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- **Temporary Stations & Substation Requirements**
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The Lutherville Volunteer Fire Company in Baltimore County, MD, is a two-story station that consists of six bays. Due to site constraints, the department located its administrative and living quarters on the upper levels of the station.

Photo courtesy Manns Woodward Studios

## A4 Anatomy of the Apparatus Bay

Robert Manns of Manns Woodward Studios looks at three key factors that influence modern apparatus bay design—factors that make apparatus bays much more than just a garage. Specifically, Manns looks at the evolution of apparatus, building code development, and building systems technology, including topics such as exterior walls, floor drainage, lighting, heating systems, exhaust systems, air circulation and more.

## A12 Going Vertical

Christopher Kehde of LeMay Erickson Willcox Architects addresses the critical questions that many architects and fire department members ask when considering trending issues related to single-story stations, multi-story stations and mixed-use facilities. Kehde offers three case studies to illustrate the decision-making process for three departments examining issues related to “going vertical.”

## A18 Design on a Budget

Ronny J. Coleman reviews some of the minimum features to include in a station for efficiency and safety of personnel, focusing primarily on temporary stations and substations. Coleman provides a chart that details the functional aspects of fire stations that apply to volunteer substations, including apparatus bays, hose storage, PPE racks, administrative areas and more.

## A22 Target-Harden Fire Stations

Dana Compton of Komatsu Architecture addresses the need to protect “essential facilities,” such as fire stations, in the event of a terrorist attack or natural disaster, so that such facilities can continue to function and serve the public. She covers a variety of considerations for security in and around fire stations, taking into account basic requirements and Environmental & Historic Preservation restrictions for the use of UASI funds.



### ON THE COVER

The Fontaine Avenue Station No. 10 in the City of Charlottesville, VA. Read more about this facility on p. A12.

Photo courtesy LeMay Erickson Willcox Architects

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For news related to fire stations around the country as well as original content related to station design tips and trends, visit [firehouse.com/stations](http://firehouse.com/stations).

By Robert Manns



# ANATOMY OF THE APPARATUS BAY

**Three factors influence apparatus bay design, making these spaces more than just a common garage**

**W**hen leaders and architects are tasked with designing a fire station, they should be well prepared to respond to uninformed criticism from the public. During budget hearings, bond referendums and community input meetings, perhaps one of the most common remarks made is, “It’s just a garage, it shouldn’t cost that much!” Being positioned to respond to such a comment can be the difference maker in the success or failure of gaining project approval.

While fire stations consist of many spaces beyond the bays, apparatus storage space is almost always the largest component. Three key factors have come to influence the design of apparatus bays that differentiates them from the common garage.

First, firefighting apparatus and equipment has substantially evolved within the past decades. Equipment size has significantly increased throughout history, and innovation continues to occur.

Second is the advent and continued development of building codes. Officials throughout the country have come to realize that fire stations and other essential facilities, such as police stations and hospitals, are critical to the service of the community, and that they must be protected from hazards that might take them out of service.

Third, the advancement of construction materials and methods have changed the landscape of the way buildings are constructed. Newer materials are capable of longer spans, can achieve high levels of durability, fire resistance and improved energy performance.

## Factor 1: Evolution of apparatus

A little more than century ago, firefighters operated out of stations built as a home for horse-drawn pumpers. As the fire service continued to evolve, so too did the technology for apparatus and fire stations. Few of the stations of that era demonstrated the planning foresight to accommodate the size and weight of future generations of apparatus.

The length and width of fire apparatus has grown exponentially to the point where many departments are forced to order expensive customizations to ensure that the truck can even fit within the bays. The batteries and generators associated with apparatus have increased the electrical requirements for “shore” lining, and the weight of equipment places tremendous strain on the concrete slabs and foundations. Historically, apparatus bays were once part barn, part garage. The “mechanical” function has since evolved from clearing manure to evacuating carcinogen-laced vehicle exhaust.

With the continued advancement of apparatus design, many departments are faced with the challenge of operating a modern-day fleet of equipment from

buildings more than 50 years old. As technology and automation continue to develop at a rapid pace, departments should do their best to forecast what the next 50 to 100 years of apparatus design might look like. Be sure to plan for maximum flexibility. If you think drone response is farfetched, just remember, the guys chasing a horse down the street never dreamed of a 107-foot tiller.

## Factor 2: Building code development

Events such as the Chicago fire (1871), San Francisco earthquake (1906) and Hurricane Andrew (1992) decimated and paralyzed communities. In the United States, such natural and manmade disasters have prompted the continual development of building codes to ensure that all types of structures are designed to meet a minimum standard to protect the life safety, health and overall well-

**The recently complete Mechanicsville Volunteer Fire Company in St. Mary's County, MD, implements a wide range of modern technology to ensure full operational preparedness.**

*Photo by Jason Germeroth*

*Photo courtesy Manns Woodward Studios*





**Philadelphia's Engine 37 struggles to fit in a station that is more than 100 years old.** Photo courtesy Triborough

ness of occupants. Today, commonly adopted building codes, such as the International Building Code (IBC), designate fire stations and emergency vehicle bays as essential facilities. This classification requires them to be constructed in a fashion that enables them to withstand strong winds, heavy snow loads and

