

Laboratory Ovens SOP

Summary

- Lab ovens are common instruments in a variety of research disciplines. Most often, they are used to remove moisture or trace solvents from materials, initiate polymerizations or crosslinking, or provide heat for other chemical transformations in non-volatile materials.
- Ovens present an electrical, fire, and burn hazard.
- Be careful of what you put into an oven. Avoid heating more than trace quantities of volatile and organic solvents, flammable solvents, and **NEVER attempt to heat or dry potentially explosive or shock-sensitive materials**. Only use intrinsically safe (i.e., with wiring and electrical connections which are incapable of serving as a source of ignition as verified by the manufacturer) ovens for flammable or combustible materials.
- Regularly inspect your oven for any loose or damaged wiring, physical defects, water or heat damage, and service according to manufacturer's instructions.

What are Laboratory Ovens?

Laboratory ovens are standard equipment found in most clinical, forensic, electronics, material processing, and research laboratories. Laboratory ovens provide uniform temperature and precise temperature control for heating, baking, evaporating, sterilizing and other industrial laboratory functions. Oven temperatures range from ambient to less than 500°C.

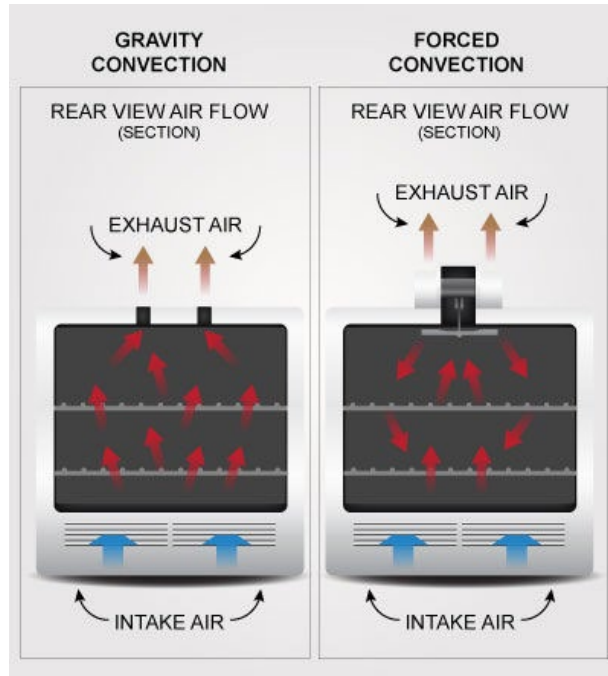
There are several varieties of laboratory ovens: Vacuum, high-temperature, forced air convection, and gravity convection ovens.

Vacuum Ovens – These drying ovens remove moisture and solvents from objects under reduce pressure. Heat is produced from the oven's interior and reduced pressure is generated via a vacuum pump, minimizing oxidation during drying. Vacuum ovens are intrinsically safe because the vacuum pump removes vapors from the heating chamber, which means these are safe to use with trace amounts of flammable or combustible materials. Always be sure to use a cold trap on the vacuum line to prevent evacuated solvent vapors from entering the pump, which could cause the pump to malfunction, and from being exhausted in the occupied lab space. See the [Vacuum Pump SOP](#) at the EH&S Website for more information on pumps and traps. Always be sure to vent the trap and empty after each use.

High-Temperature Ovens – These ovens deliver maximum temperatures of 400°C - 500°C. Additional insulation lines the oven walls and doors, and a higher voltage is required to reach these elevated temperatures.

Forced Air Convection Ovens – Also called mechanical convection ovens, these units push warm air around the oven chamber with the help of a blower fan. This creates a uniform distribution of warm air and provides rapid heat up and recovery time. Convection heating may cause excessive drying due to the force of the fan (see diagram below).

Gravity Convection Ovens – These units create a uniform heating environment by relying on the fact that hot air naturally rises when it expands and becomes less dense than the air around it. These ovens provide a more energy-efficient alternative to forced convection ovens (see diagram below).



Comparing Gravity and Forced Convection in ovens.

What are the Hazards?

High Temperature Hazards

Burns and potentially fire hazards are inherent with processes using elevated temperatures. Only place items in the oven that can withstand the high temperatures of the unit, otherwise they may melt or ignite. Be cautious to not overheat material as toxic airborne contaminants may be generated through thermal decomposition and fire and/or explosion may result. Be sure to only use intrinsically safe ovens when drying materials containing small amounts of flammable or combustible liquids. Never put solids that are visibly wet with solvent in any oven.

