General Lab Safety Procedure

Purpose

The purpose of this procedure is to support work practices for protecting laboratory personnel from potential health hazards in the laboratory.

1. Laboratory Safety Guidelines

1.1 GENERAL LABORATORY SAFETY

- Do not eat, drink, or apply cosmetics in the lab.
- Store food and drink in food designated refrigerators only. Don't mix chemicals and food.
- Tie back medium length and long hair when working near flames or entangling equipment.
- All accidents, no matter how minor, should be reported to the faculty/staff member supervising the laboratory.
- Know the location of all safety equipment (e.g. eyewash, fire extinguisher, fire blanket, safety showers, spill kit) if available.
- Keep aisles clear.
- Maintain unobstructed access to all exits, fire extinguishers, electrical panels, emergency showers, and eyewashes.
- Do not use corridors for storage or work areas.
- Do not store heavy items above 6 feet high.
- Consult a coworker if planning to work alone or running an unattended operation.
- Never work alone in the chemistry lab or when performing high-risk operations.
- Keep area clean and uncluttered; clean up area upon completion of task or at end of the day.

1.2 PERSONAL PROTECTIVE EQUIPMENT (PPE)

- Review SOP, MSDS and other hazard information to determine appropriate PPE to wear based on chemical hazards encountered.
- Lab coats and safety glasses are to be worn at all times in the chemistry lab and when using hazardous chemicals.
- Remove gloves when leaving the laboratory, so as not to contaminate doorknobs, etc.

1.3 ELECTRICAL SAFETY

- Don't use permanent extension cords.

1.4 CHEMICAL SAFETY

- Know the hazards of the chemicals you're working with. Consult the material safety data sheet (MSDS) or other appropriate references prior to using a chemical with which you're unfamiliar.
- Make sure all chemicals are clearly and currently labeled with the substance name.
- Use volatile and flammable compounds only in a fume hood. Procedures that produce aerosols should be performed in a hood to prevent inhalation of hazardous material. Be sure the fan is on at all times when using a fume hood. Fume hoods should not be used for storage.
- Material Safety Data Sheets (MSDS) shall be provided for all hazardous chemicals before use.

- Keep proper records of time sensitive chemicals (oxidizers, THF, and organic peroxides), and dispose of all these chemicals before their expiration date.
- Perform proper housecleaning of your lab area once a year to discard of unused chemicals and materials. General chemicals that have been around for three years or more should be discarded.
- Provide a check in procedure for incoming researchers and visiting researchers. Review safety and operational procedures with them.
- If a researcher will be leaving Caltech, please go through a check out procedure with your researcher (visiting and otherwise) that all chemicals and related materials (desiccants, silica filtration beads, etc.) are also properly disposed of, prior to them leaving Caltech. This helps to avoid any unknowns in your lab area, which are difficult to manage by the Institute.
- Clean up of large spills should not be attempted. Call Environmental Health and Safety Office at 6727 for clean up.

1.5 FLAMMABLE AND COMBUSTIBLE LIQUIDS

- Use fire-hazard chemicals in vented hoods and away from sources of ignition. Fire-hazard chemicals are chemicals with a flash point below 200° F (93.3° C).
- Store flammable liquids in excess of 10 gallons in approved flammable liquid storage cabinets.
- Follow proper storage procedures for flammable and combustible liquids. This includes not storing corrosives and flammables in the same cabinet.

1.6 OLD, DAMAGED, OR NO LONGER USEFUL EQUIPMENT

- Review the equipment asset list for your lab at least once a year to see if you have old, damaged, or outdated equipment that require disposal.
- For proper disposal, notify the Safety Office if you believe that the equipment has been used for radiological, biological, or chemical work. The types of equipment should be decontaminated and certified prior to disposal, and the Safety Office is able to assist you with this process.
- Contact your Building Administrator if you have a large amount of e-waste for disposal, as they work with you to get this matter taken care of, or you may take it over to the Recycling Center on the first Wednesday of each month between 9:00am and 12:00pm for proper disposal.
- Do not leave old equipment in the hallways, as these are potential fire hazards.

