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by Stephen Hilt, Ray Holliday & Dianne Jones

Firehouse Storm Shelters

Working With Architects to Survive the Onslaught

Designing a station to have resilience to extreme weather occurrences ensures operational efficiency during emergency situations while also keeping staff safe.

Over the years, building codes were updated to establish a standard of safety to protect emergency personnel 24/7. Large areas of the country now require firehouses to include storm shelters. That said, storm shelters, hereafter referred to as tornado shelters and/or hurricane shelters, add a layer of cost and complexity to the design and construction process as well as particular permitting requirements and a distinct set of considerations. An experienced design team can help you to understand, navigate and execute.

Complying with FEMA, ICC and IBC

FEMA, International Code Council (ICC) and the International Building Code (IBC) work together to determine and outline safety standards for tornado and hurricane shelters.

For many years, design and construction relied on two FEMA pamphlets: "Taking Shelter from the Storm: Building a Safe Room for Your Home" (FEMA P-320) and "Safe Rooms for Tornadoes and Hurricanes: Guidance for Community and Residential Safe Rooms" (FEMA P-361).

In 2008, ICC used both of these pamphlets as the framework for the agency to further develop the ICC 500 Standard for the Design and Construction of Storm Shelters. Since the 2015 model code, the IBC has required certain areas of the country to meet ICC 500 requirements.

The IBC says that in areas where the shelter design wind speed for tornadoes is 250 mph—in accordance with Figure 304.2(1) of ICC 500—9-1-1 call stations, emergency operation centers, and fire, rescue, ambulance and police stations must comply with Table 1604.5 as Risk Category IV structures and include a storm shelter that's constructed in accordance with ICC 500.

Shelter specifics

ICC 500 maps help to determine the wind speeds that a shelter must be designed to meet based on its location.

The IBC requires the construction of tornado shelters within zones that are most

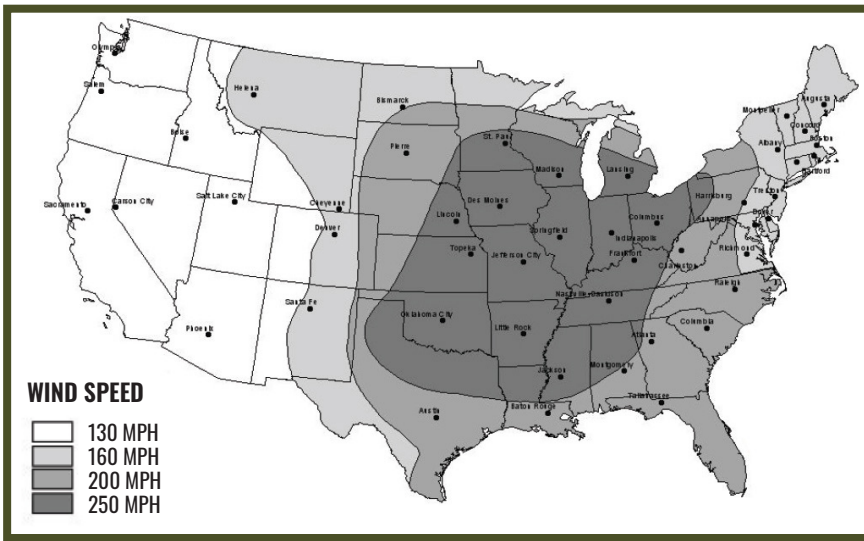

Figure 304.2(1). Values are nominal three-second gust wind speeds in miles per hour at 33 feet above ground for Exposure Category C. (Multiply miles per hour by 0.477 to obtain meters per second.) Location-specific storm shelter design wind speeds shall be permitted to be determined using the ATC Hazards by Location website (hazards.atcouncil.org).

susceptible to severe EF5 tornadic activity. Firehouses that are located outside of the 250-mph wind zone might need to meet other storm protections or requirements that their state insurance codes require.

Tornado shelters protect from relatively quick and severe wind events. These are designed to be occupied for a two-hour duration and to be capable of protecting against tornado events and wind speeds according to ICC's Design for Wind Speeds for Tornadoes map (see previous page).

The architect should dedicate a few meetings solely to what's required for the shelter's construction.

Departments that are outside of the 250-mph zone might wish to provide a lower level of protection at lower cost by designing a hardened area or building that serves as a relatively safe zone for staff while improving the resilience of the firehouse. However, there is a significant difference between a hardened area and a true tornado shelter. Whenever a zone is identified as a tornado shelter or safe room, the design must meet ICC 500 standards for the designated area.

The requirements for hurricane shelters are slightly different, because they must protect staff for a total of 24 hours. The wind speeds that are required for hurricane shelters are shown in the ICC's Design for Wind Speeds for Hurricanes map (see upper right). These shelters require more restrooms than a tornado shelter has, storage of drinking water for all occupants and a design that accommodates rainwater drainage.