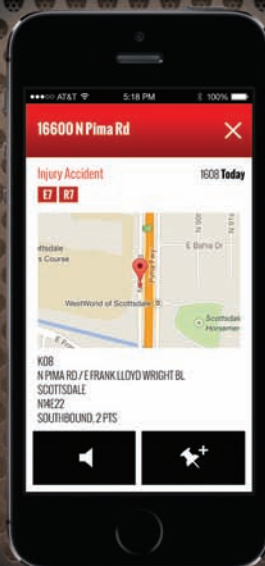
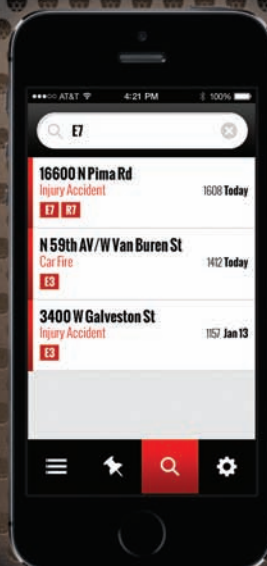
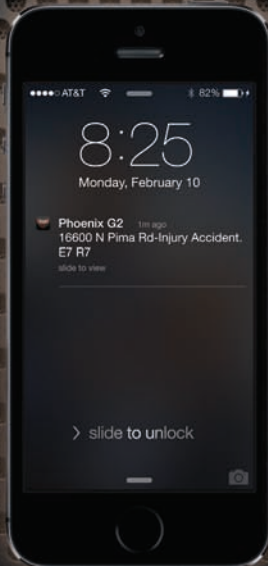
seismic activity to ensure that a widespread event does not sideline emergency responders.

Additional codes and standards further subject apparatus bays and fire stations to unique design requirements. For example, NFPA 1 requires that all new fire stations, regardless of size or usage of materials, be protected throughout by an automatic fire sprinkler system. Such regulations ensure that the building is protected should a fire occur while the department is active on a scene, or that personnel are protected should a piece of apparatus catch on fire while they sleep in their bunks. NFPA standards 1581 and 1500 address issues regarding first responder health by establishing requirements for treating vehicle exhaust and infectious disease control.

In short, for the good of a community, fire stations and apparatus bays must be designed to be stronger and better protected from natural disasters, manmade disasters, blood-borne pathogens, and carcinogens than most other types of buildings. These codes and standards, among others, directly impact the design and costs associated with structural, mechanical, electrical and plumbing systems of the bays, and render them unique from any other building type. It should be expected that continued research surrounding cancer and cardiac arrest in the firefighting community will ultimately spark additional provisions that further impact the financial costs of these essential facilities.

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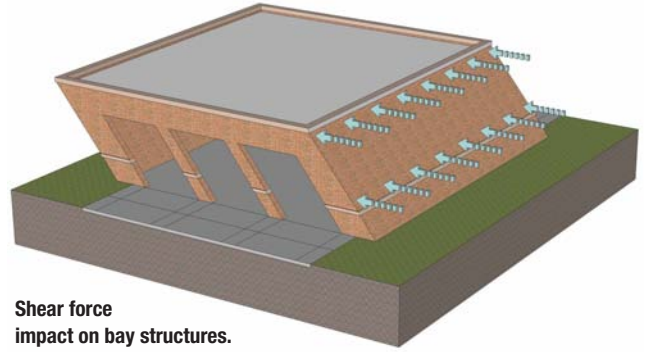
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## Factor 3: Building systems technology

Today, apparatus bay designs take advantage of modern building systems to ensure optimal preparedness and energy efficiency. The combination of technology, construction methods, and systems that goes into these spaces are unique from any other building. Understanding the fundamentals of each component and recognizing that they are interwoven to create a cohesive structure is essential, as these systems are what truly sets apart the apparatus bay from a garage.

**Exterior walls and structure:** Tall unbraced walls and columns have a natural tendency to want to deflect and buckle from the loads carried from above. Additionally, large openings, such as those that occur at the apparatus bay doors, tend to create conditions where the building will be subject to phenomenon known as structural shear “racking” wherein the end walls are prone to falling into one another like dominos. Such issues are not exclusive to fire stations, however given the height and size requirements of most bays, a stout reinforcing and lateral bracing system is often required to develop a safe and code-compliant structural design that can withstand severe weather.

**Apparatus bay slabs:** The structural apparatus bay slab must support the load of equipment and is largely dependent upon good soil conditions at the site. Slabs are often substantially thicker than what might be found in conventional construction.



Shear force impact on bay structures.

When evaluating potential sites, be sure to conduct preliminary geotechnical studies early in the process to ensure that the soils can support the load of the apparatus.

**Floor drainage:** Ideally, bays should be designed with a gently pitched slab design that conveys any water to a trench drain located under each piece of equipment. Locating a continuous trench drain under the centerline of each piece of equipment provides several key advantages:

- Water draining from the apparatus is kept away from walking paths thus reducing the risks of slips and falls.
- Wheel points are nominally at the same elevation reducing stress on vehicle suspension.

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#### High windows flood the bay with natural light.

Photo courtesy Manns Woodward Studios

most systems, interoperability with the station alerting system is also now possible. Departments might consider wiring the controls to the bay lighting to a relay for the alerting system so that lights are automatically turned on when a call is received. If washing and maintenance operations are taking place inside the bays be sure to specify damp-proof fixtures.

*Natural lighting:* Clerestory windows and skylights can be utilized to flood the apparatus bay with natural light, significantly reducing the costs associated with providing artificial light. Light

fixtures can be wired to dimmers and control devices that monitor the amount of natural daylight entering the space. When sufficient natural light is available the lights will be dimmed, or turned off.

*Heating systems:* Heating the apparatus bay is crucially important to maintain occupant comfort and equipment functionality. Radiant heat is ideal for all instances as it allows the building to efficiently recover from the cold air that may rush in from an open bay door. Radiant energy is stored in objects or thermal mass (concrete slab), which then radiates heat into

- Vehicles are not required to contact the drains, thus reducing the wear and tear on the drain covers.