1.7 EMERGENCY RESPONSE PROCEDURES

- Emergencies on campus (ex: police, fire, paramedics, chemical, etc.) **CALL 5000.**

1.7.1 Fire

- Remain calm
- Alert others
- Close doors
- Evacuate to EAP (Gates courtyard)

1.7.2 Earthquake

- Remain calm
- Drop, cover, and hold
- Evacuate when shaking stops if building damage present

1.7.3 Shelter in Place when

- A chemical or biological spill elsewhere on campus
- Severe weather
- Or an armed individual on campus

1.7.4 Biological, Chemical, and Radiological Incidents

- Attend to injured persons
- Confine the area
- Get help-notify Safety or Security
- Evacuate if necessary

1.7.5 Personal Injury

- Check the area for additional hazards
- **Call 5000** and notify the supervisor
- Care:
- Remove the injured/exposed individual from the area, unless it is unsafe to do so because of the medical condition of the victim or the potential hazard to rescuers.
- Report the exposure to EH&S.
- Flush contamination from eyes/skin using the nearest emergency eyewash/shower for a minimum of 15 minutes. Remove any contaminated clothing.
- Bring to the hospital copies of MSDSs for all chemicals the victim was exposed to.

Lab Specific Procedure

2. Laboratory Specific Safety Procedure

2.1GUIDELINES FOR USING NANOMATERIALS

Exposure standards have not been established for engineered nanoparticles in the United States or internationally [Safe Nanotechnology 2008.] Therefore, the guidelines below are designed to help researchers implement a combination of engineering controls, work practices, and personal protective equipment to minimize potential exposures to themselves and others.

As a general and quick guide to the exposure risks and prudent control measures to be used for common laboratory operations involving nanomaterials, refer to the table below. It is important to consider if the nanoparticles are in an agglomerated or aggregated form, functionalized, suspended in liquid, or bound, as these conditions may affect the exposure potential.

Quick Guide: Exposure Risks and Control Measures for Common Laboratory Operations Involving Nanomaterials

Activity types, by Risk of Exposure	**Primary Control Measures**
Low Probability: • Non-destructive handling of solid nanoparticle composites or nanoparticles permanently bonded to a substrate	• Disposable nitrile or PVC gloves. Do not reuse gloves. • Wet cleaning procedures and/or HEPA vacuum for surfaces/equipment.
Medium / High Probability: • Working w/ nanomaterials in liquid media during pouring or mixing, or where a high degree of agitation is involved (e.g., sonication) • Handling nanostructured powders* • High speed abrading/grinding nano-composite materials • Maintenance on equipment used to produce nanomaterials • Cleaning of dust collection systems used to capture nanoparticles	• Conduct task within a fully enclosed system (e.g., glove box), or fume hood • Disposable gloves appropriate for the solvent in which the particles are suspended. Do not reuse gloves. • Safety eyewear (+ face shield if splash potential exists) • Wet cleaning procedures for surfaces/equipment
High Probability: • Generating nanoparticles in the gas phase or in aerosol (spill or liquid) • Manipulation of nanoparticles in gas stream	• Work in enclosed systems only (e.g., glove box, glove bag, or sealed chamber).

2.2 COMPRESSED GAS CYLINDERS

- **For all lab personnel:**
  - Should be familiar with the gas container content and the potential hazards. They should have access to the appropriate Material Safety Data Sheet.
  - Secure cylinders at the top and bottom. Keep the cylinder capped when not in use.
  - All gas cylinders, including lecture and empty bottles, should be in an upright manner and chained.
- **For lab personnel responsible for changing out compressed gas cylinders:**
  - Wear safety glasses when handling compressed gases.
  - Do not lubricate, modify, force, or tamper with cylinder valves.
  - Always make sure that the regulator appears sound before attaching it to a cylinder.
  - Make sure that the correct regulator and CGA connector is being used. See CGA Connection Chart at the end of this document. If the connections do not fit together readily, the wrong regulator or a defective regulator is probably being used.
  - Use only the correct fittings and connections to ensure compatibility. Make sure that the threads on the cylinder and the connection mate, and are of a type intended for gas service.
  - Attach the regulator securely with the secondary valve closed and preferably with the regulator flow backed off (counterclockwise) before opening the cylinder valve wide.
  - When cylinders are no longer in use, shut the valves, relieve the pressure in the gas regulators, remove the regulators and cap the cylinders.
  - Before returning empty gas containers, a check should be carried out to ensure that the container valve is closed (and not leaking) and that the valve outlet plug (or cap nut) has been securely refitted.
  - Leave a small amount of contents in the cylinder to avoid contamination.
  - Segregate gas cylinder storage from chemical storage.
  - Keep incompatible classes of gases stored separately. Keep flammables from reactives which include oxidizers and corrosives. For example, keep cylinders containing oxygen or oxidizing gases away from flammable solvents, combustible materials, unprotected electrical connections, gas flames or other sources of ignition.
  - Always label cylinders so you know their contents; do not depend on the manufacturers color code. Gas cabinets should have a clear label on the outside.
  - Note the name and phone number of the supplier of the cylinder. Cylinders are generally "loaned" when they are distributed, and the empty cylinders are to be returned to the supplier once you are finished with the gas.
  - If a cylinder of material has been here for more than three years, please contact the EHS Office and mark it for return to the supplier.