Requirements

A tornado shelter or a hurricane shelter can be the whole building, part of a host building or a stand-alone structure. Five key factors play into planning of such tornado shelters and hurricane shelters: materials, accounting for occupancy, ventilation, power, and essential features and accessories. Having upfront conversations with a design team and code officials about these factors helps to determine costs.

Materials. Tornado and hurricane shelters for firehouses typically are designated areas within the host building. Finding an area that can perform double duty as a shelter as well as a daily operational space reduces costs. Because a tornado shelter and a hurricane shelter must be constructed of concrete masonry units (CMUs) or concrete walls, many support spaces that are near the apparatus bay can double as the shelter. This reduces the added cost for the wind-force-resisting construction while benefiting the work zone with cleanable and abuse-resistant walls.

Accounting for occupancy. The code official has wide authority in determining the calculation method for a shelter's required occupant load. A facility's design team works with local authorities to designate that load. For shelters for firehouses, the most common requirements are to account for either the total number of staff per shift or the maximum number of staff during a shift change. If your facility includes a large training room, local authorities might require your shelter to be large enough to accommodate the entire occupant load of the training room plus on-duty staff.

Ventilation. The type of ventilation that's used for the shelter, either passive or mechanical, can affect the budget based on how local code officials interpret the code. Some code officials allow the ductwork that serves a mechanical ventilation system to be breakaway in case of a host building collapse; others require the entire ductwork system that serves the shelter to be fully wind-rated to meet the same storm protections of the shelter itself. The difference of this interpretation can change the expected cost of the ventilation system dramatically.

Power. Power for life-support systems in tornado shelters frequently is provided by battery inverters. However, for hurricane shelters, a more robust solution is required, because the shelters are occupied for longer periods of time. A common solution for this is a backup generator, but it introduces another level of protection to be interpreted and confirmed with the local building official. The surest answer to the dilemma is to protect the generator itself within a fully ICC 500-compliant structure. However, that

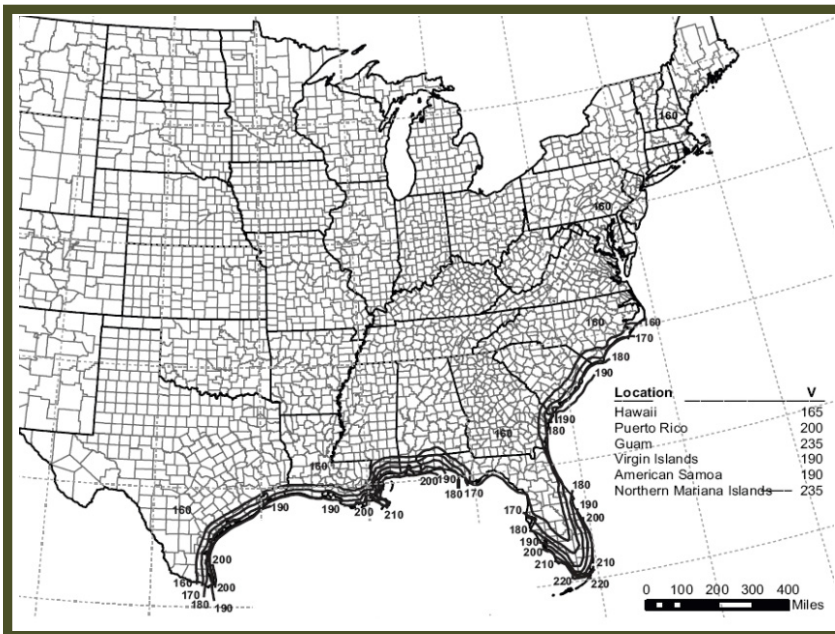

Figure 304.2(2). Values are nominal three-second gust wind speeds in miles per hour at 33 feet above ground for Exposure Category C. (Multiply miles per hour by 0.477 to obtain meters per second.) Linear interpolation between contours is permitted. Islands and coastal areas that are outside of the last contour shall use the last wind speed contour of the coastal area. Location-specific storm shelter design wind speeds shall be permitted to be determined using the ATC Hazards by Location website (hazards.atcouncil.org).

Five key factors play into planning of such tornado shelters and hurricane shelters: materials, accounting for occupancy, ventilation, power, and essential features and accessories.

can be prohibitively expensive, because it's a challenge to provide enough storm-protected ventilation. Because a generator enclosure isn't occupied and the goal is to maintain the equipment in operable condition, many building code officials allow for a lower standard of protection.

Essential features and accessories. ICC 500 also includes requirements for the number of restrooms that are required in the shelter, egress to/from the shelter, room and wayfinding signage, and the first aid supplies that are provided.

Testing and certification

The process of ensuring that a tornado shelter or a hurricane shelter meets ICC 500 requirements can be a somewhat complicated ordeal. The owner has additional responsibilities in this vein during design and construction than is the case typically.

Although an experienced architect can help to guide the process, the owner of the facility ultimately is responsible for hiring certain specialists for certification.

The latest version of ICC 500 requires the owner to directly hire a peer design reviewer who will check the architects' and engineers' drawings during design to verify that the proposed shelter meets ICC standards.

