INTERNATIONAL CODE COUNCIL

People Helping People Build a Safer World™

CODE CORNER

ABOUT CODE CORNER

CCFS would like to remind you to check with your local "Authority Having Jurisdiction (AHJ)" for questions and opinions concerning your local Fire and Building Codes. The information contained in this article is supplied as a courtesy by the International Code Council (ICC) and is based on the International Fire and Building Codes and their respective commentaries. Your local codes or ordinances may vary.

This month's Code Corner will focus on flammable and combustible liquids - an issue faced by virtually every college and university. While flammable and combustible liquids certainly present added dangers by their mere presence, quality training, following simple operational practices and exercising appropriate storage precaution will go far toward preventing incidents.

Chapter 34 Flammable and Combustible Liquids

General Comments

Flammable and combustible liquids are essential in our modern lifestyles. These liquids are used for fuel, lubricants, cleaners, solvents, medicine and even drinking. The danger associated with flammable and combustible liquids is that the vapors from these liquids, when combined with air in their flammable range, will burn or explode at temperatures near our normal living and working environment.

The use of these liquids is accepted in all occupancies if the liquids are in appropriate containers and the quantity is very limited. When the quantities exceed these limited amounts or the use of the flammable or combustible liquids increases the potential danger, the code requires that measures be taken to control the potential danger. These measures are to prevent the possibility of flammable and combustible liquids igniting.

Although the dangers of flammable liquids are well known, accidents involving flammable liquids remain one of the most common fire scenarios in the United States. Statistically, the more common flammable or combustible liquids (gasoline) rather than the most dangerous flammable or combustible liquids account for the most fires. There are five factors that account for the involvement of flammable liquids in these fires: (1) personnel inadequately trained in safe operating procedures; (2) hazardous operations not isolated from other operations; (3) equipment and flammable or combustible liquids improperly used; (4) poor property maintenance and supervision and (5) inadequate control systems.

These five factors suggest that a holistic approach to flammable and combustible liquid fire safety is required. By beginning with people, a safety system has a better chance of working successfully and consistently. Trained personnel recognize the importance of safe practices to their personal safety, and are more likely to demand that necessary safeguards be installed in their homes and workplaces. Because all of us tend to become complacent as time passes, inspectors, owners, operators, managers and employees must work together to maintain vigilance over the system's continued operation.

3404.3 Container and portable tank storage. Storage of flammable and combustible liquids in closed containers that do not exceed 60 gallons (227 L) in individual capacity and portable tanks that do not exceed 660 gallons (2498 L) in individual capacity, and limited transfers incidental thereto, shall comply with this section.

☿ *Storage containers not exceeding 60 gallons (227 L) and portable tanks not exceeding 660 gallons (2798 L) are regulated by this section. The use of these containers and portable tanks is limited to incidental transfers of flammable or combustible liquids.*

3404.3.1 Design, construction and capacity of containers and portable tanks. The design, construction and capacity of containers for the storage of Class I, II and IIIA liquids shall be in accordance with this section and Section 6.2 of NFPA 30.

☿ *Design, construction and capacity of containers and portable tanks are addressed in Section 6.2 of NFPA 30.*

3404.3.1.1 Approved containers. Only approved containers and portable tanks shall be used.

☿ *It is difficult at best to determine by examination that a container or portable tank complies with Section 6.2 of NFPA 30. One practical approval method is to require listed containers or portable tanks.*

3404.3.2 Liquid storage cabinets. Where other sections of this code require that liquid containers be stored in storage cabinets, such cabinets and storage shall be in accordance with Sections 3404.3.2.1 through 3404.3.2.2.

☿ *Containers and portable storage tanks are to be stored in liquid storage cabinets.*

3404.3.2.1 Design and construction of storage cabinets.
Design and construction of liquid storage cabinets shall be in accordance with this section.

