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RESEARCH + DEVELOPMENT

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FIRE STATION SHARED FACILITY STUDY

BACKGROUND

Welcoming public spaces are in decline. A Public space that encourages dialogue and welcomes everyone is a core aspect of democracy. This public space must find itself engrained within the very fabric of the communities they serve. The demand and necessity of the space presents a truly unique opportunity for Shared Facility Fire Stations. This space may be a bridge to inform and introduce the public not only to first responders such as firefighters, but all public safety official and government officers. The area can be primarily used to house activities, events and training aimed at community organization, communication and education. The space can also deliver its function via local community organization leaders. What could be provided is an unifying hub of which the community can organize itself around. A space for discourse regarding local civic decisions and public safety awareness.

OBJECTIVES

The objective of this research effort is to investigate the possible impacts associated with a fire station shared facility, specifically paired with a multifunction civic space. The secondary objective is to identify design aspects and components of high performing fire stations and compare the utility and impact. The research also seeks to find any patterns or trends across a range of design solutions. The purpose of this report is to provide pre-design data to help facilitate an architectural design team to create a high-quality, research-based design solution within the bounds of a mid-range budget. By abstracting key components from high performance and high aesthetic building precedence, the research seeks to deconstruct and analyze design solutions from built examples from across the planet.

METHODS

1) Quantitative research includes:
    a. NFPA 1500 Analysis
    b. NFPA 1581 Analysis
    c. NFPA 1710 Analysis
2) Qualitative research includes:
    a. Program Type Demand
    b. Typological Analysis
    c. Design Component Isolation and Analysis
        i. Formal Consideration
        ii. Material Considerations
            1. Interiors
            2. Exterior (Metal)
            3. Exterior (Wood)
    d. Sustainability Considerations
3) The quantitative method to investigate the standards and regulations outlined by the National Fire Protection Agency.

4) The qualitative method uses 14 fire station case studies from around the world. The methods will be the device used to analyze architecture's current position toward the construction and

organizations of fire stations within the various environments and communities they serve.

RESULTS

NFPA 1500 - *Standard on Fire Department Occupational Safety, Health and Wellness Program.*

Special consideration regarding Facility Safety (Chapter 10), designers should adhere to Section 10.1 Safety Standards:

10.1.2 Fire departments shall provide facilities for disinfecting, cleaning, and storage in accordance with NFPA 1581.

10.1.3.3 When smoke detectors activate, the general evacuation alarm signal shall operate throughout the entire building.

10.1.3.4 All existing and new fire department facilities shall have carbon monoxide detectors installed in locations in sleeping and living areas, such that any source of carbon monoxide would be detected before endangering the members.

(Standard 9.1.3.5 requires the installation of carbon monoxide and smoke detectors throughout the facility.)

10.1.5 The fire department shall prevent exposure to fire fighters and contamination of living and sleeping areas to exhaust emissions.

New fire stations should include airlocks in the area between the living space and apparatus bay where positive airflow or an air curtain can help remove contaminants in the bays from the living spaces.

10.1.6 Any components of the protective ensemble that are contaminated shall not be allowed in sleeping and living areas.

(Protective ensemble storage must be done in areas away from the sun, and with little fluorescent lighting. The space needs to have ventilation to remove particulates from the area and needs to be away from the living area).

10.1.8 Stations utilizing poles to provide rapid access to lower floors shall ensure that the area around the pole hole is secured by means of cover, enclosure, or other means to prevent someone from accidentally falling through the pole hole.

(Poles can reduce response times from an upper level by 50% or more).

Other Considerations Associated with NFPA 1500

Cardiac events continue to be the leading cause of fire fighter deaths. An interior material pallet that has a calming effect combined with integrated emergency signals could possibly help reduce the strain during nighttime emergencies.

Designs must include safety features such as operable windows in the workout area. Indoor /outdoor fitness areas have been used when space is limited, but the fitness area must have easy access to the apparatus bay.

Training areas allow crews to learn about the latest safety and health programs, so ample space provides a functional learning space is part of this standard.

