



# Kiln Risk Management Best Practices

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## Goal

Schools seek to maintain a safe, secure environment, including a safe, secure arts environment. Thousands of kilns are used safely in schools and studios throughout the world. With a good understanding of kilns, safe practices, and adequate training, a district can avoid explosions, fires, and other accidents. The main thrust of kiln safety standards involve preventing injuries to staff and students, and minimization of explosion and fire hazard risks.

The concentration of effort is to avoid situations wherein the explosive limits of fuel are allowed to exist, whether the flammable material comes from the fuel being used or whether it emanates from the object being fired. Major emphasis is placed on the pre-startup sequence (i.e., what has to be done prior to lighting the burners or electrifying the elements in the system) because most incidents occur when a system is started.



## Safety Recommendations

Districts have an obligation to provide safe, secure facilities and programs. Kilns are high temperature furnaces used to fire clay and ceramic items. Kilns are usually insulated with ceramic fiber material (CFM) or firebricks. They require programming, loading, unloading, cleaning, monitoring, and servicing. The many hazards that may be encountered when operating kilns include:

1. Inhalation of toxic fumes (from all types of kilns and smoke from sawdust kilns), which can include sulfur oxides, nitrogen oxide, fluorine, chlorine, carbon dioxide, and carbon monoxide
2. Inhalation of or contact with fibers from kiln insulation material and clay or ceramic glaze dusts must be reviewed to ensure exposure does not exceed any permissible exposure limit as identified under Cal-OSHA regulatory framework.
3. Contact with hot equipment and materials resulting in burns
4. Contact with sharp pieces of broken projects resulting in lacerations
5. Fire
6. Electrical/gas supply

The safety of a district's kilns involves many choices and operations: choice of kiln for suitability to use, its location, its installation, commissioning, inspection, testing, maintenance, and operation. Operation includes use of Personal Protective Equipment (PPE) and proper selection and use of materials subject to being fired. The best practices in this publication, coupled with manufacturer recommendations, art instructor training, California Division of the State Architect (DSA) recommendations, National Fire Protection Agency (NFPA) guidelines, local building and fire inspector guidelines, and employee training, should ensure safe use of these devices.

ASCIP recommends that district's consider age appropriateness and ability of students for kiln firing practices and operations. For example, Raku is not suitable for K-12 students. Raku is a process in which work is removed from the kiln at bright red heat and subjected to post-firing reduction by being placed in containers of combustible materials, which blackens raw clay and causes crackling in the glaze surface.



## Location and Construction

ASCIP recommends that the placement and construction of the kiln be carefully considered by districts. The system should be located in an area where obvious hazards do not exist. The structural requirements include either the use of explosion relief panels (designed to relieve internal pressure in case of an explosion) or the construction of the system such that it is built out of 3/16-in. steel plate in order to contain potential explosions.

### Locations

1. Kilns should not be operated in classrooms.
  - a. Sheds have been used with success and
  - b. Unused custodial closets may be used if no other supplies are stored in the same closet, if they meet code requirements, requirements below, and maintain a minimum of 36 inches from combustible material.
2. Controlled access – lockable
3. Visual access from the outside
4. Large enough for kiln-related materials only
5. Hard wired electrical supply available in accordance with local electrical and fire safety codes and in accordance with manufacturers' suggested installation instruction. Installation must be performed by a qualified electrician.
6. Easily accessible with no obstructions
7. Compliance with Title 5, California Code of Regulations – School Facility (CA Dept. of Education) is essential. Kiln should be located in a safe, properly wired and ventilated area.
8. Kiln should either be outdoors or properly vented to the outside. Follow the kiln manufacturer's instructions and use trained heating, ventilation and air-conditioning (HVAC) personnel for proper installation and compliance with the California Building Code, Fire Code and the Uniform Mechanical Code.
9. Room should be accurately tested and the adequacy of the system's ventilation documented using proper testing equipment.
10. New rooms being constructed as Kiln rooms are to be constructed with wall materials rated for two-hour fire protection, per the California Building Code. Existing rooms undergoing conversion to Kiln Room use should have walls finished with a layer of 5/8-inch type X drywall and should be in sound physical condition, without unprotected penetrations or openings.
11. The room should contain only kiln-related items. Room should be for kiln use only; no other class activity should occur in the same room.
12. Room should be free of obstructions and able to be easily accessed.
13. Art supplies can be stored under certain conditions as follows:
  - a. A minimum distance of 18" must be maintained from noncombustible surfaces and 36 inches from combustible surfaces.
  - b. No combustible materials can be stored on kiln at any time.
  - c. No flammable paints, solvents or aerosols may be stored in kiln room at any time.