☿ *Liquid storage cabinets are designed to protect containers and portable storage tanks and their contents from damage and ignition sources. Liquid storage cabinets can be constructed of metal or wood. Cabinets listed under UL 1275 and cabinets constructed according to this section are approved.*

3404.3.2.1.1 Materials. Cabinets shall be listed in accordance with UL 1275, or constructed of approved wood or metal in accordance with the following:

1. Unlisted metal cabinets shall be constructed of steel having a thickness of not less than 0.044 inch (1.12 mm) (18gage). The cabinet, including the door, shall be double walled with 11/2-inch (38 mm) airspace between the walls. Joints shall be riveted or welded and shall be tight fitting.

2. Unlisted wooden cabinets, including doors, shall be constructed of not less than 1-inch (25 mm) exterior grade plywood. Joints shall be rabbeted and shall be fastened in two directions with wood screws. Door hinges shall be of steel or brass. Cabinets shall be painted with an intumescent- type paint.

☿ *Unlisted liquid storage cabinets and cabinet doors made of steel are to be double-wall cabinets with tight fitting joints. Minimum steel thickness is 18 gage [0.044 inch (1.12 mm)]. Unlisted liquid storage cabinets and cabinet doors made of wood are to use rabbet*

TABLE 3404.3.4.1
MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF FLAMMABLE AND COMBUSTIBLE LIQUIDS IN WHOLESALE AND RETAIL SALES OCCUPANCIES[a]

TYPE OF LIQUID	MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA (gallons)		
	Sprinklered[b] per footnote densities and arrangements	Sprinklered per Tables 3404.3.6.3(4) through 3404.3.6.3(8) and Table 3404.3.7.5.1	Nonsprinklered
Class IA	60	60	30
Class IB, IC, II and IIIA	7,500[c]	15,000[c]	1,600
Class IIIB	Unlimited	Unlimited	13,200

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, 1 gallon = 3.785 L, 1 gallon per minute per square foot = 40.75 L/min/m^2.

a. Control areas shall be separated from each other by not less than a 1-hour fire barrier wall.

b. To be considered as sprinklered, a building shall be equipped throughout with an approved automatic sprinkler system with a design providing minimum densities as follows:
   1. For uncartoned commodities on shelves 6 feet or less in height where the ceiling height does not exceed 18 feet, quantities are those allowed with a minimum sprinkler design density of Ordinary Hazard Group 2.
   2. For cartoned, palletized or racked commodities where storage is 4 feet 6 inches or less in height and where the ceiling height does not exceed 18 feet, quantities are those allowed with a minimum sprinkler design density of 0.21 gallon per minute per square foot over the most remote 1,500-square-foot area.

c. Where wholesale and retail sales or storage areas exceed 50,000 square feet in area, the maximum allowable quantities are allowed to be increased by 2 percent for each 1,000 square feet of area in excess of 50,000 square feet, up to a maximum of 100 percent of the table amounts. A control area separation is not required. The cumulative amounts, including amounts attained by having an additional control area, shall not exceed 30,000 gallons.

joints fastened with wood screws in two directions to develop a tight joint. The minimum wood is to be 1-inch (25 mm) exterior grade plywood. The cabinet is to be painted with an intumescent- type paint. The plywood grade will increase the cabinet's durability and the intumescent-type paint will reduce the ignition properties of the plywood.

3404.3.2.1.2 Labeling. Cabinets shall be provided with a conspicuous label in red letters on contrasting background which reads: FLAMMABLE—KEEP FIRE AWAY.

☿ *Label the liquid storage cabinet to restrict ignition sources from the immediate area.*

3404.3.2.1.3 Doors. Doors shall be well fitted, self-closing and equipped with a three-point latch.

☿ *The door is to be self-closing and tight fitting. This prevents flammable or combustible liquid that has leaked or spilled in the storage cabinet from easily escaping the storage cabinet.*

3404.3.2.1.4 Bottom. The bottom of the cabinet shall be liquid tight to a height of at least 2 inches (51 mm).

☿ *To control the flow of any spills, the cabinet is to be liquid tight for at least 2 inches (51 mm) from the bottom. This prevents flammable or combustible liquid that has leaked or spilled in the storage cabinet from easily escaping the storage cabinet.*

3404.3.2.2 Capacity. The combined total quantity of liquids in a cabinet shall not exceed 120 gallons (454 L).

The quantity of flammable and combustible liquids in a cabinet is not to exceed 120 gallons (454 L). Controlling the quantity of flammable and combustible liquids in a liquid storage cabinet controls the fire hazard by limiting the amount of liquid that can be involved in a single incident.