NFPA 1581 - *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting.*

Special Consideration regarding Storage (Chapter 9)

9.1.1 Ensembles or ensemble elements shall not be stored in direct sunlight while not being worn.

9.1.2 Ensembles and ensembles elements shall be clean and dry before storage.

9.1.8 Proximity firefighting protective coat and trouser elements shall be stored by hanging to

limit the damage caused by creasing and shall not be stored folded.

9.1.9 Ensemble and ensemble element storage shall be clean, dry, and well ventilated.

Other considerations Associated with NFPA 1581

This standard also requires departments to have separate laundry facilities for contaminated PPE and uniforms and station clothing, towels and bedding.

Laundry areas are being separated where personal belongings can be cleaned in the living areas where PPE doesn't enter the living space and is laundered near the apparatus bay. Waste water removal and airflow need to be considered when designing these areas.

Considerations Associated with NFPA 1710 - *Standards for Operations of Career Fire Departments*

Design can have a major impact on response times for a career fire department, from the organization of the program to access from the second floor to the first-floor apparatus bay. Design ultimately impacts the time it takes crews to get dressed and board the apparatus.

When designers consider moving from point A to point B it should be at a run, not a walk. Designers must understand what actions are going on in certain areas, such as designing functions and objects to be concealed in the kitchen that can add time in their response.

The easiest solution to decrease response time is to give firefighters direct access without bends or turns in hallways. Circuitous circulation can slow down egress and create hazards. Door swings are to be designed so that fire fighters will not open a door into another firefighter's path of travel.

Per NFPA 1710: The 2015 edition of the International Building Code states that public facilities that are in zones where winds can reach 250 mph are required to have storm shelters, and this include fire and police stations.

The standards and requirements don't just affect the fireground, but also the facilities where firefighters live and train. Those standards, when applied properly, can help with the firefighter's overall mission to protect the community and themselves.

Program Type Demand

The decline of public engagement can be correlated with the decline of public space. Historically this space would be used primarily for debating civic issues and participating in decisions that affected the surrounding community.

In the layered systems of the cities of the future, we will need to focus on the public spaces that are found inside various building types and make them accessible to the public.

The research investigated the possibility for a civic based multifunction space as the partner for a fire station shared facility. The demand was partially identified through the public outcry via a journalist, architectural critics, and community organization leaders for a secure public space. A space that did not just benefit the privileged and wealthy but also low-income populations, immigrants and young people. Demand was also identified through the existing programmatic adjacency to the facility partner.

A fire station serves a civic function; a program type of an adjacent function can assist in the logistical and social concerns of a mixed facility (this evidence was supported by the majority of shared facility fire stations holding a public safety function). The solution this research uses is a multipurpose civic space to conduct community organization meetings and increase public participation in communities at large.

This space in theory would be a catalyst for public discourse between the government and the community. A space for the public to engage in civic dialogue; by housing events, classes and programs sponsored by the fire department,

police department, community-based organizations, and public safety officials.

Residents can register to vote, hold town hall meetings, organize a neighborhood watch, have coffee with a cop, or many of the other civic functions the space could host. Leaders of Community organizations and Local Public Officials both are concerned about the disconnect between the public and local officials.

A civic multipurpose space could be a catalyst for community growth organization. When not scheduled for a civic function the space could be rented to hold various meetings and events bringing a secondary economic component to the shared facility.

Figure 01: Richmond Fire Hall (Richmond, Canada)

Typological Analysis

Upon analysis of the 14 selected precedence studies, a trend emerged regarding the use of formal language to signal toward differences in programmatic function. In this trend the apparatus bay is represented by a large volume and is typically designed with a feature to surrender the hierarchy to the fire house. The fire house volume is set at the human scale and typically includes the offices and living quarters for the firefighters.