*Artificial lighting:* Artificial lighting has made tremendous strides in the past 10 years. Departments should consider high bay LED or T-8 fluorescent fixtures with instant-on capability as “payback” periods are often very short. Positioning the lights between the apparatus will ensure that parked apparatus do not cast shadows on walking surfaces. If overhead infrared radiant heat is being utilized, be sure to carefully coordinate fixtures outside of the heater combustibility zone. As with

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the surrounding space, thus warming the environment. The energy is stored in the slab, rather than in the air allowing the space to quickly recover.

Two primary forms of radiant heat function well within the bay environment: overhead infrared radiant heat and in-floor radiant heat.

Overhead radiant heat requires careful coordination of the unit location to ensure objects that are subject to combustion or damage are kept outside of the specified clearance requirement. Units should be located so that the radiant energy "hits" the floor and not the apparatus.

In-floor radiant heat utilizes pipes or tubing located within the apparatus bay slab to convey warmed liquid through the bays. Heat is typically generated at a boiler and the system can be utilized via a manifold to melt snow and ice on aprons and sidewalks. Careful quality control during construction must take place to ensure damage does not occur to the piping during the cutting of control joints.

## **Vehicle exhaust is a serious issue for first responders, and codes and standards require that it be addressed.**

*General exhaust systems:* In many circumstances, regardless of vehicle exhaust systems, building codes require that apparatus bays be ventilated with fresh air. Advanced and cost-effective sensors can detect a wide range of unhealthy gasses, inclusive of carbon monoxide. When quantities reach unsafe levels, fresh air intake and exhaust fans are activated to "exchange" the volume of air in the building with fresh air. Intake fans or motor-operated louvers provide fresh air at lower elevations and are then exhausted high to achieve a complete cycle. The system can also be manually activated to assist with air circulation on hot days.

*Vehicle exhaust systems:* Vehicle exhaust is a serious health hazard for first responders, and codes and standards require that it be addressed. Numerous systems exist and are heavily debated amongst vendors, departments and design professionals. Each type of solution presents its own unique advantages and disadvantages. HEPA filtration-type systems provide a clean look, can accommodate any type of apparatus, but they are not necessarily a direct source capture and require filter replacement. Hosed connections capture exhaust at the source but can present maintenance challenges associated with connections and can clutter the bays with hanging hoses. Vehicle-mounted systems capture exhaust at the source but do not necessarily solve the problem if the department expects fill-in or reserve units to be used. In any case, vehicle exhaust systems are critical to the health and wellbeing of first responders. Each department should carefully evaluate the selection of their system with their design team to ensure that it fits their operational vision.

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**Air circulation:** Large industrial fans can supplement HVAC systems during both the heating and cooling season to achieve occupant comfort in the bays. High bay structures, such as apparatus bays, tend to experience air stratification where hot air collects at the top of the

bays. Low-speed, high-volume fans help to de-stratify the air and improve air quality and overall comfort. During the winter months, the fans can work to mix high temperatures found at the ceiling with the lower temperatures on the floor, creating a more energy-efficient heating system.

**Doors:** Many conventional and unconventional apparatus bay door options exist. When evaluating doors, consider cost, impact on other construction systems, energy efficiency, speed, security, life span, aesthetics and safety. Every door type has unique building height/depth clearances and construction requirements. When considering costs, be sure to evaluate the “entire” costs. How will the door selection impact the length and height of the bays and what are those associated costs? What is the life span of the door system and how much should the department plan on spending in maintenance? While sectional doors function well and typically provide a lower installation cost, it may be a better long-term financial decision to invest in costlier four-fold doors that might provide a better insulation value and lower maintenance.

**Floor and wall finishes:** Consider utilizing quality resinous epoxy floor coating systems that resist staining, increase visibility, improve sanitation, and increase safety through slip resistance. Lines, markings and custom floor graphics can be added to most floor finish systems to improve driver safety. Utilizing high-performance coatings instead of paint on the bay walls will provide a durable finish that is capable of resistance to moisture, chemicals, high heat and abrasive cleanings.

**Structural protection:** Protect structural columns and piers with sacrificial elements, such as bollards, to prevent accidents that can cause catastrophic collapse. Bollards should have a highly visible color and should protect the jambs of openings by overlapping the edge of the opening. When designing exterior lighting, be sure to illuminate the columns between doors with light to make it easier for drivers.

**Additional infrastructure:** Additional infrastructure is typically required to support apparatus operations. Elements may include retractable power reels, air reels and water reels. Coordinate and locate these reels with the requirements of your apparatus while still leaving enough flexibility for future equipment. Another consideration, allowed

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**General exhaust systems satisfy basic code requirements to ventilate the space.**

*Photo courtesy Manns Woodward Studios*

by some jurisdictions, is to provide an overhead fill line that is connected to the fire line before the meter. Such a configuration can allow the department to fill equipment from within the building after returning from a call. Be sure to coordinate the weight of a fill line with the structural system.

**Alerting systems:** Alerting, access and surveillance systems can be integrated throughout the entire building and keep first responders safe, aware of their timing and inform them of call information in an accelerated manner. Integrating the system throughout the bay can also assist in keeping the apparatus area safe.

## Not just a garage

So, no, the apparatus bay is not a just a garage; it is far more complex. It is a space like no other, that is vital to community safety. It is a space exclusively intended for storing and maintaining the most expensive and complicated vehicles on the road, ensuring that they can be quickly and safely deployed on time, every time for those who may need it most.

The mechanical systems, structural design and architectural functionality of the bays are uniquely detailed to give first responders and each piece of apparatus the best chance of success in the most trying conditions. Chances are, your critics' local repair garage doesn't have to meet such demanding expectations. ■

ROBERT MANNS is a founding principal architect of Manns Woodward Studios, a Baltimore-based firm that specializes in the design of fire stations and public safety training centers. He carries more than 15 years of experience in the design of first responder facilities, and has been the lead designer for more than 30 fire stations and training centers over the course of the past 5 years.