3404.3.3 Indoor storage. Storage of flammable and combustible liquids inside buildings in containers and portable tanks shall be in accordance with this section.

Exceptions:

1. Liquids in the fuel tanks of motor vehicles, aircraft, boats or portable or stationary engines.

2. The storage of distilled spirits and wines in wooden barrels or casks.

☿ *Indoor storage in containers or portable tanks is governed by this section with two exceptions.* The requirements of this section are not applicable to fuel in vehicles and portable engines. *The small quantity of fuel and the protection provided by the fuel containers provide sufficient safety for these uses to be indoors. Distilled spirits and wines in wooden barrels or casks are allowed indoors. This exception is covered in Section 3401.1.*

3404.3.3.1 Portable fire extinguishers. Approved portable fire extinguishers shall be provided in accordance with specific sections of this chapter and Section 906.

☿ *Portable fire extinguishers are useful for controlling small fires. Section 906 contains the size and spacing for portable fire extinguishers to be used on a fire involving flammable or combustible liquids that have a liquid depth of 0.25 inch (6.4 mm) or less.*

3404.3.3.2 Incompatible materials. Materials that will react with water or other liquids to produce a hazard shall not be stored in the same room with flammable and combustible liquids in accordance with Section 2703.9.8.

☿ *Materials that generate heat or become combustible when exposed to water or other liquids are not to be in the same room as flammable or combustible liquids. This is to remove a potential ignition source.*

3404.3.3.3 Clear means of egress. Storage of any liquids, including stock for sale, shall not be stored near or be allowed to obstruct physically the route of egress.

☿ *The means of egress must be usable to be effective. The placement of flammable or combustible liquids near or in the route used to exit the room or building produces a risk that is not acceptable.*

3404.3.3.4 Empty containers or portable tank storage. The storage of empty tanks and containers previously used for the storage of flammable or combustible liquids, unless free from explosive vapors, shall be stored as required for filled containers and portable tanks. Portable tanks and containers, when emptied, shall have the covers or plugs immediately replaced in openings.

☿ *An empty container or portable tank is as dangerous and possibly more dangerous than a full container or portable storage tank. There is a possibility that the vapor- air mixture in the container or portable storage tank could reach the LFL. This potential danger requires that empty containers and portable tanks be handled and stored as if full of flammable or combustible liquid.*

3404.3.3.5 Shelf storage. Shelving shall be of approved construction, adequately braced and anchored. Seismic requirements shall be in accordance with the International Building Code.

☿ *Shelving for containers and portable tanks is to be adequate to support the container and portable tank under normal loads and seismic loads. Failure of shelving could cause damage to containers and portable tanks or leakage*.

3404.3.3.5.1 Use of wood. Wood of at least 1 inch (25 mm) nominal thickness is allowed to be used as shelving, racks, dunnage, scuffboards, floor overlay and similar installations.

☿ *The minimum thickness of wood is to be 1 inch (25 mm).*

3404.3.3.5.2 Displacement protection. Shelves shall be of sufficient depth and provided with a lip or guard to prevent individual containers from being displaced.

Exception: Shelves in storage cabinets or on laboratory furniture specifically designed for such use.