## Heating Systems

ASCIP recommends that districts carefully consider the appropriate heating system for their kilns. Heating system requirement standards cover an extremely broad range of design parameters—defining the location of components combined with their suitability for use. The recognition that fuel isolation valves do fail leads to redundancy combined with proof that the valves actually close when required. Even new electric solenoid valves do not positively stop fuel flow; manufacturers of these valves provide a specification of closed leak rate. Since majority of incidents happen at the initial light-off/start-up of systems, staff should take precaution when lighting kilns.

## **Electrical and Fuel Management**

Districts should carefully consider the electrical and, if applicable, natural gas or other fuel requirements of kilns. Many materials release volatile fuels during the firing process. Ceramic forming techniques increasingly incorporate a range of organic plasticizers; these materials can release gases which create explosive conditions during the heating process. Monitoring the internal kiln and oven space for flammability is imperative.

Additionally, consideration should be given to failures and ventilation issues that could result in hazardous conditions. Manufacturers should be consulted on mitigation strategies for such incidents.

## Installation and Maintenance

Each facility must recognize the inherent risk in the operation of ovens and furnaces, regardless of code application and rigorous design. The lifecycle of most systems is measured in decades. Therefore, proper maintenance, testing and inspection should be a part of standard procedure. Replacement of key devices before the end of their lifecycle should be done with discipline.

Design standards for kilns, furnaces, and ovens have been developed by the National Fire Protection Association (NFPA), through **NFPA 86 Standard for Ovens and Furnaces**. The **authority having jurisdiction (AHJ)** could be a number of entities, including the Division of State Architect (DSA), your local fire marshal; and/or your county or city building inspectors, etc., as well as district facilities and maintenance operations.

### Installation

1. As with all electrical products there is danger of electrical shock. Use only properly sized and rated copper wire when installing the power supply for your kiln. ASCIP recommends that this work be done by a licensed electrician.
2. Kilns should always be located in a dry place to prevent electrical shock and corrosion.
3. Follow all manufacturer's instructions for installation. Always observe fire, building, DSA and safety codes when installing any product.
4. If there are fire sprinklers located in the kiln room make sure they are rated high enough so they will not be set off when the kiln is at peak temperature. Consult with a licensed fire protection contractor to obtain the correct sprinkler head design and installation prior to using the kiln.
5. Have a fire extinguisher rated appropriately for electrical fires easily accessible near the kiln.
6. Kilns get hot. Observe all instructions to ensure proper clearances from flammable or temperature sensitive objects and living things.
7. Ventilation is key to maintaining a healthy work environment and proper room temperature. Proper installation of vent will clear potentially harmful fumes from the room. To ensure proper room temperature is maintained, consult a qualified HVAC professional.
8. The proper placement of thermocouples is crucial to the proper operation of all automatically controlled kilns. Check all thermocouples for damage and correct placement.
9. Kilns should be plugged directly to an outlet. Never use an extension cord.
10. Make sure the power cord is routed in such a way as to not touch any portion of the kiln that gets hot.
11. Be careful of pinch hazards when working on or assembling the kiln.
12. Be sure to properly tension the springs on kilns equipped with lid lifters.