Architects no longer can hire peer reviewers, but they can provide recommendations, including based on relationships with providers with whom they worked out a streamlined process. By pairing a peer reviewer and designers who are familiar with each other's methodologies, potential delays over minor document and formatting issues can be avoided.

During construction, owners must make sure that inspectors budget for normal testing as well as that which is outlined in Section 110 of ICC 500. This includes time for continuous inspection that's required during a specific portion of construction. Tested and rated building assemblies and products generally are recommended, because any unproven or custom solution requires costly and time-consuming testing.

Owners are required to submit the plan that will identify the activation procedures for the shelter and the role designations of staff during a storm. The plan includes a floor plan, site plan, and egress plan. Sleeping accommodations and storage locations for supplies must be shown.

Of course, architects are permitted to help the owner to provide the floor plan.

Meeting code and budget

Costs that are associated with the assembly of a tornado shelter and hurricane shelter must consider additional testing and observation during construction, the enhanced structural design of the shelter

itself, and additional material and labor costs. An experienced team of designers, engineers and contractors can help to save costs by avoiding delays and construction errors through organized planning, coordination and communication.

One of the biggest time savers is to make sure that the entire construction team—meaning every trade that's involved—is coordinating responsibilities. The architect should dedicate a few meetings solely to what's required for the shelter's construction.

It's a good idea to require the construction crew to build a mock-up wall of the shelter assembly. This gives each trade a trial run on what's expected for construction and another reminder that this portion of the station requires extra attention.

An example of what can go wrong: Say an apprentice electrician misses the shelter pre-installation meeting. Later, that individual cuts into the CMU to recess the electrical outlets. This voids the structural integrity of the tested wind force-resisting construction assembly, which results in the entire wall needing to be replaced.

It's crucial that each person who is involved in constructing the shelter understands that every part of it must be built exactly as shown in the approved and tested assemblies. The structural engineer should include site visits specifically to observe the build at key stages of construction. Spotting an issue before a concrete pour can help to prevent time-consuming and costly corrections.

Mitigating the expense

Although the additional costs that are associated with a tornado shelter and hurricane shelter are significant, a department might be capable of offsetting some of the expense with grants. You can check out the page on safe rooms on the FEMA website for more information or contact your state hazard mitigation officer. Furthermore, the extra planning and costs of shelter construction can be manageable with a good design team. ■

FOR MORE STATIONS: firehouse.com/stations

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Turnout Gear & Equipment Cleaning

When it comes to creating a decontamination laundry area at a firehouse, it's essential to know the basics and to plan ahead.

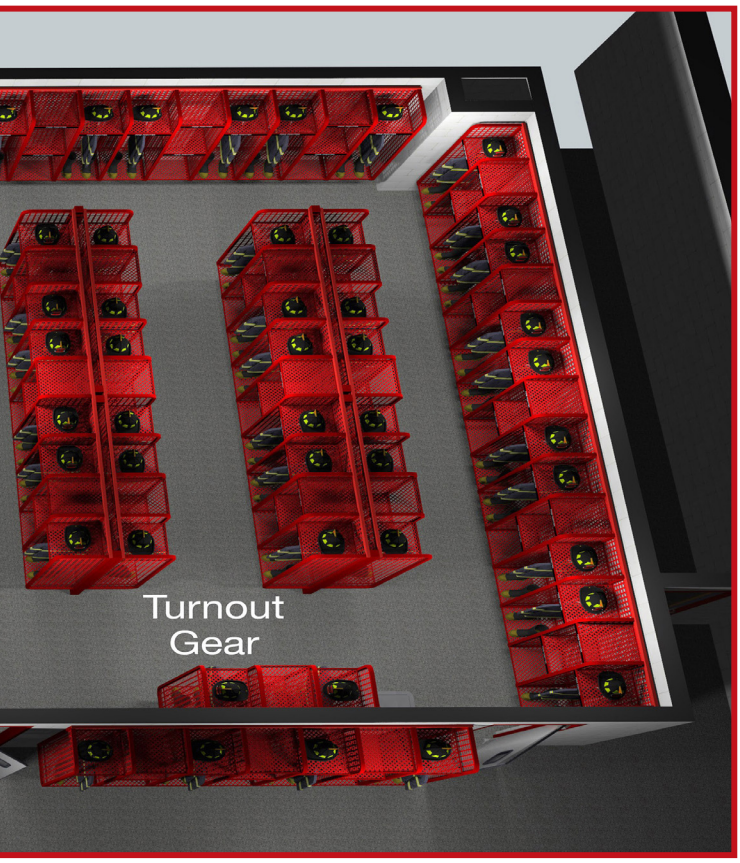
by Robert Mitchell

Over the past few years, the fire service has learned much about the dangers of contaminants that travel from the fire scene back to the station. Research and experience have taught us that a well-designed decontamination space in the station is essential to firefighter health and safety. The layout of the decontamination laundry can support decon protocols for the cleaning of personnel and PPE returning from the fire scene.