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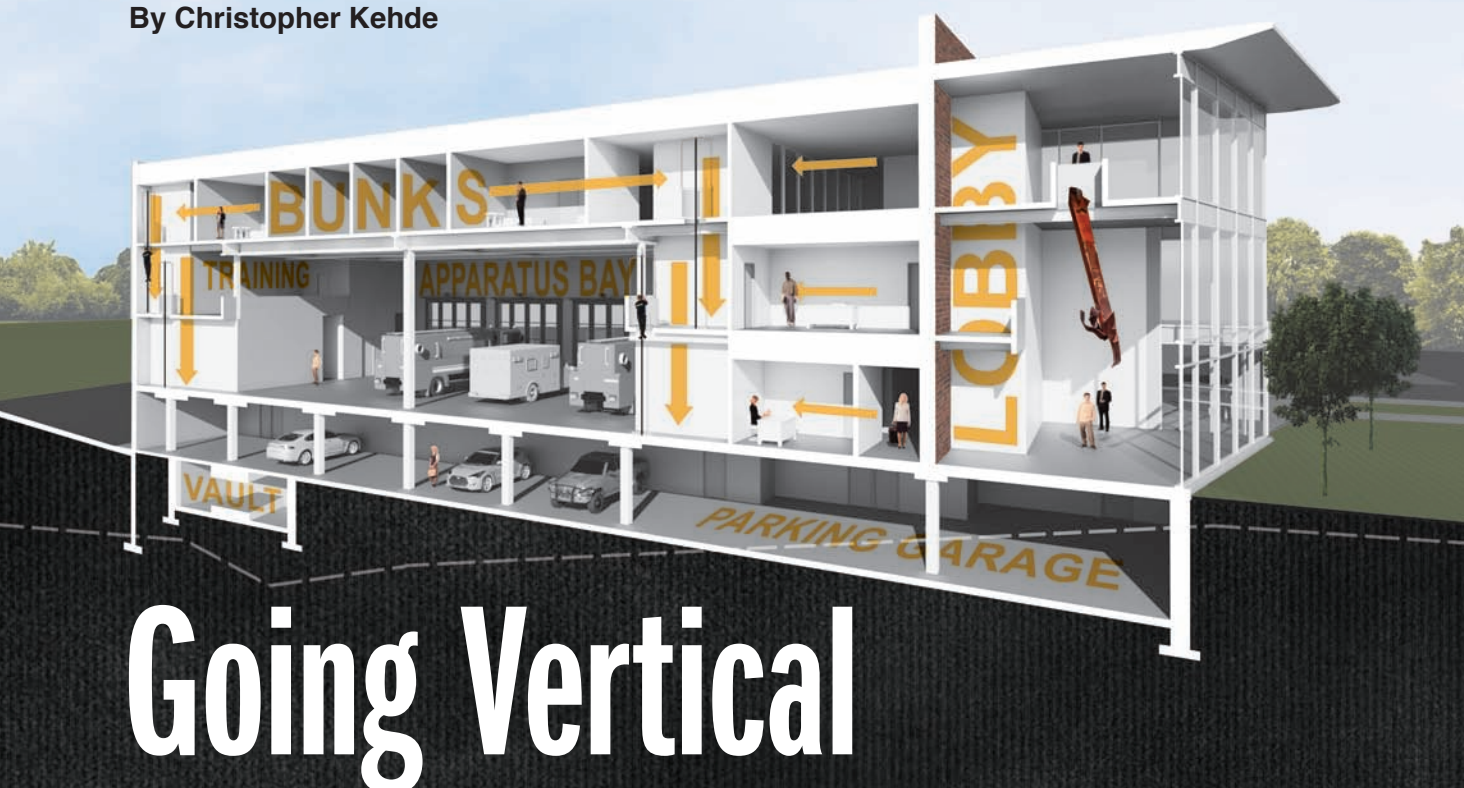
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By Christopher Kehde



# Going Vertical

## Answers to burning questions about single-story, multi-story and mixed-use stations

The City of Charlottesville, VA, built the Fontaine Avenue station in 2014 after more than 50 years without a new station. Images courtesy LeMay Erickson Willcox Architects

**A**s property values and population densities continue to rise, many fire and rescue departments are considering options to minimize their building footprint and maximize the development potential for available sites. Architects are regularly asked to compare single-story and multi-story fire stations and, as such, this article provides answers to many of the trending questions related to single-story stations, multi-story stations and mixed-use facilities.

### Why go vertical?

Multi-story fire stations are often found in densely populated urban centers, where property values are high and construction projects of all types look to maximize the development efficiency by maximizing the number of stories. As development growth expands into the suburbs and once-rural areas, the property values increase with the demand for land. Similar situations arise where fire and rescue departments must optimize the development potential of their limited financial resources. This may lead to “going vertical.”

### Is a one-story station better?

Many fire and rescue departments with both single- and multi-story fire stations prefer single-story stations when

feasible. Response time and firefighter safety are central to all decisions in fire station design, and a single-story station places all occupied spaces for the responding personnel on the same floor level as the apparatus bays, avoiding the need for vertical response via poles or stairs.

Another key factor is the relative cost of vertical construction. A single-story, four-bay station is typically cheaper than a two-story station with the same program, due in part to the additional construction costs related to stairs, poles and elevators.

### How do we know if a one-story station will fit on our site?

Early in the design process, you and your architect will prepare a Program of Requirements for your project. This program document will provide a room-by-room description and square footage of each space in your proposed building, and will tally the square footage into a total building area.