## Maintenance

1. Kilns should be regularly maintained.
  - a. This includes regular inspection, particularly where sockets and flexible cables are used.
  - b. Kilns should be periodically tested to ensure that the bonding, insulation connections, and electrical protection are operational.
  - c. If faults are found, the kiln should be taken out of service until the faults are repaired.
2. Any work carried out on the kiln should be done by a trained professional who is familiar with the type of equipment.
3. School or district kiln operators should maintain up-to-date records of the nature and extent of all maintenance and repair work carried out on the kiln(s).
4. Always unplug the kiln before performing any repairs or general maintenance. If your kiln is wired direct, turn off the breaker.
5. Use only OEM replacement parts. Improperly sourced parts may pose a hazard to you and your kiln and void your warranty.
6. Never modify your kiln without first consulting the manufacturer. Improper modifications may pose a hazard to you and your kiln and void your warranty. Items such as alternative thermocouples, controllers, and kiln coatings may ruin your kiln if improperly installed or applied.
7. Replace any electrical components that are discolored, brittle, or corroded.
8. The controller is a temperature control device. It is not a safety device. Follow all manufacturer instructions. The controller contains static-sensitive parts that may be damaged by static electricity. Use caution to avoid creating static that may damage the equipment. In areas where static electricity is common, or during dry times of the year throughout the country, touch the kiln lid handle before touching the controller to discharge the static.

## Operations

Each facility must recognize the inherent risk in the operation of kilns and furnaces, regardless of code application and rigorous design. Training of all operators and maintenance personnel should be a continuous process.

### Checklist for Kiln Operation

1. Is operator of kiln trained?
2. Are operating rules and instructions posted near the kiln(s)?
3. Is the ventilation working adequately in the kiln enclosure?
4. Do you have the appropriate personal protective equipment (PPE)?
  - a. Thermal gloves
  - b. Aprons (fire rated)
  - c. Eye and face protection--IR and UV protective glasses
  - d. Respirators as necessary.
5. Do you fire the kiln approved hours of operations?
6. After firing, do you leave the extraction fan on, open the kiln door and allow the gas emissions to disperse before unloading?
7. Is the kiln area free from obstructions and able to be easily accessible? An 18 inch clearance needs to be maintained for non-combustible material and 36 inch clearance for combustible material.
8. Is the kiln enclosure area cleaned as prescribed by manufacturers?
9. Are personal hygiene procedures followed after the use of the kiln?
10. Is the kiln inspected at regular intervals and maintained in good order?

### Hygiene of those Working around or with Kilns

1. Food or drink is not to be consumed in classroom, studio, or workshop areas.
2. Hands should be washed before leaving the classroom, studio or workshop areas, before handling food or drink, before using toilet facilities and after using thermal insulating gloves.

### Operation

1. The actual starting of the kiln and all actions associated with the kiln while it is in operation to include the actual opening of the kiln upon completion.
2. High school students may operate kiln after training and under the direct supervision of instructor. All training of students must be documented and receive Parental Release prior to operating.
3. All students may participate in the loading and unloading of the kiln with instructor supervision and proper training.
4. Students may construct, operate, load and unload simple kilns where learning outcomes pertaining to kiln operation are relevant to a particular course of study.

In this activity, students must be under the direct supervision of the teacher at all times.