Some basics

Our current understanding of the health risks to firefighters and the importance of decon has much in common with the transformation of healthcare practices that occurred in the 19th century. That was a time when practitioners began to more fully understand how infections spread. Doctors who proudly wore bloodied aprons through their long days of surgery learned to change surgical gowns and to wash their hands between patients. Instruments were cleaned using newly designed sterilizing equipment. Surgical suites were modified for ease of cleaning. Incidents of infection decreased.

Today in the fire service, our understanding of the risks that are posed by exposure to toxins and carcinogens has led to new protocols at the fire scene and a significantly greater emphasis on decon at the station. Whether building a new facility or retrofitting an older station, it's essential for those who are involved in the design of the facility to understand operational needs and how to scale the decon laundry area to meet those needs. The area that's set aside for decon can vary in size from around 500 sq. ft. to more than 1,000 sq. ft. This is determined by operations, size of staff and frequency of fires.



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Without careful planning, one might find oneself shoehorning in a washer, only to find out that it can't be serviced (because the space doesn't accommodate it), that the drainage system can't handle the flow or that wall surfaces don't stay clean because of exposed piping or a rough finish.

Decon laundry plan: area by area

Best practices of a proper decon laundry include:

The Pathway. Members who are returning to the station should enter directly into a gross decon area, then the laundry, the showers that

Gross decon area elements are metal shelving, a tub sink and a gross decon chamber.

Installation & Maintenance Tips

Countertops and Shelving

- Should be made of stainless steel for easy cleaning
- Some should be deep enough so PPE can be laid out without falling to the floor

Surfaces

- When possible, install smooth surfaces; they are particularly easy to clean; watch out for nooks and crannies that can harbor dirt and germs
- All piping should be buried in the wall to ensure smooth, easily cleaned walls
- The ceiling is difficult to clean and often is neglected; consider a washable suspended ceiling
- Install sanitary coving at the wall and floor junction

Clearances

- Required equipment maintenance defines acceptable clearances; absolutely follow manufacturer specifications, which can vary from one to the other
- Watch room door sizes; future and potentially larger equipment might require wider door openings

Anchoring and slab requirements

- Equipment anchoring isn't trivial; anchors must be strong enough to secure a washer/extractor that can weigh 4,500 lbs. or more and can produce significant G-force during extraction; always be sure to refer to manufacturer recommendations
- The slab under the washer/extractor must be designed specifically to handle the load

Plumbing and drainage

- Make sure that the plumbing engineer is aware of all of the specifications before work starts
- A typical 65-lb.-capacity machine discharges approximately 25 gallons or more of water in 30 seconds at the start of extraction; drainage must accommodate that
- Laundry equipment manufacturers generally prefer trench drains; stainless steel is preferred; it should be in-slab for new construction but can be an above-slab box for renovation

Failure to plan plumbing and bury it in the wall leaves a room impossible to keep clean.

Key Messages

Members of the department know its operations. Get them involved early and keep them involved through construction.

How all of the parts and pieces fit together must be understood, so the decontamination area layout and equipment support the department's protocol, properly address health and safety, and are easy to maintain. By designing a well-thought-out and properly equipped decon area, the importance of the decon process is demonstrated to staff and the public.

Remember:

- Determine your protocol and design to it
- Evaluate the required throughput rate and number of people in the space
- Allow for ergonomics of the tasks
- Consider proposed and future equipment
- Understand manufacturer requirements
- Design the area so that it's easy to clean, and keep it clean

have clean clothes lockers and the living area. The end result of all of this is members entering the Cold Zone of the station are clean and ready either to participate in a debrief session, to return to the station living quarters or to return home.

Location, Location, Location. It's essential that the decon laundry is located in the Hot Zone, so there's no need for personnel to cross into the Warm or Cold Zones for the decon process. The decon laundry must be separated physically from the apparatus bay and from the administrative/living space of the station. In addition, contaminants should be kept inside of the decon area by maintaining a negative air pressure differential via correctly designed ventilation.

The ventilation rate in the decon laundry when it's occupied should be six air changes per hour. An occupancy sensor should be installed to determine when it's time to turn the fan to the higher rate.

Gross decon area

The central elements of this space are metal shelving to hold contaminated PPE, a general-purpose tub sink that includes drip-dry racks and a gross decon chamber that has a high-volume hand sprayer (the kind that might be found in a commercial kitchen). A washing machine or ultrasonic cleaner for SCBA face masks, air bottles, and helmets often is included.

Laundry area

Once member gross decon is complete, the laundry area of the station comes into play.

Two kinds of washers are located here: a washer/extractor that's designed for decontaminating PPE and a residential washer that can produce higher temperatures for suitable PPE and members' personal clothing that was at the incident scene (see "Hot Picks: Clothes Washers & Dryers," firehouse.com/21256885).

The laundry area of a firehouse should include a washer/extractor that's designed for PPE and a high-temperature residential washer for suitable PPE and personal clothing.

Failure to plan proper spaces in a firehouse's decon laundry area can lead to equipment being installed in a way so that it can't be repaired without the removal of both the disconnect and the machine.