The program should also account for key site design requirements, such as the number of parking spaces, building setbacks, landscape buffers, easements, utilities, storm water management strategies, additional on-site amenities (training areas, emergency generator, etc.) and whether the station will have bi-directional or back-in bays.

The program and building area can then be used as the basis for site studies that will analyze the proposed site (or sites) relative to the programmatic requirements and the viability of achieving the program in a one-story station.

## **Case Study #1: Fairfax County, VA, Fire and Rescue Station No. 19 – Lorton Volunteer Fire Department**

The suburban site for Fairfax County Fire and Rescue Station No. 19 – Lorton Volunteer Fire Department is 3.25 acres, and the project scope calls for the existing fire station to be replaced by a new 23,000-square-foot station on the same site. Based on an agreement between the County and the volunteers, the new facility will be constructed and owned by the County, and the volunteers will have dedicated space in the facility.

Based on the site size and program square footage, it may seem that a single-story station would fit comfortably on the site. However, as the program was



**Fairfax County Fire and Rescue Station No. 19 – Lorton Volunteer Fire Department.**

developed and the site was analyzed, several key factors ultimately steered the project toward a two-story solution:

- The project was on a corner site, which resulted in two street fronts and increased building setbacks on

two sides of the property. Also, due to adjacent residential properties, there were significant landscape buffer requirements.

- There was a Resource Protection Area (RPA) on the northwest corner of the site that impacted the buildable area of the site.
- The new facility would include a new 3,200-square-foot community hall that required 70 additional parking spaces.

What initially seemed like a generous site was quickly filled by building program area, parking, zoning required landscaping and additional site amenities, including a fuel station, extrication pad and back-up generator. These combined factors resulted in the need to build up to maximize the development area.

In the design solution, the bunks, lockers and showers were located on the second floor over the kitchen, dining room, dayroom and administrative spaces. The bays and community hall are high volume, single-story spaces.

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## What about response time?

Response time and responder safety are central to all decisions in fire and rescue station design. Assessment of turnout time, as the portion of response time that occurs within the station, takes into account the distance traveled from regularly occupied spaces to the bays and

also takes into account the complexity of the response path. The response path should be clear and direct with as few turns as possible. In multi-story stations, the response path will include vertical response via some combination of stairs, poles and, in some stations, slides; proper location of these elements within the sta-

tion can provide highly efficient access to the bays. With proper consideration, appropriate turnout time can be readily achieved in either single- or multi-story station designs.

## What program areas should be on the upper stories?

If your site assessment suggests that you will need to go vertical to meet your programmatic requirements, you will need to carefully consider which program areas will be located on each level. Key programmatic adjacencies should be considered as this will define groups of spaces that will want to be located together on the same floor.

The bays and all relevant support spaces will be grouped together on the first floor. Dormitory spaces such as the bunks, showers and lockers will typically be grouped together. Likewise, the day spaces (kitchen, dining and dayroom spaces) are often grouped together, as are the administrative office spaces. While all three of these program groups could readily be located on either the first floor or upper floors, the response path from day and night spaces should be considered. Bunks are often located on the second story, as this provides a level of sound separation from more active and loud areas in the station; however, this also requires a waking responder to immediately navigate stairs or a pole as part of the response path. In some situations, all of the program spaces other than the bays and bay support spaces may need to be located on a second floor over the bays. Ultimately, response path, responder safety, program adjacencies and the building footprint will all factor into the decision of which program areas will be located on each floor.

### Case Study #2: Charlottesville, VA, Fire Department – Fontaine Avenue Station No. 10

The City of Charlottesville built the Fontaine Avenue station in 2014 after more than 50 years without a new station. The City recognized that response times to the west side of the city, including to the University of Virginia, would be greatly improved if a new station was built in that area. Due to the density of develop-

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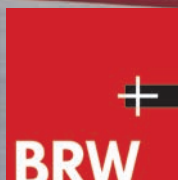
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Charlottesville, VA, Fire Department Fontaine Avenue Station No. 10.

ment throughout the city, the available sites were limited, and the selected site of approximately 1 acre had a 30-foot-deep ravine slicing through the center from front to back. The extreme site conditions required that a vertical solution be considered from the outset of the project.

The 40,000-square-foot fire station includes underground parking for 33 vehicles, four bi-directional apparatus bays, a two-story lobby with a 9/11 memorial, administrative office spaces, a training room that doubles as an Emergency Operations Center, and extensive scenario training areas both on training mezzanines inside the building and along the exterior facades.

During the design process, the department decided that the kitchen, dining room and dayrooms should be on the ground floor immediately adjacent to the apparatus bays. The bunk and locker rooms were located over top of the apparatus bays, with vertical response via slide poles and stairs on both sides of the bays.

Due to the height of the bays, transfer slide poles were provided from the third floor. Transfer poles divide the vertical travel distance into two pieces,

with one pole going from the third floor to a landing, and a second pole from the landing to the ground.

### How can we maximize our vertical development potential?

Mixed-use facilities can be a very cost-effective means to maximize the development potential of a site. This concept is regularly applied to commercial developments that may have retail shops on the lower level and residential or office spaces on upper floors. The same concept can be applied to fire and rescue stations. A single- or multi-story fire and rescue station can be located on the ground floors, with other municipal agencies or commercial spaces above.

A variation of the mixed-use development concept can be a public/private partnership, where a private developer coordinates efforts with a municipality to provide a public facility as part of a private development. One scenario could be that the municipality owns an aging fire station in a densely populated urban area. A developer might offer to build a new fire station on the site in exchange for the opportunity to construct multiple floors of commercial space above.