The elements for the ovens may be exposed and can be easily damaged if bumped or scraped. They are very expensive to replace. The heating elements are operated at a high current and can be dangerous if touched. The elements are sometimes coated in ceramic material, which can crack and

deteriorate from moisture fluctuations (i.e. drying glassware that is freshly rinsed and very wet) or actual water dripping on to the element.

Health Hazards

Many laboratory ovens contain refractory ceramic insulation, which can produce respirable fibers or dust with crystalline silica when handled. Crystalline silica may cause chronic lung injury (silicosis) after prolonged exposure or a heavy exposure in a short time. Silicosis is a form of disabling pulmonary fibrosis which can be progressive and may lead to death. The International Agency for Research on Cancer (IARC) reports sufficient evidence of carcinogenicity of crystalline silica to humans. IARC classifies ceramic fiber as 2B (possible carcinogenic to humans).

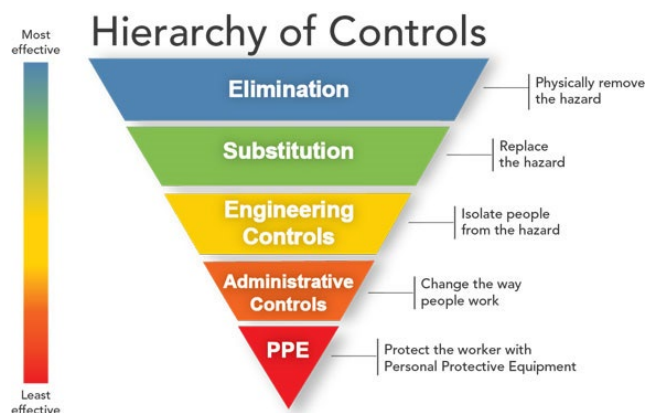


What Activities Could Pose a Risk?

- Opening/servicing your oven unit without specified training.
- Altering wiring, and altering or disabling the safety features, such as safety interlocks, sensors, etc.
- Using common oven mitts, cryogenic gloves, or no gloves instead of thermal-rated glove protection to place and retrieve items from the oven.
- Overheating materials beyond their melting points. Melting points can be found on a material's SDS.
- Using a malfunctioning oven.
- Heating sealed vessels in an oven may result in an explosion.
- Heating or evaporating hazardous materials in an oven without containment (i.e., a cold trap on a vacuum oven or placing the oven in a fume hood): Do not heat samples or glassware with traces of chemicals that pose respiratory hazards. Evaporation in the (non-vacuum) oven will release vapors into the atmosphere, where yourself or other lab members may breathe the toxic materials.
- Heating flammable or combustible materials in ovens that are not intrinsically safe.

How Can Exposures be Minimized?

When working with any hazardous material or process, always conduct a thorough risk assessment and employ the hierarchy of controls to minimize risk. Specific applications of the hierarchy of controls to the unique hazards of laboratory furnaces are listed below. Apply the controls in the order of most effective to least effective (see graphic at right), and apply as many controls as possible to reduce the risk to the lowest achievable level.



Elimination/Substitution

- Avoid drying glassware that has been freshly rinsed and is still wet. Towel-dry or air-dry wet glassware prior to heating.
- Heat materials to the lowest possible temperature to reduce the severity of potential burns and oven failure.
- When purchasing an oven, please consider purchasing those with safety features.

Engineering Controls

- Work in a well-ventilated area.
- Purchase units with over-temperature protection detectors that automatically shut the oven off in the case of thermal runaway.
- When heating hazardous materials in ovens, always use a cold trap with vacuum ovens or place the oven in a fume hood.

Administrative Controls

- Before Use:
 - All oven operators must complete safety training specific to the oven they will work with.
 - Read the instrument's manual thoroughly, and understand the oven's capabilities, limitations, safety features and safety protocol intimately. Always follow manufacturer protocol and recommendations closely.
 - Consult with the manufacturer and your PI to ensure that your planned experiments are appropriate for the unit. For instance, never overheat the materials or their containers: Pyrex should not be heated above 300°C. Always check the manufacturer's recommended usable temperature range of containers prior to use in an oven, and do not use containers for applications outside of the range.
 - If you are using a shared oven with a material that could be damaged or create a safety hazard at a higher temperature, clearly label the oven to not adjust the temperature.
- Open hot ovens with care. Stand to one side when opening the door to avoid high temperature.
- Keep the oven's wiring tidy and away from other heat-generating sources. Damaged wiring could result in an electrical fire.

