WHY FIRE SPRINKLERS IN SCHOOLS?

By Stephen Ziga, CPD, CET

The requirement for sprinkler systems in our educational facilities is ever-growing. Many existing elementary, high school, and university facilities in this country were built prior to any code requirement for sprinkler protection. As these buildings age or as the surrounding population increases, these buildings require interior renovations or expansion. In both cases, sprinkler systems may be required to be added based on the project scope. This article focuses on the typical and atypical fire protection needs you may find for elementary, secondary, and higher education facilities.

YESTERDAY'S BUILDINGS

When you venture into older school facilities, you first enter that time warp and see yourself during those awkward yesteryears. You see the cinderblock walls, concrete columns, tile floors, and suspended ceilings with dim fluorescent fixtures (see Figure 1). Typically, the only fire sprinkler systems are dry stair tower standpipes, fire hose stations, and some sprinklers attached to the domestic water system. The thought process was that in the event of fire, an evacuation system would help building occupants escape in a safe and timely manner. Remember those fire drills?

TODAY'S BUILDINGS

Many of today's new secondary and higher education buildings take a crossover approach to their design function. These buildings may include a mix of standard classrooms, science laboratories, office space, open community areas, gymnasiums, swimming pools, or cafeterias. In addition, many school facilities may be utilized for programming beyond education (i.e., school and community meetings and events). Each of these different uses requires special consideration for the design approach to sprinkler protection.

The architectural design of schools is much different than years ago. The concept has shifted from blocks of classrooms along long corridors to more open, naturally lit spaces. Atriums and grand entrances serve multifunction purposes and events.

Monthly fire drills still are required as indicated in International Fire Code (IFC) Section 405.

OCCUPANCY TYPES

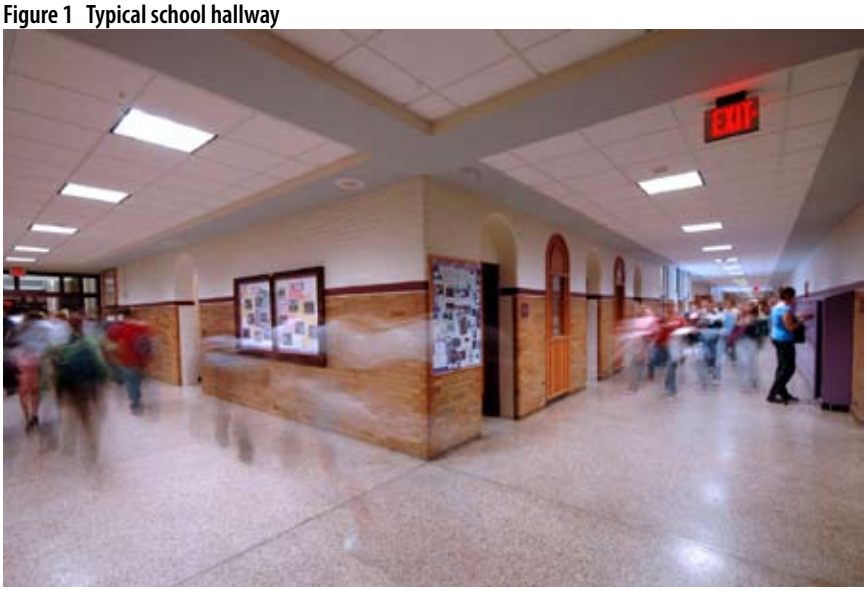
The use and occupancy classification define the requirements to which we must adhere. K–12 schools, colleges, and crossover amenity buildings in large campus settings (i.e., classroom buildings, gymnasiums and pools, cafeterias, and administration buildings) require specific review to ensure the proper fire protection system placement.

Per the 2006 International Building Code (IBC), Educational Group E occupancies include, among others, the use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through the twelfth grade (IBC Section 305.1). Business Group B occupancies include, among others, the use of a building or structure, or a portion thereof, for office, professional, or service-type transactions, including storage of records and accounts. This includes educational occupancies for students above the twelfth grade (IBC Section 304.1). Assembly Group A occupancies include, among others, the use of a

building or structure, or a portion thereof, for the gathering of persons for purposes such as civic, social, or religious functions; recreation, food, or drink consumption; or awaiting transportation (IBC Section 303.1).