2.3 CORROSIVE AND CONTACT-HAZARD MATERIALS

Corrosive, allergenic, and sensitizer information is given in MSDS and on chemical container labels. Handling processes should be designed to minimize the potential for splash, splatter, or other likely scenarios for accidental contact. Handle corrosive chemicals and contact-hazard chemicals with all proper safety precautions according to the way they will be used. This may include wearing both safety goggles and face shield, gloves tested for absence of pinholes and known to be resistant to permeation or penetration, and a laboratory apron or laboratory coat. Additional protective clothing (i.e., apron, over sleeves) is appropriate where chemical contact with body and/or skin is foreseeable.

- Do not pour water into acid. Slowly add the acid to the water and stir.
- Open bottles or carboys slowly and carefully and wear protective equipment to guard hands, face, and body from splashes, vapors, gases and fumes.
- Use a mechanical aid or a pipette bulb for pipetting.
- Wipe drips from containers and bench tops. Be especially careful to wipe up visible residues of sodium hydroxide and potassium hydroxide from all surfaces. Skin contact with dry residue will result in burns.
- Strong acids/bases are to be handled in a fume hood.
- Corrosives should never be stored above eye level.

2.4 PHOSPHORIC ACID

- Reacts with metals to liberate flammable hydrogen gas.
- Incompatible with sodium tetrahydroborate producing a violent exothermic reaction.
- Heat generated with: alcohols, glycols, aldehydes, amides, amines, azo-compounds, carbonates, caustics, esters, ketones, phenols and cresols, organophosphates, epoxides, combustible materials, unsaturated halides, organic peroxides.
- Formation of flammable gases, with aldehydes, cyanides, mercaptins, and sulfides.
- Formation of toxic fumes with cyanides, fluorides, halogenated organics, sulfides, and organic peroxides.
- Do not mix with solutions containing bleach or ammonia.
- Incompatible with nitromethane, chlorides + stainless steel.

2.5 HYDROCHLORIC ACID

- Incompatible with hydroxides, amines, alkalis, cyanides, sulfides, sulfites, formaldehyde, copper, brass, and zinc.
- Hydrochloric acid solution in water is a strong acid: it reacts violently with bases and is corrosive.
- Reacts violently with oxidants forming toxic chlorine gas. Attacks many metals in the presence of water, forming flammable/explosive hydrogen gas.
- When heated to decomposition, emits toxic hydrogen chloride fumes and will react with water or steam to produce heat and toxic and corrosive fumes. Thermal oxidative decomposition produces toxic chlorine fumes and explosive hydrogen gas.
- If involved in a fire use water spray and neutralize with soda ash or slaked lime.

2.6 FUME HOODS

- Ensure the fume hood is labeled with a certification date of less than one-year prior.
- Maintain hood sash at or below the maximum height indicated by an arrow on the side of the fume hood. Close the hood sash when not working in the hood.
- Equipment used in hoods should be placed securely on blocks to allow air to flow under and around the equipment.
- Keep chemical sources and equipment at least six inches away from the face or rear of the hood.