Privacy is a vital element of the design of Hot Zone showers and lockers.

Because toxins from the fireground can pass through PPE and undergarments and can enter the skin, undergarments should be washed at the station in the decon area. They shouldn't be washed in the living quarters nor sent home for laundering, per *NFPA 1851: Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

Determining the size of the washer/extractor that's required should happen during programming before the design process of a new station begins. Be sure to consult NFPA 1851 recommendations.

A washer/extractor that has a capacity of 60–65 lbs. can meet the needs of many departments, but the choice should be based on the size of staff and the number of calls for the department.

Individual manufacturer recommendations for machine capacity might vary, so ask questions and be careful not to oversize. Bigger isn't always better. If your typical laundry load is too small for the size of the machine, the load can become unbalanced and make for extra wear and tear on seals, bearings and bushings. In the same vein, don't undersize the laundry load. A load that's too big for the machine can decrease the effectiveness of the cleaning process.

Whenever selecting and installing any equipment, be sure to follow all manufacturer recommendations and to understand and follow specifications. That said, not all manufacturers publish such information. If that's the case, demand it. Keep in mind that the more that you know, the better the questions that you can ask.

Plan for soap storage. This might seem as though it's a minor matter, but far too often, containers that feed the machine and that are stored for future use end up on the floor of the room, which can create trip hazards and cleanup problems.

You must consider time, space and air-contamination issues that are related to gear dryers. There are two basic types of gear dryers: the externally vented cabinet and the tubular, internally vented rack. As much as 40 percent of polycyclic aromatic hydrocarbons (PAH) that can contaminate PPE on the fireground remain in the gear after washing. Rack drying can be a quick option, but contaminants that remain in the gear will vent directly into the room. A solution that's used in some stations is to locate racks in a separate drying room that can be ventilated out of the station.

Typical time for the gear washing process is 45 minutes, but drying of the gear can require 2–3 hours. To address this time difference, install hanging racks for the gear that's waiting for dryer time. Tubular racks in a separate room allow minimum turnaround time while not reintroducing contaminants into the air stream.

Shower and locker area

Next to the effectiveness of personnel decontamination, privacy is a number one concern in the shower and locker area. To address the matter, one should include individual shower stalls that are enclosed with doors that are designed to ensure privacy. Those who are involved in the design of the stalls should include a dry area for dressing. Beyond that is a curtained shower.

Nearby to all of this should be a locker area where each firefighter can keep street or station clothing to bring into the shower stall for changing. ■

FOR MORE STATIONS: firehouse.com/stations

ROBERT MITCHELL is the principal of Mitchell Associates Architects PLLC. Mitchell has 30 years of experience designing fire stations and has been involved directly in more than 190 fire station and emergency services facilities projects, affecting more than 330 fire stations. More than 40 of his stations were recognized in national fire service magazines; seven won national gold prizes. Mitchell recently developed the "basis of design" for future fire stations for Philadelphia that addressed new stations and renovations, dealing directly with firefighter safety and health and decontamination. He is the author of the chapter on fire station renovation and additions for the "Fire Station Design Handbook," which was published by the International Association of Fire Chiefs Foundation, and his design ideas for incorporating training features into fire stations are featured in the "FEMA Fire Station Design Manual." Mitchell is licensed in nine states and is certified with the National Council of Architectural Boards.

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Large windows make the lobby-museum of the Sumter, SC, Fire Department headquarters station highly visible and inviting to the community.
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We Will Never Forget

by Ken Newell

The relationship with the community and the pride of current and past members can be strengthened by designing a museum or memorial into a renovated or new firehouse.

I always have loved history. I can remember back to when I was a small child and every two weeks on Saturday, my dad and I would go to our small-town barber shop for our haircuts. I would be in the chair first, then my dad. When I got out of the chair, Dad would give me a dime to buy a soda pop in a glass bottle. I then spent most of the next 30 minutes staring at all of the old photographs, plaques and memorabilia that were on the walls and shelves. That barber shop served as somewhat of a museum in a town that was too small to have a dedicated museum. Many of the photos were of those who lost their life as members of the military or as public servants. I never have tired of learning about all of those who went before me.

After Sept. 11, 2001, the phrase "We will never forget" was reintroduced into American society with new vigor.

As I have stated before on many occasions, it helps us to keep in mind those who went before us, many of whom lost their life in service to their nation or community.

History is important. There are many examples of nations, communities and even small groups that suffer the consequences of not remembering or recognizing their history. History reminds us of where we have been, and it shows us the good and bad in the past. History teaches us how we should live if we simply pay attention. It connects us with our earlier family members and friends and honors them for the sacrifices that they made to perform selfless acts.

As a public safety architect, I have spent the past four decades of my career providing fire station design services for some of the bravest, most honorable citizens in our communities. The

firefighting community has a long history of service and sacrifice. Without question, every fire department has an impressive and important story to tell. As in the case of that old barber shop, many departments' walls and shelves are full of photos, plaques, flags and other types of memorabilia. Unfortunately, many other departments haven't considered or found effective ways to show their rich history to their community or even to their own members.