#### Case Study #3: City of Alexandria, VA, Fire Station 209 – Station at Potomac Yard

The Station at Potomac Yard was the first new fire station built in the City of Alexandria in 40 years. The facility is five stories tall and includes a 22,000-square-foot four-bay fire station, 64 affordable housing units on four floors, 1,400 square feet of retail, and two stories of underground parking.

During review of a 167-acre development plan submitted and prepared by the developer, the City planning reviewer recognized that this large development project would represent a new and significant demand for fire and rescue service. The developer and City negotiated terms whereby the developer donated the parcel of land and money toward the construction of a new fire station. The City then recognized the opportunity to maximize the development potential of the site by constructing four floors of affordable housing above the new fire station.



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City of Alexandria, VA, Fire Station 209 – Station at Potomac Yard.

Design of this mixed-use facility recognized the unique nature of the adjacent functions and special measures were taken to address sound and secu-

rity issues. To address noise concerns, a double-ceiling system was installed in the fire station. The first level of apartments were built on a floating slab system to isolate sound transmission from the station below, and the residential units were built in a U-shape above the living

quarters of the fire station below, leaving an elevated plaza above the apparatus bays. For security purposes, separate entrances are provided for the different user groups, and digital access controls are provided at all fire station entrances.

## What's next?

The design and construction of a new fire and rescue facility is a lengthy and complex process, and awareness of priority issues and key design considerations will help keep your project on the path to success. The answers provided here should serve as a primer for further dialogue with an architect experienced in fire and rescue station design to determine if “going vertical” is the best option for your next station. ■

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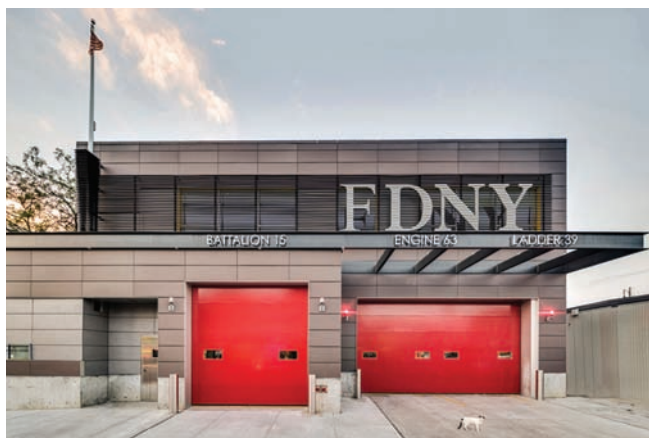
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# Design on a Budget

## Minimum requirements for temporary stations and substations

**I**t is very unlikely that there is a more ubiquitous public building than the fire station.

If we assume that career fire departments are generally situated in locations that allow firefighters to meet a five-minute response time 90 percent of the time, then the fire station cannot help but be one of the most predominate public owned facilities across the landscape.<sup>1</sup> However, the volunteer fire service lives by a different standard.<sup>2</sup> Volunteer fire departments must frequently protect rural and remote locations, resulting in fire stations being placed on the outside border of the community response zones. And sometimes, volunteer fire departments protect sparsely populated areas with a minimum of a tax base to support the operation.

That does not mean that all fire stations are equal in capacity or functionality. To the contrary, fire stations range from the simplest of structures to the most complex of buildings.

Many volunteer fire departments have a public facility need that is significantly more expensive than they have resources to meet. If your organization is adequately funded and can afford to build to the highest of standards, you are to be congratulated. But if your organization is desperate for physical facilities, then the remainder of this article might be useful to your decision process.

### Minimum standards

In the fashion world, there is a term called the “little black dress.” That term implies fundamental minimums of sophistication. We have a need in the fire service to adopt a basic fire station configuration for the same reason—to set a minimum standard for what is called a “fire station.”

Over the past several years, I have visited hundreds of volunteer fire departments. The quality of volunteer fire stations ranges from undesirable scenarios in which fire apparatus are sitting out in the weather to multi-million dollar facilities that are a joy to behold.

With this in mind, in this article, we will focus on a simple question: What is the minimum you should be planning for if your funds are limited? Further, we’ll focus on a key factor in station design: the elimination of fire apparatus sitting out in the weather—a scenario that renders the vehicle almost useless in inclement weather.

An excellent resource for any community that is planning a new fire station is to look at the Whole Building Design Guide (WBDG) website.<sup>3</sup> It is an excellent website to begin the planning process for any fire station, and one that is particularly useful in guiding decisions as to what you can afford or not afford to put into a structure. The section



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# FIRE STATION DESIGN



**Temporary shelters serve to protect apparatus without breaking the bank.**

on design considerations is particularly appropriate.

When your department is faced with a scenario in which a piece of equipment is going to be stored outside, the department must institute a decision-making process that reduces the consequences

of deterioration of the rolling stock. Not all building systems offer low-cost and time-effective solutions that might be considered at this point in time. It is important to consider not just the construction of the fire station but also the issue of long-term budgets. Many fire departments have turned to metal buildings as a temporary solution that can be recycled or reutilized.



Putting up a metal building can be accomplished in as little as six months, which means it can be completed during

the best weather conditions. According to manufacturers' information, they can be as low as \$71.00 a square foot.<sup>4</sup>

Additionally, the decision to build a substation to house an apparatus cannot be taken lightly. The substation concept is linked with the station location criterion and the Standards of Cover. Yet there are thousands of substations that do not have a basic minimum fire station design. If we look at the ICS concept of typing engines and other resources, perhaps it is time to type fire stations as well.

Table 1 on p. A21 shows functional aspects of fire stations that apply to volunteer substations. Designing a temporary building should take into consideration the components listed in the chart.