- Don’t store equipment and chemicals in the hood to avoid dead air spaces and to prevent blocking back baffles.
- Visually inspect baffles (openings at the top and rear of the hood) to be sure slots are open and unobstructed.
- All electrical devices should be connected outside the hood to avoid sparks that may ignite a flammable or explosive chemical.
- Do not use a fume hood for any function which it is not intended. Certain chemicals or reactions require special constructed hoods. Examples are perchloric acid or high pressure reactions.
- If you are not sure if there is sufficient airflow in your fume hood due to extra equipment, please contact the EHS Office and we will perform a survey for you.

2.7 LIQUID NITROGEN

The selection of materials to be used with cryogenics is important because of the changes in physical properties of materials at very low temperatures. The Dewar flask is the most common container used for storage and transfer of cryogenic fluids. When using the Dewar, follow these procedures:

- Cover the Dewar with a cap that allows escape of built-up pressure and keeps air and moisture out.
- Transfer cryogenic liquids from large Dewar vessels with special transfer tubes designed for the particular application.
- Tipping or tilting to pour the liquid may damage large Dewars.
- Do not use heat guns or similar equipment to warm transfer tubing quickly for disconnection.
- Handle containers carefully to protect the vacuum insulation system of Dewars.
- Place large Dewars on dollies that move freely so there is no possibility of personal injury or damage to the supported Dewars.
- Due to extremely cold temperatures of cryogenic liquids and “boil-off” gases, use the following personal protective equipment (PPE):
    - When cryogenics are present, safety glasses with side shields
    - When cryogenics are poured or transferred,
        - Safety glasses and a full face shield
        - Loose-fitting thermal gloves
        - Long-sleeved clothing (lab coat)
        - Long pants
        - Closed-toe shoes

Anyone using cryogenic material must receive instruction in using cryogenic materials safely from their lab supervisor or safety officer.

If there is a cryogenic spill, immediately leave the area. If you believe the cryogen has caused significant oxygen depletion, do not re-enter the area unless the oxygen content of the atmosphere is at least 19.5% and there is no flammable or toxic mixture present.

2.8 HYDROFLUORIC ACID

Hydrofluoric acid, a solution of hydrogen fluoride gas (HF) in water, is one of the most corrosive and dangerous chemicals encountered in the laboratory. The following special safety precautions are necessary when using this chemical, regardless if using dilute or concentrated HF.

2.8.1 First Aid Procedures and First Aid Kits

In the event of HF exposure, immediately start the first aid procedures as outlined in the **Hydrofluoric Acid First Aid Instructions** below. Once first aid has been started, call 5000 to transfer person to emergency room.

Post Caltech's **Hydrofluoric Acid First Aid Instructions** in labs that keep or use HF gas or solutions; see attached HF first aid instructions.

2.8.2 Personnel Exposures

- See the attached **Hydrofluoric Acid First Aid Instructions** for personnel exposures.

2.8.3 First Aid Kit

First aid kit must contain calcium gluconate gel for use in emergencies.

- 2.5% calcium gluconate gel can be purchased through many lab safety supply vendors.
- Ensure gel is intended for HF "dermal exposures" and has an effective shelf life of at least one year.
- Create a system to refresh your supply of gel before the expiration date.

2.8.4 Personal Protective Equipment (PPE)

- Wear appropriate PPE, which includes:
    - Goggles and face shield
    - Butyl rubber or neoprene gloves
    - Lab coat and closed-toe shoes

2.8.5 Safe Work Practices

- Work in a fume hood with the sash opening minimized—sash must not be opened beyond the stickered arrow.
- Storage of HF and HF waste should be in a closed, labeled, chemically compatible container (e.g. polyethylene or Teflon). Glass, metal, and ceramic containers are not compatible with HF. It should have a polyethylene secondary containment tray.
- Avoid using glass containers. HF will etch and degrade glass.
- Use smallest quantities necessary.
- Check PPE for damage before using.
- HF waste should be placed in a chemically compatible container with a sealed lid and clearly labeled.

2.8.6 Spills

- If HF is spilled outside fume hood, evacuate the area, close the doors, post the area with a sign to prevent others from entering, and call 5000.
- Small spills inside the fume hood can be cleaned up by a laboratory staff if they have received spill cleanup training, have the correct equipment, understand the hazards, and are confident in their ability to clean up the spill safely and dispose of waste properly. Lime soda, ash, sodium bicarbonate, or a spill absorbent specified for HF should be used for cleanup. Organic spill kits that contain Floor-Dri, kitty litter, or sand should not be used because HF reacts with silica to produce silicon tetrafluoride, a toxic gas.