Some exceptions to Assembly Group A follow:

Figure 1 Typical school hallway



- A building used for assembly purposes with an occupant load of less than 50 persons shall be classified as a Group B occupancy.
- A room or space used for assembly purposes with an occupant load of less than 50 persons and accessory to another occupancy shall be classified as a Group B occupancy or as part of that occupancy.
- A room or space used for assembly purposes that is less than 750 square feet in area and is accessory to another occupancy shall be classified as a Group B occupancy or as part of that occupancy.

For this article's purpose, the typical assembly occupancies you may come across with secondary and higher education buildings are Group A-2, Group A-3, and Group A-4 occupancies.

- Group A-2 assembly uses are intended for food and/or drink consumption including but not limited to banquet halls, nightclubs, restaurants, taverns, and bars (this occupancy also should include dedicated cafeteria areas).
- Group A-3 assembly uses are intended for worship, recreation or amusement, and other assembly uses not classified elsewhere in Group A including but not limited to art galleries, places of religious worship, community halls, exhibition halls, gymnasiums (without spectator seating), indoor swimming pools (without spectator seating), indoor tennis courts (without spectator seating), lecture halls, libraries, and museums.
- Group A-4 assembly uses are intended for viewing of indoor sporting events and activities with spectator seating including but not limited to arenas, skating rinks, swimming pools, and tennis courts.

WHEN ARE SPRINKLERS REQUIRED?

One would want to believe that all educational-type buildings require sprinkler protection throughout. However, different sizes, heights, uses, and allowed exceptions may do away with the need for sprinklers in some of these buildings.

Group E (IFC Section 903.2.2). Per the International Fire Code, an automatic sprinkler system shall be provided for Group E occupancies as follows:

- Throughout all Group E fire areas greater than 20,000 square feet in area
- Throughout every portion of educational buildings below the level of exit discharge

An exception is that an automatic sprinkler system is not required in any fire area or area below the level of exit discharge where every classroom throughout the building has at least one exterior exit door at ground level.

What this code section states is that separated fire areas of 20,000 square feet or greater or floor areas below ground level trigger the sprinkler requirement. However, if you are dealing with a single-story school with a fire area greater than 20,000 square feet with exit doors in each classroom, the building may be permitted to exclude sprinklers. Multistory buildings with fire areas greater than 20,000 square feet require sprinklers throughout.

Group A-2 (IFC Section 903.2.1.2). An automatic sprinkler system shall be provided for Group A-2 occupancies where one of the following conditions exists:

- The fire area exceeds 5,000 square feet.
- The fire area has an occupant load of 100 or more.
- The fire area is located on a floor other than the level of exit discharge.

This requirement for sprinklers applies to dedicated cafeteria areas.

Group A-3 and Group A-4 (IFC Sections 903.2.1.3 and 903.2.1.4). An automatic sprinkler system shall be provided for Group A-3 and A-4 occupancies where one of the following conditions exists:

- The fire area exceeds 12,000 square feet in area.
- The fire area has an occupant load of 300.
- The fire area is located on a floor other than the level of exit discharge.

An exception is areas used exclusively as participant sports areas where the main floor area is located at the same level as the level of exit discharge of the main entrance and exit.

Group B. These occupancies have no code-enforced sprinkler requirement unless the building height exceeds 55 feet, the basement area exceeds the code-allowed travel distance to exits, or the building area exceeds the allowable height and building area. Rubbish and linen chutes, if installed, do require sprinkler protection.

Automatic Sprinkler System Increase per IBC. Where a building is equipped throughout with an approved automatic sprinkler system, the allowed values for maximum height may increase by as much as 20 feet, and the maxi-

mum number of stories may be increased by one. In addition, you may increase the maximum area by an additional 200 percent for buildings with more than one story above grade plane and an additional 300 percent for buildings with no more than one story above grade plane (see Table 1).