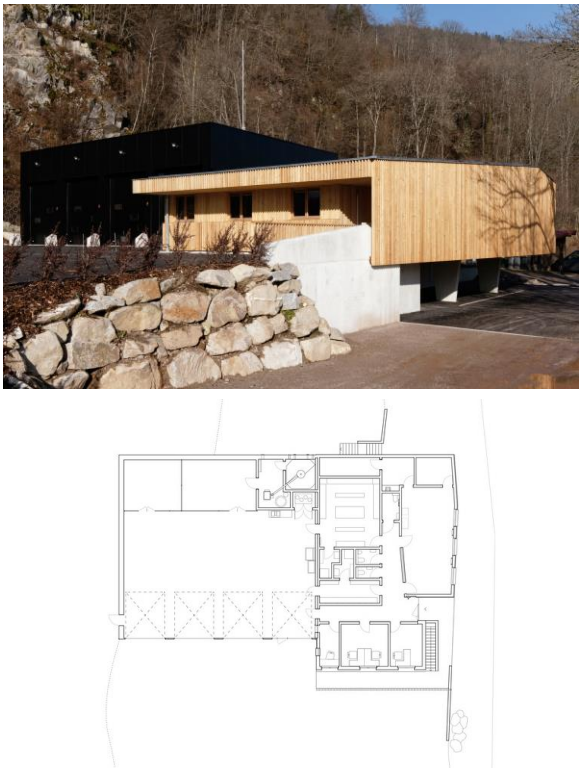


Figure 02: Fire Station of Metzeral (Metzeral, France)

Figure 03: Fire Station #5 (Levis, QC, Canada)

Figure 04: Fire Station #76 (Gresham, Oregon)

It is believed that by differentiating the volumes in form and material, it can be a great benefit toward wayfinding. In the case of a shared facility the extremes of private and public space heavily influence the program. Isolating which volume holds each space will be of paramount importance.

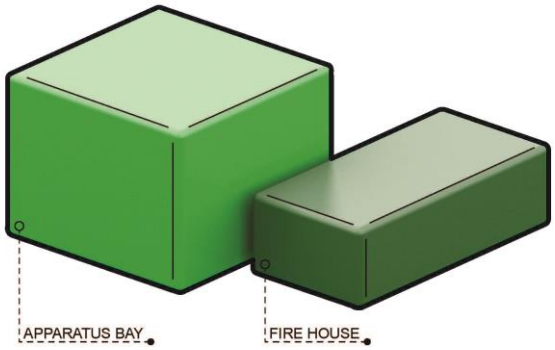


Diagram 3.1

Design Component Isolation and Analysis (Performance, Utility, and Aesthetic Contribution)

Formal Gestures

Figure 05: BOCA Fire Station (Boca del Rio, Veracruz Mexico)

In the study of the BOCA Fire Station (as shown in Figure 05) the isolated design components favored in the project are held primarily in the division of space in the floor plan. This strategy applied to the shared facility would see the civic multipurpose space housed in one wing and the Fire House would occupy the other wing. The entry gate encloses the apparatus bay below (this strategy would be most viable on a site with moderate to extreme grade change).

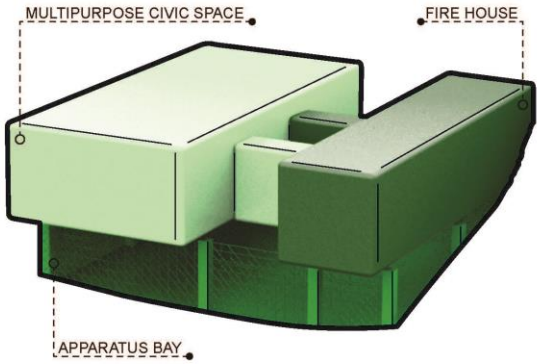


Diagram 5.1

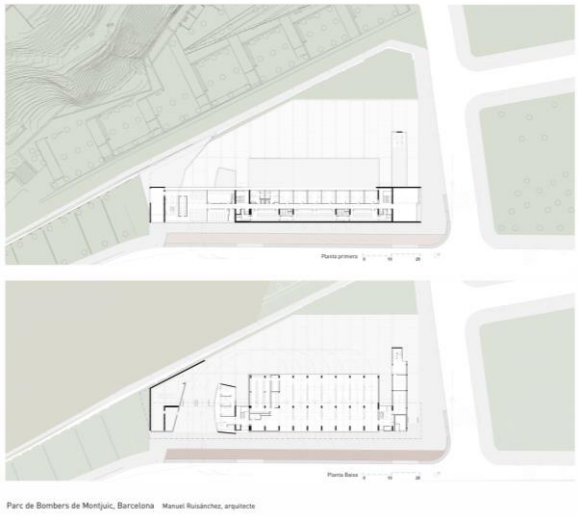


Figure 06: Montjuic Fire Station (Passeig de Montjuic, Barcelona, Spain)