2.8.7 Hazards Associated with Other Fluorine Compounds

- Many chemicals containing fluorine, such as ammonium fluoride, sodium fluoride, sulfur tetrafluoride, and ammonium bifluoride, may react with acid or water to produce HF. Review the MSDS of all fluoride compounds carefully for safety precautions to reduce the risk of creating a HF hazard. If the manner in which the fluorine compound is used can create HF, follow the precautions for HF and keep topical antidote on hand.

HYDROFLUORIC ACID FIRST AID INSTRUCTIONS

POST THESE FIRST AID INSTRUCTIONS IN THE ROOM WHERE THE HYDROFLUORIC ACID IS USED OR HANDLED.

Location of calcium gluconate gel:
Building and Room:
Exact Location in Room:

BACKGROUND ON HF

Hydrofluoric acid (HF) exposure is very toxic and can be fatal if not treated immediately. HF is absorbed quickly; however, damage/symptoms can occur hours to days later. **Any person exposed to HF must have <u>immediate</u> first aid, followed by <u>immediate</u> medical treatment from a physician.** When seeking medical attention **bring a copy of the HF Material Safety Data Sheet** to the Emergency Room.

SKIN EXPOSURE	EYE
1. Immediately flush affected area with water for <u>15 minutes</u> under emergency eyewash/shower station or other water source. Remove all contaminated clothing while flushing with water. 2. After flushing, apply calcium gluconate to burn site with clean, gloved hand. Continue massaging gel into the affected area of skin. Reapply every 15 minutes until emergency medical assistance arrives. 3. For emergency medical assistance, call: • 5000	1. Immediately flush eyes with water for at least <u>15 minutes</u> under emergency eyewash or other water source. If only one eye is affected, be careful not to flush contaminated water into the other eye. If possible, provide continuous irrigation during transport. 2. Do not apply calcium gluconate gel to eyes. 3. For emergency medical assistance, call: • 5000
INHALATION	**INGESTIO**
1. Remove to fresh air 2. Get medical assistance immediately, call: • 5000	1. Do not induce vomiting. 2. Rinse mouth with cold water. 3. If the victim is conscious, have them drink lots of water to dilute the acid. 3. For emergency medical assistance, call: • 5000

Table : Compressed Gas Association Connection Chart for Regulators
[from CCE Safety Manual]

CYLINDER GAS TYPE	**CHEMICAL SYMBOL**	**CGA CONNECTION** Standard/Alternate
Acetylene	C_2H_2	510/300
Air	----	590/346
Allene	CH_2:C:CH_2	510
Ammonia Anhydrous	NH_3	240/705
Ammonia (VHP)	---	660
Antimony Penta Fluoride	SbF_5	330
Argon	Ar	580
Argon (Research Grade)	---	590
Arsine	AsH_3	350/660
Boron Trichloride	BCl_3	660/330
Boro Trifluoride	BF_3	330
Bromine Pentafluoride	BrF_5	670
Bromine Trifluoride	BrF_3	670
Bromoacetone	$BrCH_2COCH_3$	300/660
Bromochlorodifluoromethane	$CBrClF_2$	668/660
Bromochloromethane	CH_2BrCL	668/660
Bromotrifluoroethylene	Br FC:CF_2	510/660
Bromotrifluoromethane	$CBrF_3$	668/320, 660
1,3 - Butadiene	CH_2:CHCH:CH_2	510
Butane	$CH_3CH_2CH_2CH_3$	510
Butenes	CH_3CH_2CH:CH_2	510
Carbon Dioxide	CO_2	320
Carbon Monoxide	CO	350
Carbonyl Fluoride	COF_2	660/750
Carbonyl Sulfide	COS	330
Chlorine	CL_2	660
Chlorine Pentafluoride	CLF_5	670
Chlorine Trifluoride	ClF_3	670
Chlorodifluoroethane	CH_3CCL F_2	510/660
Chlorodifluoromethane	CH Cl F_2	660/668
Chlorofluoromethane	CH_2 Cl F	510
Chloroheptafluorocyclobutane	C_4F_7Cl	660/668
Chloropentafluoroethane	C_2CLF_5	668/660
Chlorotrifluoromethane	$CClF_3$	668/320,660
Cyanogen	C_2N_2	750/660
Cyanogon Chloride	CNCl	750/660
Cyclobutane	C_4H_8	510
Cyclopropane	C_3H_6	510
Deuterium	D_2	350
Deuterium Chloride	DCl	330
Deuterium Fluoride	DF	330
Deuterium Selenide	D_2 Se	350 / 330
Deuterium SulFide	D_2S	330
Diborane	B_2H_6	350
Dibromodifluoroethane	$C_2H_2Br_2F_2$	668/660
Dibromodifluoromethane	CBr_2F_2	668/660
1,1 - Difluoroethylene	FCH:CHF	320
Dichlorosilane	H_2 Si Cl_2	330/510
Diethylzinc	$(C_2H_5)_2Zn$	750
Dimethylamine	$(CH_3)_2NH$	705/240
Dimethyl Ether	CH_3OCH_3	510
2,2 Dimethyl Propane	$C(CH_3)_4$	510
Diphosgene	$ClCO_2CCl_3$	750/660