## In sum

If you have the money to build the most magnificent fire station possible, then do so. However, if you have apparatus sit-

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Table 1

Apparatus Bay	Day Room Area	Administrative Area
Most temporary fire stations only need to house one vehicle. However, one of the basic models that can be used for fire stations offers two bays.	Day room areas should be large enough to serve as a training area.	There should be an office for the fire officers to do paperwork and carryout administrative functions.
Electrical Power	Restrooms	Water Supply
The station should be equipped with an emergency generator.	Restrooms should be available for both genders.	Water supply should be available to replenish tanks with a minimum of effort.
Hose Storage	PPE Rack	Parking
There should be adequate storage for replacement of one entire hose load configuration for the apparatus in the station.	There should be an adequate facility to hang PPE for the volunteer cadre assigned to that station.	Lot size should accommodate a number of vehicles anticipated for a recall response.

ting outside in substation locations, you should do everything in your power to shelter them. While there is no standard design for volunteer or combination fire departments, putting up a temporary shelter is a good management practice. It

is the basic idea of the “little black dress.” It serves a purpose without breaking the bank. While the temporary station cannot possess all the “bells and whistles” as a permanent station, it services a basic need—to protect the rolling stock. ■

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1. NFPA 1710: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations and Special Operations to the Public by Career Fire Departments
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3. Whole Building Design Guide: wbdg.org/building-types/community-services/fire-station
4. Praeger, C. “Metal Buildings for Firehouses.” *Fire Engineering Magazine*, 162:1

RONNY J. COLEMAN is a 50-plus year veteran of the fire service. He is the former Fire Marshal of the State of California from 1992 to 1999, and the past president of the Fire & Emergency Television Network. He served as the Fire Chief in Fullerton, CA, and San Clemente, CA. He is a certified Fire Chief and a Master Instructor in the California Fire Service Training and Education System. For his retirement in 1999, the California Fire Chiefs Association created an annual “Fire Chief of the Year Award” named in his honor. A Companion Fellow of the Institution of Fire Engineers, he has an associate’s degree in fire science, a bachelor’s degree in political science and a master’s degree in vocational education.

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By Dana Compton



# Target-Harden Fire Stations

**An important step to help protect  
your facilities against attack**

Electrical systems must have enough capacity to support all security measures that are installed, such as door access systems and cameras.

*Photo by Gary Logan*

**T**hreats of crime and acts of terrorism are becoming more prominent in today's society, especially in metropolitan areas. In the unfortunate event that something of this scale happens in your town, your essential facility must be ready for anything and able to protect the occupants inside. "Essential facilities" include fire stations, police stations, emergency operations centers (EOCs) and schools. It would be increasingly difficult to respond to an emergency of this kind if your fire station and its occupants are compromised.

One of the best ways to ensure the safety of your essential facility is through target-hardening. Target-hardening is defined as taking measures to

make committing an attack on your facility more difficult and reducing the opportunities for criminals to achieve their goal. It would be nearly impossible to make a facility completely attack-proof, but the goal is to make the attack more difficult and risky for the perpetrator.

By their nature, fire stations have some limitations from a fully secure or hardened exterior from all potential threats. However, certain measures can enhance the safety and time for personnel to respond. This article assumes some of the more common countermeasures but is not all-inclusive, as each community will have different setting and site details to consider.

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## How can I target-harden my fire station?

Whether you have an existing fire station or are considering building a new station, there are actions you can take to harden your facility from attack. Target-hardening components in a facility are categorized by the type of attack they oppose, such as forced entry, explosives and toxins/airborne agents.

Forced entry can be deterred by installing toughened glass made of acrylic or polycarbon as well as installing latticework or screens in front of windows. Metal door and window shutters are also effective. Deadbolts and vertical-bolt locks, door anchor hinges with non-removable pins, and tamper-proof exterior screws in fittings can deter forced entry by making it more difficult to gain access through traditional means of entry. Vertical metal or small-mesh fencing and steeply angled roofs with parapets and ridges are difficult to climb.



**Forced entry can be deterred by installing toughened glass made of acrylic or polycarbon as well as installing latticework or screens in front of windows. Metal door and window shutters are also effective.**  
*Photo by Gary Logan*

Apparatus bay doors, however, present a unique breach or intrusion point that many operational policies will decline to address out of tradition, a policy that only each fire department can address. Bollards are a common hardening tool, as they prevent vehicles from ramming the facility.

Bollards also create a stand-off zone, thus making an explosive less effective. Any stand-off distance helps increase the chance for survival and minimizes damage to the nearby structures.

Ben Cole, PE, principal and senior mechanical engineer with TLC Engineering for Architecture, has many years of experience in target-hardening facilities to prevent toxins and airborne agents from entering the structure. For your station's HVAC system, the primary concern is the protection of openings. Cole suggests locating outside air intakes as high and inaccessible as possible to decrease the possibility of someone throwing an object into the air intake. For an existing station, one solution is to put burglar bars or welded mesh on the air intakes instead of attempting to

relocate them. This can prevent entry and/or the introduction of something chemical or biological into the station.

Another recommendation is an emergency shutdown for the HVAC system. If there is a perceived threat, the occupants can shut the system down so it would no longer distribute through the building. To take it one step further, an exhaust for the entire facility can be installed. This is helpful in an area where mail or packages are delivered or stored. If a package or envelope contains a suspected biological threat, the occupant has the capability of activating an exhaust fan to isolate the threat and remove it entirely from the building.

From an electrical standpoint, the outside transformer is a critical area to protect by isolating and enclosing it. If the local fire marshal requires the facility to have an exterior disconnect switch, a solution is to install a cage to protect it. The way these

cages are designed, fire marshals can use their regular key to access the switch if needed.