In this example, the Montjuic Fire Station, similar to the BOCA station. Where the previous case study held apparatus circulation within the building footprint, this configuration (aided by a generous site) allows for a more flexible apparatus circulation, which can decrease response time. Depending on site constraints and circulation requirements these strategies can create more opportunities for movement while reducing the building footprint. Unique to this scheme is the use of form to frame a threshold. Applied to the shared facility, the three primary program components; the apparatus bay, fire house, and civic multifunction space would be the primary blocks defining an integrated entry. In this case, the civic space would occupy the west wing, keeping the public space on the ground floor and easily accessible. The fire house, a linear volume resting atop the apparatus bay.

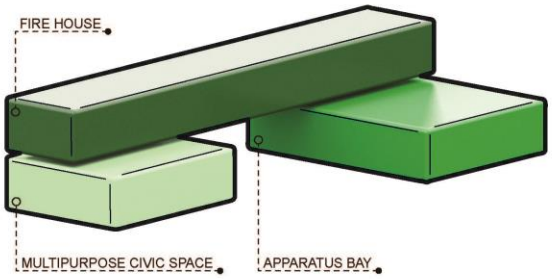


Diagram 6.1

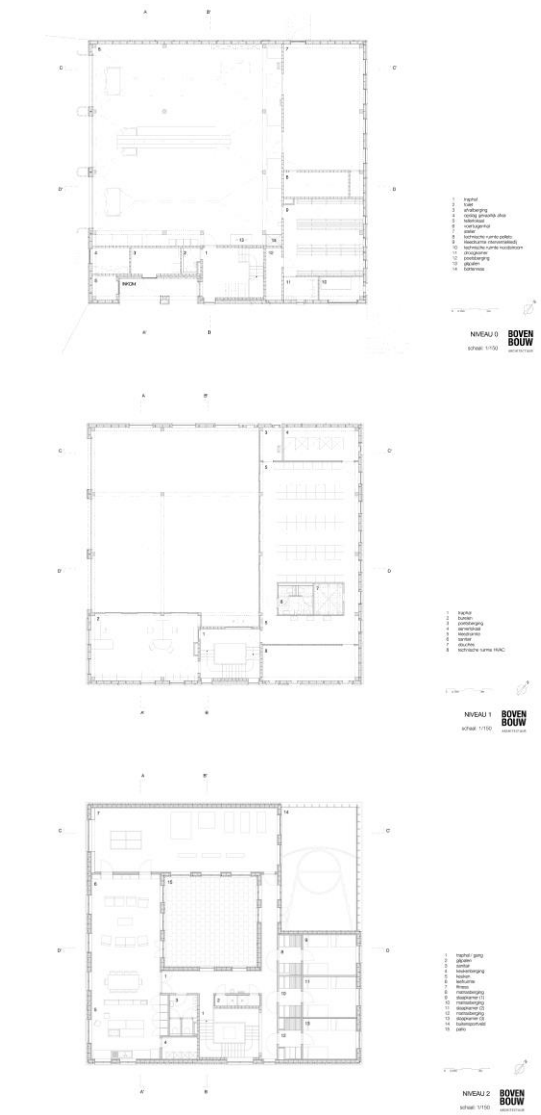


Figure 07: Fire Station Berendrecht (Antwerpen, Belgium)

The formal arrangement of Fire Station Berendrecht represents a unified shared facility solution. A strategy as applied to the Shared Facility in question sees the offices becoming the main transition space between the living and the hard program; from which there is a visual relationship to the fire truck and the street. Within this transition zone the showers are located. Situated below is the garage and gear storage. The civic multifunction room can have a relationship with a recreation room, which fire fighters and the public could share. On a compact site, this compressed and efficient building type offers a “one volume” solution.