Ethane	C_2H_6	350
Ethane (Research Grade)	---	350
Ethylacetylene	$CH_3CH_2:CH$	510
Ethylchloride	CH_3CH_2Cl	510/300
Ethyldichloroarsine	$C_2H_5AsCl_2$	750/660
Ethylene	$CH_2:CH_2$	350
Ethylene Oxide	C_2H_4O	510
Ethyl Ether	$(C_2H_5)_2O$	510
Ethyl Fluoride	C_2H_5F	750/660
Fluorine	F_2	679/670
“Freon 12 “ (Dicholordifluoromethane)	Cl_2	660
“Freon 13 “ (Chlorotrifluoromethane)	$CClF_3$	320
“Freon 1381” (Bromotrifluoromethane)	$CBrF_3$	320
“Freon 14 “ (Tetrafluoromethane)	CF_4	320
“Freon 22” (Chlorodifluoromethane)	$CHClF_2$	660/620
“Freon 114” (1,2 – Dichlorotetrafluoroethane)		
$Cl\ F_2\ CCCl\ F_2$	660	
“Freon 116 “ (Hexafluoroethane)	C_2F_6	320
“Freon 8318” (Octafluorocyclobutane)	C_4F_8	660
“Genetron 21” (Dichlorofluoromethane)	$CHCl_2F$	660
“Genetron 23” (Fluoroform)	$CH\ F_3$	320
“Genetron115” (Monochloropentafluoroethane)		
$Br\ F_2\ CCF_3$	660	
“Genetron 152A “ (1,1 – Difluoroethane)	$F\ CH_2\ CH_2\ F$	660
Germane	$Ge\ H_4$	660/750
Helium	He	580/677
Heptafluorobutyronitrile	C_4F_7N	750/660
Hexafluoracetone	C_3F_6O	660/330
Hexafluorocyclobutene	C_4F_6	750/660
Hexafluorodimethyl Peroxide	CF_3OOCF_3	755/660
Hexafluoroethane	C_2F_6	660/668
Hexafluoropropylene	$CF_3CF:CF_2$	668/660
Hydrogen	H_2	350
Hydrogen Bromide	HBr	330
Hydrogen Chloride	HCL	330
Hydrogen Cyanide	HCN	750/160
Hydrogen Fluoride	HF	330/660
Hydrogen Iodide	HI	330/660
Hydrogen Selenide	H_2Se	350/660
Hydrogen Sulfide	H_2S	330
Iodine Pentafluoride	IF_5	670
Isobutane	C_4H_{10}	510
Isobutylene	C_4H_8	510
Krypton (research Grade)	Kr	590
“Manufactured Gas B”	---	350
“Manufactured Gas C”	---	350
Lewsite	$ClCH:CHAsCL_2$	750/660
Methane	CH_4	350
Methylacetylene	$CH_3C:CH$	510
Methyl Bromide	CH BR	320/660
3-Methyl – 1 -butene	$(CH_3)_2CHCH:CH_2$	510
Methyl Chloride	CH_3Cl	660/510
Methyldichloroarsine	CH_3AsCl_2	750
Methylene Fluoride	CH_2F_2	320
Methyl Ethyl Ether	$CH_3OC_2H_5$	510
Methyl Fluoride	CH_3F	350