It's key to make a department's history well known, highly visible and inviting to all.

Visible from the public way

Because its inclusion in a firehouse can further the distinction of the station, placing a museum or a memorial in a location that's highly visible from the public way is a valuable approach. It can remind members of the community of the department's history of service and act as an invitation to enter the station. Whether the museum or memorial is located outside of the station or on its interior, the display should allow the visitor to enjoy it in a safe environment while not hindering emergency responses. Although the size of the museum or memorial isn't as critical as its location, the museum or memorial must be large enough to feature the department's items of historical significance.

The integration of historical content within a firehouse can tell the story of a department and community as well as honor the firefighting profession. The entry lobby of the James City-Bruton Volunteer Fire Department & Rescue Squad station in Toano, VA, displays the original fire department logo as inlaid tile flooring.
PHOTO BY GUERNSEY TINGLE

Rest and Reflection

Incorporation of a memorial plaza at a firehouse can serve as a place for visitors and department members to rest as well as to reflect on the history of the department and those who served, or still are serving, the community. The plaza doesn't have to be a large area. Even the smallest of entryways or "off the beaten path" areas can house statues, plaques, flags, memorial benches, fountains, etc.

Most museums and memorials that are in stations are combined with the public lobby. Therefore, they are located on the public face of the station. This positioning allows for the opportunity to show off the department's history, day or night, through properly sized and placed windows.

The recently completed Sumter, SC, Fire Department headquarters houses the department's restored 1908 LaFrance fire steam engine in the museum/lobby along with other historical artifacts. Floor-to-ceiling windows show the museum pieces at all hours of the day. Because the museum is, in fact, the lobby, the public encounters the department's history each time that they enter the station.

Murals and large-scale vinyl graphics of historic photos on walls that are visible from the exterior can serve as cost-effective methods of telling a department's history

Firefighter-made elements, such as the custom kitchen table in the Harrisburg, NC, Fire Department Station No. 3, can combine a department's history and the talents of the members of the department.

Historical displays aren't just for visitors to the station. All of the elements can be used successfully in the private areas of the station, too.

and to attract the public into display spaces. All interior opportunities are elements that can be lit well at night, which would make them visible during daytime hours, too.

Over the years when I spoke at the Station Design Conference or to department representatives directly, I urged people to remember that the design process of a significant project that contains a museum or specific historical emphasis, whether renovation or new construction, can benefit from the input from and collaboration with historical societies, architectural review boards and other such groups. Further, greater relationships with schools, local museums, chambers of commerce and others can emerge as an additional benefit.

The public lobby of the new Raleigh, NC, Fire Department Station No.6 utilizes many repurposed materials from the original station, including the fire pole, wood flooring (used for wall surfaces), brick (used as floor pavers) and door hardware.

Other interior elements

Numerous other interior elements can be used to display the department's history. Display cases provide the opportunity to regularly rotate different pieces.

Department seals, logos and replica patches can be built, poured or recessed into a variety of floor finishes.

Retired fire poles can be displayed in public spaces or even set up for low-height slides in display areas for children.

Historical displays aren't just for visitors to the station. All of the elements can be used successfully in the private areas of the station, too. For instance, a retired fire pole can be repurposed for kitchen hanging racks or footrests at the kitchen bar.

Speaking of the kitchen, one of the ways to show off a department's history and firefighters' talent is to let them design and build a department-specific dining table. Make it a masterpiece!

A case study

When James City County, VA, dedicated the new James City-Bruton Volunteer Fire Department & Rescue Squad station, the facility became the third different building to occupy the same site over the past 110

years. The most recent previous building was the first Toano Fire Station, which was built in the mid-20th century. The original structure was the first public high school in James City County. Both of the earlier facilities served as significant gathering places for the members of the rural Toano community, situated at the midpoint along the roadway and railroad between the cities of Richmond and Hampton.

When it came time to replace the outdated fire station with a modern facility, the community was clear in its directives to Stewart-Cooper-Newell Architects, which teamed with architects of Guernsey Tingle, for the design to reflect the original, grand architecture of the historic Toano High School. Although some departments desire to attempt a replication of a previous fire station, the Toano community chose to

pay aesthetic homage to a previous structure that wasn't a fire station. Thankfully, old photographs of the two-story, early-20th century school still exist, which allowed the designers to study the structure details, replicate many building forms and provide a modern interpretation of the old aesthetic.

The project illustrates how the integration of memorials, museums and historical content within a fire station can foster relationships, tell the story of a department and community, and honor the firefighting profession, all while being cost-effective. The exterior aesthetic features of the headquarters reflect design elements and principles that were found in the historic high school from a century earlier. There are many borrowed exterior details from the original school structure, such as roof forms, the window shapes and details, masonry detailing and the entry tower element. Although the station's design language and materials are a reflection of the site's former use, the tradition of the fire department and the history of the firefighting profession also are displayed proudly.