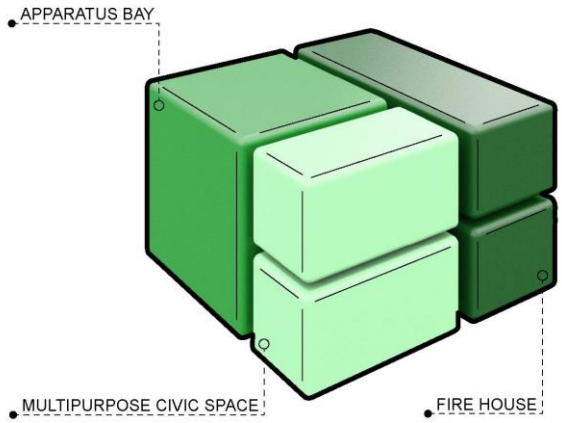


Diagram 7.1

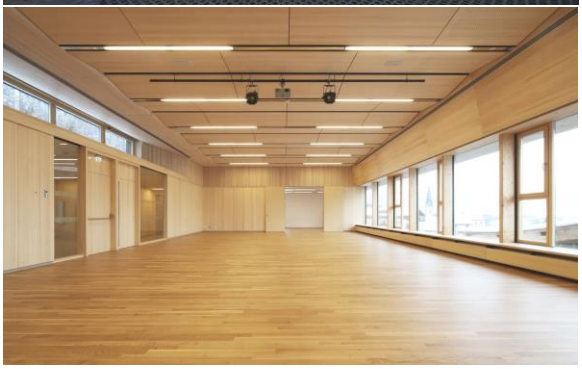
Programmatic Considerations

Figure 08: Fire Station Berendrecht (Antwerpen, Belgium)

This recreation room is enclosed by semi-transparent wood paneling to remain in contact with the outside. While the multifunction room could represent the formal bridge between the community, this recreation space could be the informal bridge, giving firefighters and community residents and healthy space to exercise.

Figure 09: Da-Yo Fire Station (Taoyuan City, Taiwan)

The roof-top park is open to the public. This feature creates insulation for the space below as well as reducing water runoff on the site. The landscape has multiple purposes that ultimately serve the members of the community.



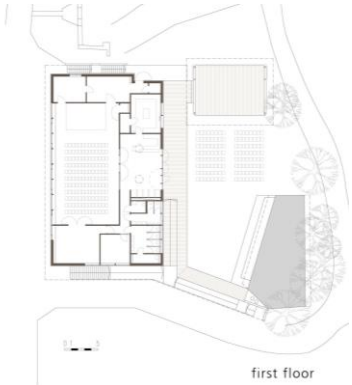


Figure 09: Fire Station Club house (Gnadenwald, Austria)

This precedent example represents the most direct interpretation of the proposed concept, instead of a civic multipurpose room the precedent's shared program is a club house for a nearby school and the surrounding community. The fire station occupies the entire ground floor and is built of reinforced concrete. The overlying club houses occupies the entire second floor. This case study is constructed with a timber structure and paneled with white fir inside and outside. Exposed soffits of the roof are coated with a weatherproof VM-zinc. The building was designed to meet the best low-energy standards.

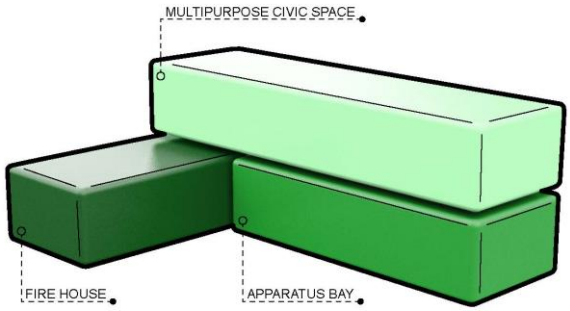


Diagram 9.1

Material Gestures

Interiors

Figure 10: Fire Station Berendrecht (Antwerpen, Belgium)

The interior of this apparatus bay is sheathed with cork for its sound dampening properties.

Figure 11: Fire Station Metzeral (Metzeral, France)

This apparatus bay's interior is clad with sound dampening panels made from recycled materials.

Figure 12: Fire Station Berendrecht (Antwerpen, Belgium)

In this case study the interior is rendered in rough material such as CMU Block and OSB board, this allows the firefighters to roughly and freely use the space in emergency situations without the worry of negotiating delicate assemblies or materials.