Authority Having Jurisdiction (AHJ). Check with the local building department and other regulatory authorities to see if they have any requirements that supersede the state-adopted uniform construction code. You might find that they require sprinklers in structures regardless of the use or size. Some clients and construction managers don't like "tipping off" the AHJ during project formation, so careful consideration and discretion may be required.

Commercial Kitchen Hoods. Each required commercial kitchen exhaust hood and duct system required to have a Type I hood shall be protected with an approved automatic fire-extinguishing system. The automatic fire-extinguishing system shall be of a type recognized for protection of commercial cooking equipment and exhaust systems of the type and arrangement protected. Pre-engineered automatic dry and wet chemical extinguishing systems shall be tested in accordance with Underwriters Laboratories (UL) 300: *Fire Extinguishing Systems for Protection of Restaurant Cooking Areas* and listed and labeled for the intended application. Other types of automatic fire-extinguishing systems shall be listed and labeled for specific use as protection for commercial cooking operations (per IFC Section 904).

Chemistry Laboratory Facilities. NFPA 45: *Standard on Fire Protection for Laboratories Using Chemicals* applies to laboratory buildings, laboratory units, and laboratory work areas. Per this standard, automatic sprinkler system protection shall be required for all new laboratories. (NFPA 45 is not an adopted code, but serves as a standard for good engineering practice.) In university laboratory settings where hazardous exhaust may be present, Section 510.7 of the International Mechanical Code requires sprinklers in the hazardous exhaust ductwork.

Chemical Storage. When applicable, chemical storage areas located in science facilities may be required to be defined as high-hazard Group H. High-hazard Group H occupancies include, among others, the use of a building or structure, or a portion thereof, for the manufacturing, processing, generation, or storage of materials that constitutes a physical or health hazard in quantities in excess of those allowed in control areas. The model building codes define the allowable quantities of compressed gases, combustible liquids, and other materials used in laboratories. Automatic sprinklers are required in Group H areas.

Table 1 Allowable Height and Building Areas

		TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE HI		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
	HGT(feet)									
GROUP	HGT(S)	UL	160	65	56	65	55	65	50	40
A-1	S	UL	5	3	2	3	2	3	2	1
	A	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500
A-2	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9500	i 5,000	11,500	6,000
A-3	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-4	S	UL	11	3	2	3	2	3	2	1
	A	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000
A-5	S	UL	UL	UL	UL	UL	UL	UL	UL	UL
	A	UL	UL	UL	UL	UL	UL	UL	UL	UL
B	S	UL	11	5	4	5	4	5	3	2
	A	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000
E	S	UL	5	3	2	3	2	3	1	1
	A	UL	UL	26,500	14,500	23,500	14,500	25,500	18,500	9,500

Notes: Height limitations shown as stories and feet above grade plane. Area limitations as determined by the definition of "Area, building" per story.
Source: International Building Code Table 503

WHEN ARE STANDPIPES REQUIRED?

Predominantly, the incoming water service, fire distribution mains, and standpipes work the same for educational buildings as other commercial-type facilities.

Per the IBC, standpipes are required in a building where the floor level of the highest story is located more than 30 feet above the lowest level of fire department vehicle access or where the floor level of the lowest story is located more than 30 feet below the highest level of fire department vehicle access. NFPA 45 requires laboratory buildings of two stories or more above or below grade to be provided with standpipes.

The typical standpipe in these types of facilities is a Class I system that provides 2½-inch hose connections to supply water for use by fire departments and those trained in handling heavy fire streams. In required exit stairways, the applicable code also may require separate standpipes. Additional hose connections may be required where travel distances exceed code-mandated limits or where identified by the local fire department or AHJ. Most building codes and the NFPA require risers and 2½-inch hose valves for Class I standpipe systems to be located inside fire-rated stairs or smoke-proof towers. This is to allow firefighters the opportunity to make their connection to the riser inside a protected area prior to entering the floor under the fire condition.

(For more information on standpipe system design, see this issue's "Plumbing Design by the Numbers" column.)

EXISTING BUILDINGS

The more difficult work always seems to be with existing buildings. Whether it's tracing out existing systems though block walls and hard ceilings or trying to figure out how to route ductwork and utility piping because of a tidal wave of ceiling obstructions, we probably spend more hours on existing building projects than on new construction.