- Regularly inspect your oven for any loose or damaged wiring, water and heat damage, or other visual defects. Contact the manufacturer or vendor directly for repairs and servicing.
- Never service or alter a laboratory oven yourself or disable safety features.
- Do not heat an oven to its maximum temperature.
- Do not dry glassware that was rinsed with an organic solvent without being subsequently rinsed with distilled water. (Small amounts of volatile organic solvents may be heated only in a vacuum oven with a cold trap or an intrinsically safe oven).
- Keep the area around the oven decluttered. Items beside the unit may get hot and melt, catch fire, boil, or explode.
- Always place and remove items from an oven with appropriate glove protection, thermal-rated tongs, and/or forceps. Please consult the [EH&S guide to glove protection](#) for information on appropriate thermal resistant gloves.
- Always use a cold trap with vacuum ovens to ensure any hazardous materials are captured to prevent release to the occupied lab space and potential damage to the vacuum pump. Ensure that traps are vented and emptied after each use.
- Dispose of oven units that are beyond their usable lifetime. Follow the [process for laboratory equipment disposal](#) described on the EH&S website.

Personal Protective Equipment (PPE)

- When working with an oven, always wear appropriate lab attire.
- **ALWAYS** wear the appropriate thermal gloves, and regularly check them for rips, holes, or tears. All-cotton terrycloth gloves are sufficient protection for temperatures up to 232°C (i.e. autoclave use), but heat- or flame-resistant gloves are required when using ovens at higher temperatures. Visit the [EH&S guide to glove protection](#) for more information.

Service Recommendations

Regularly inspect your oven for any loose or damaged wiring, water damage, heat damage, or other visual defects. If something appears damaged, worn, or is malfunctioning, DO NOT begin/continue using the oven – power off immediately. Contact the manufacturer or vendor directly for repairs and servicing. Dispose of units beyond their useable lifetime.

Exposure and Spill Procedure

In the event of an oven incident or malfunction, immediately turn off and unplug the oven if it is safe to do so. Evacuate the room and notify EH&S (413-545-2682) for assistance.

After any emergency or near-miss circumstance, notify EH&S ([413-545-2682](#)) as soon as possible and complete the [lab incident form](#).

For an Exposure:

1. Dermal Exposure: In the event that exposed skin touches the hot oven or its contents, immediately rinse affected area with copious amounts of cool water for at least 15 minutes to reduce further tissue damage. For serious burns, call 911 (report the building name, room number, and street address) or 413- 545-3111 (or simply 5-3111 from a campus line) to report the incident and request medical help. For minor burns, immediately go to UHS.

2. Inhalation: If an individual inhales fumes from a malfunctioning oven or materials placed inside the oven, immediately seek medical attention. If the person is unconscious or experiencing acute breathing difficulties, call 911 (report the building name, room number, and street address) or 413- 545-3111 (or simply 5-3111 from a campus line) to report the incident and request medical help. Never enter a room with an unconscious person to provide assistance to avoid exposing yourself as well. For inhalation exposures without acute health effects, immediately go to UHS for evaluation. Health effects from inhalation can be delayed by hours for exposure to some materials, and can be very serious, so it is important to be evaluated by medical professionals. If it is possible to do so, provide the SDS (or whatever information is available in the absence of an SDS) for any materials involved to the medical personnel.
3. Electrical Fire: If the unit is on fire, immediately evacuate the room, close the door behind you, and activate the fire alarm. Follow your lab's evacuation route and meet in your designated location outside of the building. Call 911 or 413- 545-3111 once outside to report the incident and provide information, such as locations of the fire and materials involved.

References and Sources

1. Berkley EH&S Oven SOP: <https://eta-safety.lbl.gov/safety-alert/oven-safety-lab-areas>
2. Kansas State EH&S Oven SOP: <https://www.k-state.edu/safety/lab/labsafety/topics/labequipment/laboratoryOven.html>
3. Lab Supply Network defining different ovens: <https://www.laboratory-supply.net/blog/laboratory-ovens/>
4. <https://www.labmanager.com/product-focus/how-safe-is-your-lab-oven-2798>
5. IARC: silica is carcinogenic: <https://pubmed.ncbi.nlm.nih.gov/21834268/#:~:text=The%20panel%20remarked%20that%20crystalline,causes%20lung%20cancer%20in%20humans.&text=Silicosis%20and%20lung%20cancer%20in,protect%20persons%20at%20high%20risk.>