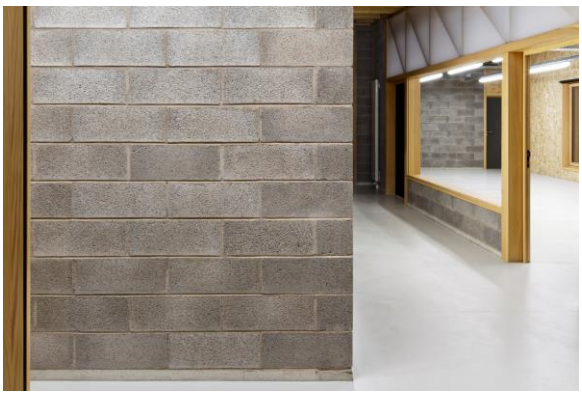


Figure 13: Fire Station Metzeral (Metzeral, France)

The set of materials (CMU and OSB) allows the project to satisfy costs requirements, this combination is a raw construction that allows the crew members to use their spaces unencumbered while rough intervention is needed.

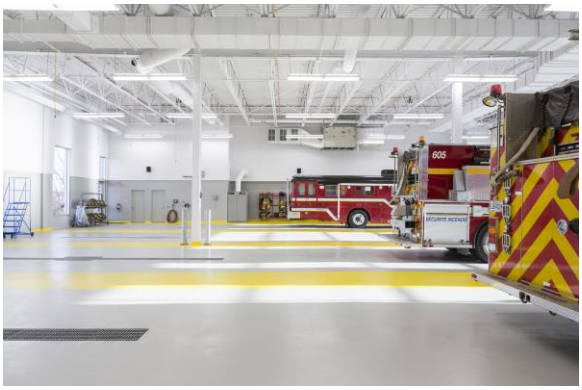


Figure 14: Fire Station Berendrecht (Antwerpen, Belgium)

This apparatus bay has a high ceiling with all technical elements visible, which make them more easily accessible. An apparatus bay painted white helps to achieve a clean, calm and modern look. Also, both natural and artificial light are reflected creating a brighter workspace to perform tasks.

Exterior (Metal)

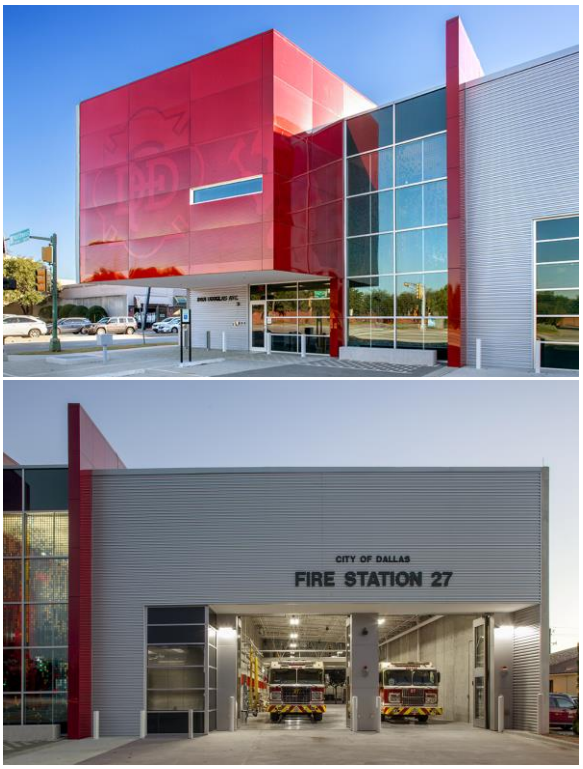


Figure 15: Fire Station No. 27 (Dallas, Texas)

Metal panels on the exterior of the apparatus bay gives a clean and industrial aesthetic. Coupled with an economic price point and low maintenance requirements, it's clear to see why this façade has become a trend in fire station construction.