Electrical systems must have enough capacity to support all security measures that are installed, such as door access systems and cameras. Also helpful in an event of this magnitude is an early warning alarm with emergency buttons throughout the facility. This system must be backed up with a powerful generator in the event of an outage.

Cole's recommendation for the building's plumbing system is the installation of a back-flow preventer outside of the building. In major cities where the fire

station ties into the main water supply system, this prevents contamination from your building into the main supply. The back-flow preventer is typically installed outside the building, but the building user may opt to locate it inside the building. If the back-flow preventer must be outside, then it should be protected from tampering.

## How do I pay for this?

A security threat assessment can be conducted to both generally identify the types of threats and preventions that are relevant to your circumstances and context and the measures that are practical for consideration at a specific existing station or new station planning effort. Security consultants and architects who design fire stations can help you with an assessment to determine your options for hardening your facility. These options can translate into cost estimates, which can then be added in to your upcoming budgets in order to begin implementation.

For the fire departments located in high-threat, high-density urban areas, the Urban Areas Security Initiative (UASI) provides funding to assist with increasing security in and around essential facilities, such as fire stations. UASI is a grant under the umbrella

of the Homeland Security Grant Program (HSGP), and awards are made to State Administrative Agencies (SAAs).

Local fire departments may apply to their state to receive these funds via sub-grants. Although each state is different, the activities implemented with these funds must support terrorism preparedness, such as target-hardening. Also consider that target-hardening can simultaneously support preparation for other hazards, such as natural disasters. Strong applications demonstrate the dual-use quality of these components (not just focused on anti-terrorism). The FY 2016 nationwide allocation was \$587,000,000. Local deadlines vary based on each state's administration, so contact your respective state department to find more information on these available funds.

**Although each state is different, the activities implemented with UASI funds must support terrorism preparedness, such as target-hardening.**

## Are there restrictions on these funds?

If considering applying for UASI funds, you must be cognizant of the Environmental Planning and Historic Preservation (EHP) restrictions on projects that have a potential environmental and/or historic impact. Compliance with these restrictions is required

under the UASI grant program and non-compliance could delay or change the scope of your project.

The National Environmental Protection Act (NEPA) of 1969 dictates that actions proposed by a federal agency are subject to a review process. By accepting federal funds, the grantee accepts the responsibility of complying with NEPA and other laws and regulations. The EHP review process must start in the pre-project phase and work cannot begin on the project until the review process is completed and an official approval notification is received.

Two of the main considerations for EHP review are ground disturbance and historic structures. Ground disturbance is anything that breaks the ground or changes the condition of the ground's surface. Some examples of ground disturbing activities include the installation of fence posts for perimeter fencing and trenching for utility lines. Buildings or structures that are 50 years old or older are considered potentially eligible for listing under the National Historic Preservation Act and must undergo an EHP review to determine whether the building is historic and whether the

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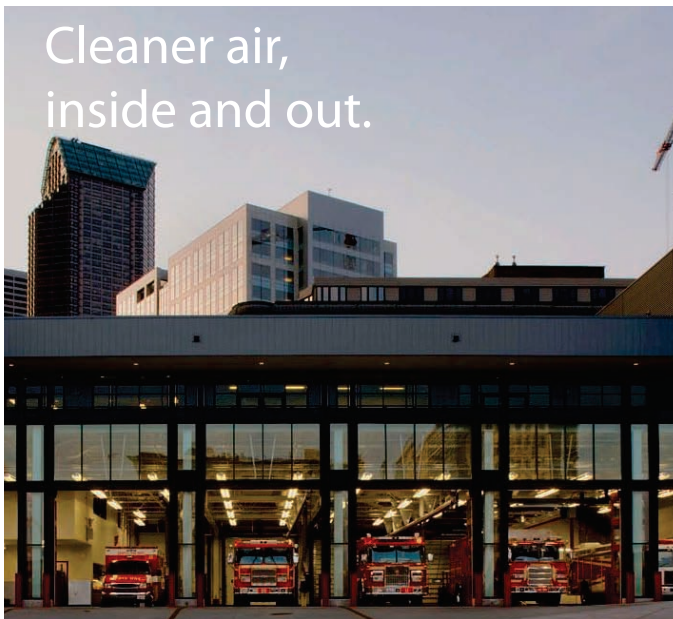
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## FIRE STATION DESIGN



**Bollards are a common hardening tool, as they prevent vehicles from ramming the facility.** Photo by Les Edmonds/Komatsu Architecture

target-hardening would impose adverse impacts that alter the character of that building.

The timeline on an EHP review can vary based on the complexity of the project, the resources affected and the amount of information that was initially provided in the grant. If the level of documentation required is relatively simple, then the total review time from receipt of a complete EHP review packet may take up to 45 business days. If the project in question requires further EHP review, then the time to complete the appropriate

documentation is likely to be longer, and may take up to a year or more to complete.

Grantees can navigate this review process themselves with the help of the Environmental and Historic Preservation Screening Form, which assists grantees in supplying the necessary information for a complete EHP review packet. Many grantees opt for assistance from an architect with NEPA compliance experience who can help you walk through the review process. Early planning and gathering of information can help make this a smooth process.

### Protect your facility

While we all hope that target-hardening won't be necessary, the simple fact is that fire departments cannot take the chance that their essential facilities could be nonoperational at critical moments when community members need them most. Target-hardening is one step to help protect facilities and enhance the safety and time for personnel to respond. ■

DANA COMPTON is the director of business development for Komatsu Architecture. Founded in Texas in 1959, Komatsu specializes in fire station and fire training center design, and served as the Architect of Record on the Bob Bolen Public Safety Training Complex for the City of Fort Worth. At Komatsu, Compton specializes in architectural marketing, business development and grant writing, with a focus on public safety, historic preservation, public and urban design, and interior design.

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