☿ *Shelving must be designed and constructed to prevent containers or portable tanks from sliding off the shelving. A container or portable tank that falls from a shelf is subject to damage or leakage. The exception covers shelving in storage cabinets, which may have locked doors or doors fitting snugly against the front of shelves to prevent containers from falling. Shelving that is part of laboratory furniture is not required to have a lip or guard because typically this kind of shelving would hold only small containers. Large containers or tanks would be floor mounted in nearly all laboratory settings. These kinds of shelves may also have other features to prevent containers or portable tanks from sliding or being knocked off the shelf.*

3404.3.3.5.3 Orderly storage. Shelf storage of flammable and combustible liquids shall be maintained in an orderly manner.

☿ *The handling of containers and portable tanks increases the possibility that an accident can occur. Containers and portable tanks arranged on shelves in an orderly manner make moving one container or portable tank to get to another unnecessary.*

3404.3.4 Quantity limits for storage. Liquid storage quantity limitations shall comply with Sections 3404.3.4.1 through 3404.3.4.4.

☿ *The quantity of flammable and combustible liquids in an area is limited to reduce the potential fire hazard.*

☿ *Table 2703.1.1(1) lists the quantity permitted per control area. Limiting the quantity per control area reduces the flammable and combustible liquid hazard to a level that the fire protection and egress requirements are designed to accept. These limits result in a building that can function with a reasonable degree of safety.*

3404.3.4.2 Occupancy quantity limits. The following limits for quantities of stored flammable or combustible liquids shall not be exceeded:

1. Group A occupancies: Quantities in Group A occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 2703.1.1(1).

2. Group B occupancies: Quantities in drinking, dining, office and school uses within Group B occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 2703.1.1(1).

3. Group E occupancies: Quantities in Group E occu-

pancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 2703.1.1(1).

4. Group F occupancies: Quantities in dining, office, and school uses within Group F occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 2703.1.1(1).

5. Group I occupancies: Quantities in Group I occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 2703.1.1(1).

6. Group M occupancies: Quantities in dining, office, and school uses within Group M occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 2703.1.1(1). The maximum allowable quantities for storage in wholesale and retail sales areas shall be in accordance with Section 3404.3.4.1.

7. Group R occupancies: Quantities in Group R occupancies shall not exceed that necessary for maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 2703.1.1(1).

8. Group S occupancies: Quantities in dining and office uses within Group S occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 2703.1.1(1).

☿ *Flammable and combustible liquids may be used in occupancies other than Group H. These other occupancies are not designed specifically for flammable and combustible liquids, so there are limitations on the quantities that can be in use or stored in these occupancies. The use of flammable and combustible liquids must be consistent with the function of the occupancy. This prevents these other occupancies from becoming a Group H occupancy. The quantities of flammable and combustible liquid are listed in Table 2703.1.1(1). The occupancies covered by these limitations are Groups A, B, E, F, I, M, R and S.*

3404.3.4.3 Quantities exceeding limits for control areas.

Quantities exceeding those allowed in control areas set forth in Section 3404.3.4.1 shall be in liquid storage rooms or liquid storage warehouses in accordance with Sections 3404.3.7 and 3404.3.8.

☿ *It is possible to have a quantity of flammable and combustible liquids greater than allowed in Section 3404.3.4.1. To control the potential hazard, these quantities must be given additional protection by being in specifically designed liquid storage rooms.*

THE INSPECTOR (continued)

Let me leave you with three thoughts: (1.) Codes are anything but dull; the debates leading to their adoption are lively and strengthen the finished product. (2.) The more we participate in the process, the more we in the college arena will be rewarded with workable and effective regulations. (3.) When it comes to preventing the fire next time, nothing can replace savvy fire code officials making their rounds.

The viewpoints expressed in The Inspector are those of the author alone. They are offered to initiate thought and debate, however, they do not necessarily represent the views or opinions of the Center for Campus Fire Safety, its officers, directors or its editorial staff.

Philip Chandler is a long time firefighter and a fulltime government fire marshal working extensively in the college environment – from large public university centers to small private colleges.

His primary responsibilities include code enforcement and education.

Phil welcomes your comments, thoughts and opinions (whether in agreement or opposition) to his viewpoints.

He may be reached at:

theinspector@campusfiresafety.org