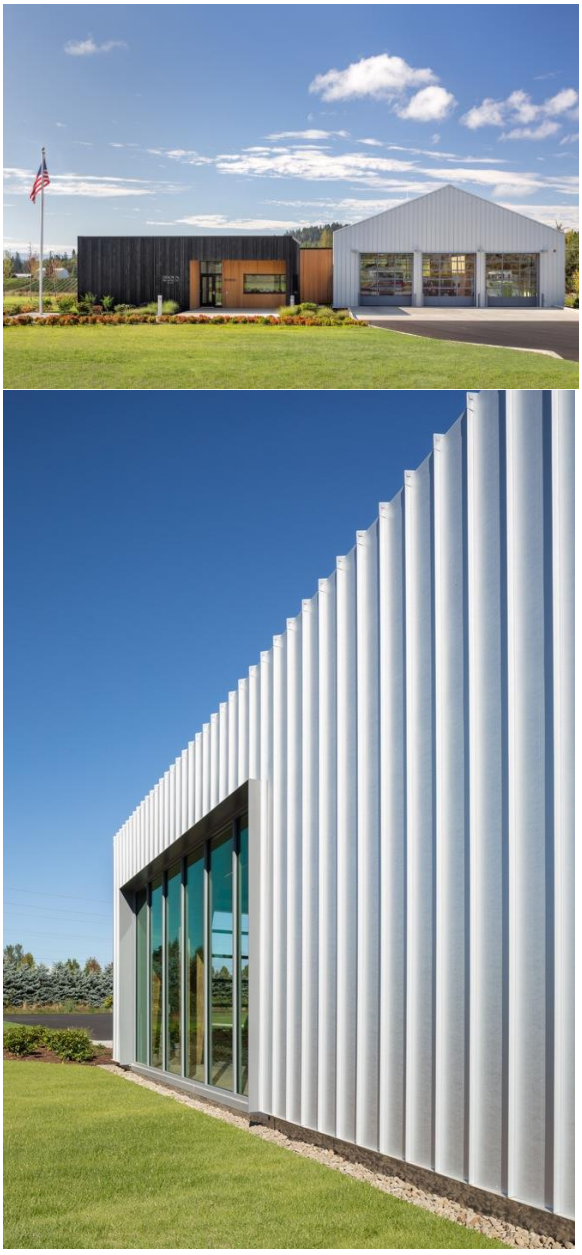


Figure 16: Fire Station No. 76 (Grisham, Oregon)

In this example, standing seam metal panel was used to give the volume a unified façade. The vertical ribs or seams protrude and cast a shadow changing the façade as the sun grazes the surface throughout the day.

Exterior (Wood)

Figure 17: Fire Station No. 76 (Grisham, Oregon)

The functional focus of the station is fire, an element of both beauty and destruction. Using reclaimed timber, this design included charring the wood surface with the traditional Japanese technique, Shou Sugi Ban. In effect, the burn provides a protection from rot, decay, insects, and turns the destructive manner of fire into an image of beauty. This specific cladding type on this building type conceptually embraces fire, turning it into a feature of protection and beauty.

Figure 18: Fire Station of Metzeral (Metzeral, France)

This wooden façade is a combination ship-lap board and batten siding. The ship lap underlay is removed at the exterior and glazed portions of building. This creates a semi-transparent view through an otherwise uniform volume. Not only does this allow light and air to pass through the volume, but it also adds a layer of security and aesthetic dimension. At night artificial light from the interior escapes through the slats creating a lantern effect.

Figure 19: Fire Station #5 (Levis, QC, Canada)

This exterior wall panel has a faux wood laminate adhered to the surface. The design decision was made not only to soften the metal panel façade, but to also mark the entry volume and bring the texture to a human scale. The use of the laminate panel gives the architect a greater ability to carry the same surface from the exterior to the interior.

Figure 20: Fire Station Club house (Gnadenwald, Austria)

The Fire Station/Clubhouse in Gnadenwald has been clad with white fir inside and out. The interior has a smooth variation of the panel giving a calm and almost utilitarian aesthetic with its use of narrow and clean joint lines. The exterior is rendered to appear as vertical planks of varying widths. This gives some variation and texture to an otherwise austere box with sharp, defined edges. Apart from the upper volume the exterior ramp and stair are clad in an indexed pattern, the varying lines of wood are secured to a metal frame that doubles as the railing.