Methyl Formate	$HCOOCH_3$	510/660
Methyl Mercaptan	CH_3SH	330/750
Monoethylamine	$CH_3CH_2NH_2$	240/705
Monomethylamine	CH_3NH_2	240/705
Mustard Gas	$S(C_2H_4Cl)_2$	750/350
Natural Gas	---	350/677
Neon	Ne	590/580
Nickel Carbonyl	$Ni\ (CO)_4$	320/750
Nitric Oxide	NO	660/755, 160
Nitrogen	N_2	580
Nitrogen (Research Grade)	---	590
Nitrogen Dioxide	NO_2	660/160
Nitorgen Trifluoride	NF_3	679
Nitrogen Trioxide	N_2O_3	660/160
Nitrosyl Chloride	NOCl	660/330
Nitrosyl Fluoride	NOF	330
Nitrous Oxide	N_2O	326
Nitryl Fluoride	NO_2F	330
Octafluorocyclobutane	C_4F_8	660/668
Octafluoropropane	C_3F_8	660/668
Oxygen	O_2	540
Oxygen Difluoride	OF_2	679
Ozone	O_3	660/755
Pentaborane	B_5H_9	660/750
Pentachlorofluoroethane	CCl_3CCl_2F	668/660
Pentafluoroethyl Iodine	CF_3CF_2I	668/660
Pentafluoropropionitrile	CF_3CF_2CN	750/660
Perchloryl Fluoride	ClO_3F	670
Perfluorobutane	C_4F_{10}	668
Perfluorobutene – 2	C_4F_8	660
Phenylcarbylamine Chloride	$C_6H_5N : CCl_2$	330/660
Phosgene	$COCl_2$	660
Phosphine	PH_3	660/350
Perfluoropropane	---	660
Phosphorous Pentafluoride	PF_5	330
Phosphorous Trifluoride	PF_3	330
Propane	C_3H_8	510
Propylene	C_3H_6	510
Silane	SiH_4	350/510
Silicon Tetrafluoride	SiF_4	330
Stibine	SbH_3	350
Sulfur Dioxide	SO_2	660/668
Sulfur Hexafluoride	SF_6	590/668
Sulfur Tetrafluoride	SF_4	330
Sulfuryl Fluoride	SO_2F_2	660/330
1, 1, 1, 2 – Tetrachlorodifluoroethane	$C_2Fl_4F_2$	668/660
1, 2, 2, 2, - Tetrafluorochloroethane – 1	C_2HClF_4	668/660
Tetrafluoroethylene	C_2F_4	350/660
Tetrafluorohydrazine	N_2F_4	679
Tetrafluoromethane	CF_4	580/320
Tetramethyllead	$(CH_3)_4Pb$	750/350
Trichlorofluoromethane	CCl_3F	668/660
Trichlorotrifluoroethane	CF_3CCl_3	668/660
Triethylaluminum	$(C_2H_5)_3Al$	750/350
Triethylborane	$(CH_5)_3B$	750/350
Trifluoroacetonitrile	CF_3CN	750/350
Trifluoroacetyl Chloride	CF_3COCl	330
1, 1, 1 – Trifluoroethane	CH_3CF_3	510

Trifluoroethylene	C_2F_3H	510
Trifluoromethyl Hypofluorite	CF_3OF	679
Trifluoromethyl Iodide	CF_3I	668/660
Trimethylamine	$(CH_3)_3N$	240/705
Trimethylstibine	$(CH_3)_3Sb$	750/350
Tungsten Hexafluoride	WF_6	330/679
Uranium Hexafluoride	UF_6	330
Vinyl Bromide	C_2H_3Br	320/510
Vinyl Chloride	C_2H_3Cl	290/510
Vinyl Fluoride	C_2H_3F	320/350
Vinyl Methyl Ether	$C_2H_3OCH_3$	290/510
Xenon	Xe	580/677
Xenon (Research Grade)	---	590