5. The kiln should not be unloaded after firing until the outside of the kiln and the pieces inside are cooled.

### **Hazard Reduction:**

1. All ceramic materials should be supplied with a Safety Data Sheet (SDS).
2. Kerosene, oil drip, wood-fired or sawdust kilns must not be used in schools.
3. It is preferable that kilns not be located in classrooms or art work areas.
4. Kiln should be on level concrete flooring or an asbestos pad.
5. Should be located in a protected area, away from foot traffic.
6. Kilns should be positioned to ensure there is air movement all around the kiln and good access for servicing.
7. Should be located near the correct electrical outlet.
8. Do not allow the pigtail cord or power supply cable to rest on the side of the kiln.
9. Kiln electrical cord should plug directly into electrical socket supply.
10. Ensure extraction system is operating before, during and after firing to prevent inhalation of kiln emissions.
11. Kilns site should be well illuminated.
12. Kilns should only be fired when staff and students are not exposed to emissions.
13. Food or drink is not to be taken into the kiln/ceramic work areas.
14. The jacket and some of the other fixtures surrounding the kiln will get hot enough to burn your skin when the kiln is heated. Therefore, it is important to be extremely careful when working close to the kiln. Post warning signs about this potential hazard in the kiln room.
15. Keep anyone who cannot understand warning signs such as small children and pets away from the kiln when it is firing.
16. Be careful when opening the kiln door while the kiln is heated. Use fire rated gloves to protect your skin and make sure clothing is kept well away from any kiln opening or hot kiln surface.
17. The elements inside the kiln chamber will cause an electrical shock if touched. Never insert metal instruments or place any part of your body into the kiln while it is firing.
18. Be sure to unplug the kiln before working on the electrical components. If the kiln is hard wired, turn off the circuit breaker using lock-out/tag-out procedures.
19. Plan on being with the kiln when it is scheduled to turn off.
20. Remove all potentially combustible materials from the kiln area.
21. Long term viewing inside the kiln chamber can cause eye damage. Therefore, it is recommended that you use IR and UV protective glasses when looking into the kiln for extended periods of time. #3 welder's green or gray glasses will protect your eyes.
22. Be cautious of intense heat around the peep holes when peep plugs are removed.
23. In the event of a severe storm, unplug your kiln. Exposure to static shock or electrical surges can damage the circuit board in the controller.

24. Kiln lids on many models are heavy. Make sure the lid brace is secure before releasing the lid and the brace is not corroded.
25. Do not place anything in the kiln about which you are unsure. Certain items may potentially melt, explode, or release toxic fumes. Items that may be damp (i.e., greenware, kiln shelves) have the potential to crack or explode inside the kiln when the moisture trapped inside them turns to vapor when heated.
26. Never allow your kiln to exceed the temperature rating listed on the serial plate.
27. For your safety, the protection of your kiln, and the protection of your ware inside the kiln, we recommend that you avoid unloading the kiln when it is above 125°F.

## Arts and Crafts Materials Used in or With Kilns

The California Education Code Section 32064 prohibits schools from ordering or purchasing any product that contains toxic or carcinogenic substances for use in grades K-6. The law also restricts the purchase of such products in grades 7-12, allowing the use only if the product bears a label informing the user of the presence of hazardous ingredients, the potential health effects, and instructions for the safe use. This restriction applies whether or not the product is included on the list of unacceptable art and crafts supplies.

Section 32066 of the Education Code requires that the Office of Environmental Health Hazard Assessment (OEHHA) develop a list of art and crafts materials "which cannot be purchased or ordered" for use in grades K-6. This list can be accessed through the following link: <https://oehha.ca.gov/media/downloads/risk-assessment/document/arthazardslistjune2018.pdf>

Purchasers must ensure that all art and craft materials to be used by students bear a statement of conformity to ASTM D-4236 (Standard Practice for Labeling Art Materials for Chronic Health Hazards), as required by federal law. Items to be used by students in K-6 must not bear acute or chronic health hazard labels. Although not required by law, avoiding art materials that bear acute or chronic health hazard labels when purchasing for grades 7-12 is a good precautionary measure.

### **General Legal Reference: EDUCATION CODE**

- 32060 Legislative findings and declarations
- 32061 Art or craft material; definition
- 32062 Human carcinogen; definition
- 32063 Toxic substance causing chronic illness; definition
- 32064 Restrictions on purchases of arts and crafts materials
- 32065 Warning labels