Part 04.00 Sustainability Gestures

Figure 21: Engine House 16 (Chicago, Illinois)

Sustainability should be a top priority whenever arranging the program and budget of a civic building. As the effects of climate change become more and more dangerous to the public, it is the duty of those in public safety to vanguard the effort to amend climate change. This effort can and should be championed through facilities, practices, policy and education.

This case study shows the cost, health and wellness benefits of a fire station designed with sustainability as a primary concern.

Sustainable features from this precedent include:

- Geothermal system with water-source heat pump units

- High-performance envelope (R-26 walls with 3.5" of continuous poly iso)

- A green roof to reduce water runoff

- On-site water retention system that repurposes water for washing fire trucks and irrigation.

- Permeable paver parking that manages storm water on site.

- Native and adaptive landscape strategies

- Low-flow plumbing fixtures

- Lighting sensors for daylight harvesting.

- Materials with high recycled content installed throughout the project.

- Large clerestory windows that allow daylight into apparatus bay.

- L-shaped window arrangements that allow for privacy in the slim vertical component while the upper horizontal component maximizes daylighting.

- Hallway clerestory that provides daylighting for primary circulation

- 75.6% of regularly occupied space daylit.

CONCLUSIONS

NFPA 1500: Review and integrate Chapter 10 requirements regarding facility safety, primarily as it relates to keep contaminants from the apparatus bay to living quarters.

NFPA 1581: Review and integrate Chapter 9 requirements regarding proper storage spaces for protective ensembles, primarily to contain and eliminate contaminants from soiled gear.

NFPA 1710: Review and understand standard or operations document, primarily Section 3.3.53 (definitions of Time) as well as 4.1.2.1 (response time objectives).

Program Type Demand: A civic multipurpose space is recommended to be considered as a partner to a shared facility fire station.

Typological Analysis: A common trend was identified where two major blocks of programming where defined (apparatus bay and fire house). Each volume then outwardly reflected in scale and material the function of the spaces inside of that volume. This made each function easily identifiable from the exterior and the reduced the overall mass of the volume.

Formal considerations: A more elaborate formal approach will aid in defining the components of the shared facility and decreases the need of wayfinding devices. A secondary option for a more compact site or building footprint can be managed as well.

Programmatic Considerations: While the multifunctional civic space could be a formal bridge to the community, providing an informal public space could be another aspect of a comprehensive outreach program.

Interiors: A combination of OSB and concrete masonry units are recommended as the primary interior finishes. It is recommended that painted surfaces should be calming in color, such as white. Cork or recycled content acoustic panels are recommended to sheath the civic space and apparatus bay.

Exterior: Metal and wood would be the recommended alternatives to a brick façade, dependent upon detailing, a cost comparative design could reveal comparative performance. All within the language of a well-received contemporary aesthetic. Using wood as a façade material heightens the profile and posturing of the building both in the community and in nature. Using wood to clad a fire station specifically upends the misconception of the fragility or performance of wood and the capabilities of those who protect it from fire. Wood is warm and inviting, a key component for the visitors of the civic space.

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6) National Fire Protection Agency 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 (2016) Retrieved on January 5th, 2019, from

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7) National Fire Protection Agency (2015) NFPA 1581 Standard on Fire Department Infection Control Program Retrieved January 5th, 2019, from

https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1581

CASE STUDIES

1) BOCA Fire Station
Taller DIEZ 05
Veracruz, Mexico

2) City of Dallas Fire Station No. 27
Perkins & Will
Dallas, Texas

3) Da-yo Fire Station
K-Architect
Taoyuan City, Taiwan

4) Engine company 16 Fire House
DLR Group
Chicago, Illinois

5) Fire Station No. 5
STGM Architectes + CCM2 Architectes
Levis, QC, Canada

6) Fire Station Gnadenwald
Gsottbauer Architektur.werkstatt
Gnadenwald, Austria

7) Fire Station Metzeral
Loic Picquet Architecte
Metzeral, France

8) Fire Station No. 76
Hennebery Eddy Architects
Grisham, Oregon

9) Fire Station Berendrecht
Bovenbouw
Antwerpen, Belgium

10) Richmond Fire Hall
HCMA
Richmond, Canada

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Fire Station Design, Public Safety, Shared Facilities, Community Outreach, Civic Space, Public Space