The station has zoned community space, such as a large community room and associated commercial kitchen, which results in a constant flow of visitors who encounter the historical aspects of the design as soon as they arrive. The wood-paneled, domed-ceiling entry lobby proudly displays the original

The architecture of the new headquarters of the Danville, VA, Fire Department borrows from the forms, details and materials of the historic Tobacco Warehouse District, where it resides and is spurring district redevelopment.

fire department logo as inlaid tile flooring. Displays throughout the station feature historical firefighting equipment and technology that was used previously by the department.

Community and member pride

Public safety departments do better when they have an active relationship with their community. Department representatives who are involved in the design of a new station or the renovation of an existing one would be remiss to not recognize how a museum or memorial can strengthen the relationship with the community—via encouraging interaction and facilitating education—which leads to generating trust.

Then there's what a museum or memorial can mean to the active members of the department: They will see on a daily basis that the community never will forget those who sacrificed everything in the performance of their job.

There's worth, too, regarding retired members, prompting reason to return to the station, where their pride in their previous service can be reinvigorated. ■

FOR MORE STATIONS: firehouse.com/stations

KEN NEWELL, AIA, LEED AP BD+C, joined Stewart-Cooper-Newell Architects in 1988. He has earned a national reputation for the programming and design of award-winning public safety facilities that are functional, practical and budget-conscious. Newell was involved directly in the planning and design of more than 350 fire stations, EMS stations and public safety training facility projects that were designed by the firm. He also consulted other architects on the design of more than 75 public safety projects in 27 states. Many of these stations received national design award recognition. Since 2000, Newell has become one of the most in-demand presenters at national public safety design conferences. His unique ability to deliver high-quality and educational presentations, on very practical topics, has earned him top ratings from audiences.

TO CONNECT: fire-station.com

by Mark Bushhouse

Healthy Station Design

Doesn't End with Hot and Cold Zones

The cost and use of prime space for a single-user toilet/shower that's located off of the apparatus bay can be offset by the capability that's afforded to reduce the number of Cold Zone toilets/showers.

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Carbon monoxide and toxin sensing, air purification systems, and decontamination rooms and showers are among the prominent ways for a department to boost member health, safety and welfare.

Removing carcinogens from a fire station requires addressing the two primary sources of carcinogens that are introduced to the station: those that are produced by fuel combustion that's generated by vehicles that are inside of the station and those that are brought to the station from structural fires. Building code and Occupational Safety and Health Administration (OSHA) requirements are in place to meet the minimum acceptable levels for general air quality and work environment safety. However, additional methods are required to enhance users' long-term health, safety and welfare and to prevent cross-contamination into living quarters and administration zones.

CO and toxin sensing

Apparatus bays have a general room exhaust system that's code-required, and that system has an integral OSHA-required carbon monoxide/nitrogen dioxide toxin alert mechanism. This mechanism engages automatically when sensors in the system are triggered by CO or NO_2 that's present in the atmosphere of the bay. When the mechanism is engaged, air is extracted from the room and a louver system is opened to let fresh air enter into the space.

A toxin alert mechanism won't engage every time, particularly not when apparatus bay doors are open or when a source-capture system is installed. Further, it isn't designed to filter out carcinogenic particulates but merely to exhaust and replace interior air with fresh outside air. That said, utilizing it during the decontamination process assists the process and improves air quality in the apparatus bay. When vehicles are running indoors or when they return from a structural fire during the decontamination process, members should engage the room exhaust system manually. This will increase the efficacy of carcinogen removal.

A similar exhaust system has the possibility to be installed in some areas of the station that are not the apparatus bays. It can be used to sense increased usage by sensing carbon dioxide and/or movement within the space and then increasing the amount of fresh air that's added into the HVAC system and, thus, replacing more of the air and refreshing the rooms. For example, installing this system in the turnout gear room and Hot Zone laundry/extractor/drying room could promote clean air in the spaces that might have built-up contaminants. In the administration and living quarters, installing a similar system in offices or bunkrooms will refresh the air in low-traffic areas. The use in private areas keeps air healthy and prevents staleness while personnel spend extended time in a small, confined space.

Installation of a room exhaust system in the Hot Zone laundry/extractor/drying room can promote clean air in the spaces that might have built-up contaminants.

Because these spaces often are shared spaces throughout the week, use of such a system prevents unintentional cross-contamination of spaces.

Installing a sensor system would negate the need for staff to run the system. This can be coupled with a manual switch to run the system on demand or can be controlled by a time clock to coincide with shift changes.

HVAC

Air purification systems provide an alternate safety measure to fire stations to remove particulates from the atmosphere in lieu of, or in addition to, source-capture exhaust systems. The multistage purification systems can remove some gases, particulates and other contaminants, including viruses. The systems come in many sizes, forms and mounting system. Furthermore, they can be installed throughout the station, including apparatus bays.

The systems have several activation methods to make their function automatic, but again, having the capability to engage the system manually to use it during the post-structural fire decontamination process strengthens the measures.

Importantly, these systems require regular maintenance and filter replacements. Station protocols should be expanded to include this. Fortunately, the unit will indicate when it needs filter changes.

