess flow should be built into manifold).
5. Dedicated N2 cylinder for manifold purge must be in place.
6. Hands-on training for gas bottle change and manifold operation from vendor required.
7. All gas lines must be stainless steel, heliarc welded and helium leak-checked.
8. Burn box at the rear end of the tube furnace (if used) must be in place.
9. Use only DISS 632 connection with a Nickel gasket.
10. DISS 632 Connection: New uncoated nickel 200 gaskets must be used.
11. \*Valve seats can leak. Hence, Phosphine cylinder valves must have a secondary seal on the outlet.
12. Appropriate PPE: Neoprene/Fire gloves, Nomex suit, face shield, ear plugs, safety glasses & Nomex hood
13. Pneumatic valve for Phosphine cylinder should be in place. The pneumatic valve must also have a manual operation valve in addition.
14. Restrictive Flow Orifice (RFO) must be in place.
15. Have Phosphine cylinder valve at a convenient/workable height.
16. Lab buddy system is a must to work with Phosphine (i.e., One must never work alone in the lab where Phosphine Gas is stored and/or used).
17. Have a lab-mate (lab buddy) with the same level of training and PPE on, visually observing and ready to assist if necessary.

* You must have easy access to both landline/lab phone and cell phone at all times.
* Lab supervisor/lab PI must be aware of your plans to work with Phosphine on a given day.
* Must have a written Standard Operating Procedure (SOP) for Phosphine use/handling in place.
* Phosphine users must have thoroughly read & signed the SOP that is written approved by the lab PI/Supervisor.
* Your set-up must be in good working condition (with valves and supply lines working properly)
* You must have a ‘Lab Emergency Contact’ list readily available at all times.
* You must have access to a routinely inspected Safety Shower & Eyewash station accessible within 10 seconds.
* Must have NFPA fire diamond posted on the door with up-to-date/latest contact information.
* You must have easy access to the SDS (Hardcopy and Electronic copy/On-line)
* You must be aware of the emergency evacuations procedure. There must be exit signs in the lab.
* You must have access to a fully stocked first-aid kit.
* You must have access to a monthly inspected fire extinguisher.

**Chemical Spill Dial 911**

**24-7 On-Call Response to Research, Environment, Health or Safety Concerns Dial 2-5561 from a campus phone or 706-542-5561 from a non-campus line.**

**Spill** – Follow the procedures set out in the [UGA Chemical and Laboratory Safety Manual.](http://research.uga.edu/docs/units/safety/manuals/Chemical-Laboratory-Safety-Manual.pdf)

[If there are any chemical-specific protocols for responding to a spill, insert them here or mark “none”:]

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# **Medical Emergency Dial 911**

**Life Threatening Emergency, After Hours, Weekends And Holidays** – Dial **911** or the emergency phone numbers listed at the beginning of the UGA Chemical and Laboratory Safety Manual

*Note: All incidents that result in an injury or property damage must be reported to ORS / ESD using a University Incident/Accident Report.*

**Non-Life Threatening Emergency** – Follow the instructions in the UGA Chemical and Laboratory Safety Manual.

*Note: All incidents that result in an injury or property damage must be reported to ORS / ESD using a University Incident/Accident Report.*

**Decontamination/Waste Disposal Procedure**

**For general hazardous waste disposal procedures, see Appendix H of the UGA Chemical and Laboratory Safety Manual.**

**Chemical Specific Procedures: [to be inserted or marked as “none”]**

**Safety Data Sheet (SDS) Location**

UGA personnel can access Online SDS through a link in the upper left corner of the ESD home page (<https://esd.uga.edu>) and logging in by using their UGA email user name and password.

**Protocol/Procedure (Add lab specific Protocol/Procedure here)**

Click here to enter text.

**NOTE**

Any deviation from this SOP requires approval from PI.

**Documentation of Training** (signature of all users is required)

* Prior to conducting any work with Phosphine , 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 access to the SDS provided by the manufacturer.
* The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last 12 months.

**Principal Investigator SOP Approval**

Print name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Signature\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Approval Date:

I have read and understand the content of this SOP:

|  |  |  |
| --- | --- | --- |
| **Name** | **Signature** | **Date** |
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