**University of Arizona**

**Hydrogen Gas Standard Operating Procedure**

*[This is a template. Fill in all necessary blanks and delete all highlighted areas when complete. Add any sections necessary for your laboratory. This will be appended to your Laboratory Chemical Hygiene Plan.]*

**Title:**  **Click here to enter the title of your SOP.**

**Approval Holder (AH):** Click here to enter text **Approval #:** Click here to enter text

**Approval Holder Phone Number(s):** Click here to enter text

**Approval Safety Coordinator (ASC):** Click here to enter text

**Approval Safety Coordinator Phone Number(s):** Click here to enter text

**Department:** Click here to enter text

1. **Purpose**

This standard operating procedure (SOP) is intended to provide guidance on how to safely Describe the procedure or process this SOP will address in Enter AH’s name’s laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before Describe the procedure or process this SOP will address. If you have questions concerning the requirements within this SOP, contact your Approval Holder (AH) or Approval Safety Coordinator (ASC).

1. **Scope**

*[Describe when this SOP applies and to whom this SOP applies.]*

1. **Hazard Description**

*[Describe the hazards presented by the procedure or process this SOP addresses. What makes it hazardous? Provide an example, if applicable.]*



Hydrogen (H2) is a highly flammable gas. Hydrogen gas forms explosive mixtures with air if it is 4–74% concentrated and forms explosive mixtures with chlorine if it is 5–95% concentrated. The mixtures spontaneously explode by spark, heat or sunlight. Auto-ignition temperature (temperature of spontaneous ignition in air) is 500 °C (932 °F). The detection of a burning hydrogen leak may require a flame detector; such leaks can be very dangerous. Hydrogen reacts with every oxidizing element, including other gases like oxygen or even compressed air.

* Physical hazards
  + Potential detonations and fires when mixed with air. Hydrogen gas leaking into external air may spontaneously ignite.
  + Hydrogen fire, while being extremely hot, is almost invisible, and thus can lead to accidental burns.
  + Dissolves in many metals and may have adverse effects on metals, such as hydrogen embrittlement, leading to cracks and explosions.
* Health hazards
  + Displaces oxygen in the air and acts as a simple asphyxiant by reducing the partial pressure of oxygen.

1. **Process & Hazard Controls**

*[Describe the steps needed to set up and complete the procedure or process in safe manner following the* [*hierarchy of controls*](https://www.cdc.gov/niosh/topics/hierarchy/default.html)*. Use as much detail as is necessary to ensure all laboratory workers can complete the procedure or experiment safely.]*

* 1. **Elimination/Substitution**

*[Describe any eliminations of hazardous chemicals or processes; alternatively, any substitutions with less hazardous alternatives that could be used to accomplish the task. Delete this section if you are unable to eliminate or substitute.]*

* 1. **Engineering Controls**

*[Describe any engineering controls (e.g. fume hoods, gas cabinets, local exhausts, blast shields, etc.) that are used to safely accomplish the task.]*

* Fume hood or gas cabinets can be used to stored hydrogen cylinders and reduce potential hazards from leaks or fires.
* Regulators should have a backflow arrestor to prevent explosions.
  1. **Work Practices**

*[Describe any work practices (e.g. staggering schedules, additional cleaning measures for particulates, etc.) that are used to safely accomplish the task.]*

* Have lab buddy system when working with highly flammable gases such as Hydrogen, Ethane, Methane, Acetylene etc.
* Eliminate likely ignition sources, and suspect unknown ignition sources.
* Store hydrogen gas cylinders away from electrical panels and emergency eyewash & safety shower.
* Always assume hydrogen is present and verify the system has been purged to less than 1 percent when performing system maintenance on a hydrogen system. Inert gases such as nitrogen and argon can be used for purging.
* Always use Stainless Steel (SS) tubing to convey hydrogen gas. Teflon tubing is okay if specified by the manufacturer.
* Remove the regulator and place the safety cap on, when the cylinder is not in constant use.
* Hydrogen gas leak detector installation is recommended.
* Prevent hydrogen leaks by meticulously connecting gas regulator and tubing. Leak test equipment regularly – piping can develop cracks and leaks over time and from repeated use.
* Compressed gas cylinders should be double chained or strapped (chains are preferred) to a stable structure such as a wall. The first chain must be one third from the bottom of the cylinder and the second chain should be one third from the top of the cylinder.
* Secure cylinders of equal sizes together to avoid chaining problems.
* If a compressed gas cylinder holding metal rack is used to restrain the cylinders, the rack must be bolted to the floor and the chains or rods must be at 1/3rd from the bottom and 1/3rd from the top of the cylinders. Clam shell (a cylindrical metal casing bolted to the floor) can be used to secure cylinders that need to be stored and used next to the experimental set-up.
* Ensure cylinders are grounded and bonded properly prior to use.
  1. **Personal Protective Equipment**

*[Describe the personal protective equipment needed to adequately protect laboratory workers when performing the process or procedure addressed by this SOP. Ensure to specify any personal protective equipment beyond the minimum (i.e. safety glasses, lab coat, gloves, long pants and closed-toed shoes).]*

* **Hand and Arm Protection**: Insulated gloves and leather gloves work best, but 100% cotton would also be acceptable.
* **Face and Eye Protection**: Safety glasses are a minimum protection; the use of a face shield with eye protection is strongly recommended to protect both the eyes and face from splashes.
* **Body Protection**: A 100% cotton lab coat is minimal protection; flame-resistant lab coat should be used and is preferred.
  1. **Transportation and Storage**

*[Describe how to safely transport and/or store (e.g. ventilated cabinet, flammable cabinet, under inert blanket, etc.) the hazardous chemical(s) or processes.]*

* **Storage:**
  + Store hydrogen gas cylinders away from electrical panels but close to an emergency eyewash and safety shower.

1. **Spills, Cleanup & Disposal**

*[Describe how to safely end the procedure or process, clean up the process or spills, and/or dispose of any waste generated.]*

Spill response should always follow the [University Chemical Hygiene Plan](https://rgw.arizona.edu/sites/default/files/cs-univeristy_chemical_hygiene_plan.pdf) Section 8.2. Please find general guidance below:

* **Cylinder Leaks**
  + The supply source shall be shut-off immediately, if it will not compromise your health
  + The area shall be evacuated, including the surrounding area
  + Call **911** immediately

**Exposure Response**

|  |  |  |  |
| --- | --- | --- | --- |
| **Inhalation** | **Ingestion** | **Skin Contact** | **Eye Contact** |
| Remove to fresh air and keep at rest in a position comfortable for breathing. If not breathing,  give artificial respiration. If breathing is difficult, trained personnel should give oxygen. Call a  physician. | Ingestion is not considered a potential route of exposure. | Adverse effects not expected from this product. | Immediately flush eyes thoroughly with water for at least 15 minutes. Hold the eyelids open and  away from the eyeballs to ensure that all surfaces are flushed thoroughly. Contact an  ophthalmologist immediately. Get immediate medical attention |

1. **Enter Additional Section Title**

*[Add as many sections as necessary to adequately describe how to safely perform the procedure or process addressed by this SOP.]*

1. **References**

* UCLA Flammable Gases SOP: <https://ucla.box.com/s/3g51tqlx2mj86ir145zmax0ql8osfi1u>