Also, the quantity of the units that's required to provide proper purification is based on the volume of the space, and an engineering team likely will need to be involved in coordinating proper installation.

Installing an air purification system in other parts of the station might not be directed to remove carcinogenic particulates but can improve the air quality of living and administration spaces. Because

Can Saunas Reduce Firehouse Carcinogens?

Some stations are installing saunas and heat exposure exercises for post-structural fire exposure to carcinogens in hopes of reducing the amount of carcinogens that stay on or within the body. However, as discussed in "Evaluation of Intervention to Reduce Firefighter Exposures," which was published in the Journal of Occupational and Environmental Medicine (JOEM) in April 2020, a study of specific interventions that are used by the fire service to reduce or mitigate exposure to carcinogens found that the use of infrared saunas after exposure to carcinogens has "non-significant reductions" in the output of carcinogens through urinary testing. Furthermore, the article specifically mentions the potential to cause harm to the cardiovascular system through heat stresses. However, the study didn't test that claim specifically, and the study authors admitted that more research must be performed to test the hypothesis.

Therefore, the installation, upkeep, maintenance and use of these heat exposure elements and spaces, not to mention the procedural time that's devoted to these protocols, is forecasting to be futile in early studies.

the system is set up with multistage filters, it removes many types of pollutants, large and small. This can keep the air that's in other areas of the station clean.

Placing these units in shared areas can clean shared air, possibly eliminating odors/dust and reducing sick time for personnel.

Some of the common areas that might be recommended for installation of these systems include lobbies, training rooms, conference rooms, shared offices, locker rooms, kitchens and dining rooms, day rooms and exercise rooms. Furthermore, the systems can be installed above ceilings for areas where aesthetics is important.

To further address the removal of carcinogens in the station, reiterating and strengthening the Hot Zone design and NFPA requirements and protocols are critical. Preferably, the hypothetical goal is that, during the decontamination process, the living quarters and administration zones (i.e., Cold Zones) remain isolated, or "out of bounds," until the process is complete.

Designing an HVAC system to provide positively pressured clean air in the transition and clean zones allows the system to prevent the contaminated air from entering the Cold Zones. However, from our group's recent experience, many users reported that protocol often is broken by a member's trip to the restroom after that individual returns from a call. Additionally, this breakdown typically includes the lack of handwashing prior to use of the toilet.

Decon rooms & showers

Finding a balance of decon rooms, toilet rooms, and Cold Zone shower or locker rooms and toilets is essential to the cost, space, and proper sequencing of health and safety protocols. The incorporation of an additional single-user toilet that's located directly off of the apparatus bay in the Hot Zone might be necessary to prevent contamination of the Cold Zone.

Also, adding to the quantity of decon rooms that are located off of the apparatus bay allows more than one firefighter to decontaminate at a time. This affords a quicker turnaround for the firefighters.

The downsides to adding multiple decon rooms are increased cost and use of prime space, in particular. However, additional Hot Zone showers could be offset by reducing the number of Cold Zone showers, because all of the Hot Zone showers can be used as Cold Zone showers once they are cleaned. As well, perhaps other carcinogen-exposure-reduction methods can be foregone in station planning entirely, giving room for additional decon showers and cleaning procedures.

Handwashing stations

Increasing the number of handwashing sinks in and around Hot Zones and directly adjacent to access to the Cold Zone should be considered mandatory.

Both infection control and decon procedures call extensively for washing with water of persons (and equipment), although

this protocol often is foregone for the easier step of hand sanitizers and cleansing wipes.

NFPA standards are very clear that using hand sanitizers and cleansing wipes is a temporary stopgap to the vital rinsing away of particulates with water and detergents, preferably as soon as a handwashing basin or sink fixture can be accessed. Hand sanitizers and cleansing wipes might antisepticise most diseases and viruses, but the same can't be said for neutralizing carcinogens.

Ideally, every time that users return to a Cold Zone, having done something as minimal as picking up a tool or touching a wall—not to mention returning from a call—they should wash particulates from their hands before entering and touching items in the Cold Zone. This task can't be performed easily when proper equipment isn't made convenient for them.

Vehicles

Washing contaminated vehicles outside of the station redirects particulates, and components of the apparatus bay washing systems, such as warm water hoses and exterior storage systems, can translate themselves easily to the exterior to facilitate that redirection of particulates.

The amount of fuel-combustion carcinogens that's generated in the station can be reduced by utilizing electric or hybrid vehicles, which can enter and leave a station without producing combustion. Although it's excessive to believe that an entire fleet will turn over to electric or hybrid vehicles in one swoop, stations can start to prepare for these vehicles by introducing the correct power source to handle the future electric load; preparing secondary spare panels and spaces for future generators; and running empty conduits to the stalls in the garage and on site for the vehicles.

Commitment

At this point in time, until more evidence is presented to all of us, further diminishing of the cancer risk within the firehouse comes down to design and equipment enhancements, ever-improving protocols and procedures, and making those actions habitual. ■

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