Owners also may not like existing building projects because of the potential for unforeseen building infrastructure items or code-required upgrades. Yes, you can flag them at the formation stage in our feasibility studies, but you truly won't know the real impact until you start engineering the systems.

For renovation projects, the International Existing Building Code (IEBC) has different levels of alterations (based on the level of work) that determine if sprinklers are required.

- Level 1 alterations include the removal and replacement or the covering of existing materials, elements, equipment, or fixtures using new materials, elements, equipment, or fixtures that serve the same purpose (IEBC Section 403.1). Alterations typically only maintain the level of existing fire protection, if any.
- Level 2 alterations include the reconfiguration of space, the addition or elimination of any door or window, the reconfiguration or extension of any system, or the installation of any additional equipment (IEBC Section 404.1). Alterations may require provision of automatic sprinkler systems and standpipe systems, as required for renovated and adjacent areas.
- Level 3 alterations apply where the work area exceeds 50 percent of the aggregate area of the building (IEBC Section 405.1). Alterations typically require provision of automatic sprinkler systems and standpipe systems, as required, throughout the existing structure.
- A change of occupancy in existing structures requires the provision of automatic sprinkler systems and standpipe systems as required by current code.

THE COST

Generally with construction projects, the cost expenditures are usually front-loaded into the building design, structure, exterior, furniture, equipment, and interior finishes. Mechanical, electrical, and plumbing systems typically undergo many value engineering exercises to best create the most cost-effective and efficient building environment.

The school board and/or project committee may not be well rehearsed in areas of design and construction, and they rely on the input of advisors and consulting firms to create the facility that meets their expectations.

Funding of new construction or capital improvement projects is a critical component. For public or state facilities, the school board must take into consideration political fallout or taxpayer and voter repercussions. Private schools need to rely heavily on tuition, fundraisers, and private donations for projects to come to fruition. In both cases, an endless amount of fiscal resources for educational projects never seems to be available. The agendas go deeper than just the need to build.

As designers and project managers, we need to be aware of the project formation early on and work with the users and school board to best understand their needs for the project. If necessary, we need to educate them on our engineering community and explain to them the reasons why we make the choices we do.

WAYS TO REDUCE COSTS

The materials and methods come into question once the first estimate has been generated. "What is this line item?" "I didn't realize that we needed sprinklers and that they cost this much." "Why do we need to add sprinklers to an existing building? Do we have to add the sprinklers now?"

Sprinkler systems generally don't offer much wiggle room in cost reduction, but a good engineer should be prepared to offer cost-reducing methods when asked.

The typical "Cadillac" sprinkler system would be something similar to concealed quick-response sprinkler heads (light hazard areas only) located in the center of ceiling tile, threaded Schedule 40 black steel pipe (for pipe 2 inches and smaller), and groove fittings for Schedule 10 black steel pipe (2½ inches and larger).

Some cost-saving ideas include the following:

- Specify recessed pendent sprinkler heads to give the installer more flexibility with his sprinkler drops.
- Remove the "center of ceiling tile" requirement so the contractor can more easily fabricate the sprinkler branch piping.
- Allow the use of extended-coverage sprinklers in large open areas (light hazard areas only).
- Allow remote area reduction if using quick-response sprinklers (light hazard areas only).
- Allow alternate methods and materials for branch sprinkler piping (i.e., lightweight steel or CPVC).

In the end, designing and specifying an automatic sprinkler system for an educational facility is much like any other commercial project. The same considerations need to be made to ensure the correct design methods have been implemented. PSD

STEPHEN ZIGA, CPD, CET, is a Principal and shareholder with hpeGROUP, LLC. Steve rewrote the upcoming ASPE ***Plumbing Engineering Design Handbook*** chapter on fire protection systems and is a technical editor for ***PS&D***. Steve currently sits on the board of directors as Vice President, Technical for the ASPE Philadelphia Chapter. His e-mail address is sziga@hpegroup.com. For more information or to comment on this article, e-mail **articles@psdmagazine.org**.