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High-Performance Precast Concrete in Federal Biomedical Building Exterior Envelopes: Integration, Safety, and Security

Federal biomedical facilities demand exceptional performance from their building envelopes. Precast high-performance concrete (HPC), particularly ultra-high-performance concrete (UHPC), offers superior durability, strength, and resilience for these critical structures. Precast components can feature exposed concrete or integrate thin brick for an architectural finish typical of the NIH Bethesda campus. HPC/UHPC precast components use similar materials to conventional concrete yet offer compressive strengths up to 29,000 psi[1,2] and flexural strengths reaching 2,900 psi.[3] UHPC surpasses conventional concrete, with low porosity and permeability and steel fiber (typically) reinforcement enhancing ductility and durability, making it ideal for federal biomedical building exteriors.

To be effective, building envelopes must manage four control layers: bulk water, water vapor, air, and thermal. Precast HPC components and panels excel at integrating these layers, even at complex junctions, such as mechanical penetrations, windows, and doors, including:

Bulk Water (Weather-Resistive Barrier): Provide outstanding control as a barrier to exterior water penetration, aligning with the requirements of NIH *Design Requirements Manual* (*DRM*) Section 4.1.2, Exterior Walls.[4] Best practice detailing should include two-stage drained joints for superior rain control and pressure-equalized rain screen systems for enhanced wind-driven rain protection. At penetrations and fenestrations, robust flashing systems, backer rods, and high quality, compatible sealants complete the bulk water control layer.

Water Vapor: Concrete permeability is well-established as the leading indicator of its longevity in exterior envelope applications, and HPC has exceptionally low permeability compared to conventional concrete and most stone materials. Dewpoint analysis is performed on the wall assembly during design to prevent condensation within the wall assembly, with consideration for the impact of negative pressurization of the interior via the HVAC system in many biomedical facilities on the vapor drive. Vapor barrier continuity must be maintained at penetrations and fenestrations using high quality, compatible materials. Generally, HPC panels over 2 inches thick act as effective vapor barriers, but perms vary based on mix design.[2]

Air: HPC panels can be components of an effective, continuous air barrier system; however, it is common to utilize the bulk water control layer to prevent water and air penetration, reducing the amount of water vapor in the panels. Continuity across panel joints, penetrations, and fenestrations is ensured via high-quality sealants, airtight collars for mechanical penetrations, and compression gaskets with properly tooled topping sealant joints at window and door interfaces.

Thermal: Concrete, including HPC, has limited insulating properties, but this is offset by high thermal mass, which contributes to energy efficiency. Continuous exterior insulation, insulated precast sandwich panels, and high-performance glazing systems help meet energy performance goals. Thermal bridging at penetrations and fenestrations must be mitigated by thermal breaks, such as insulated sleeves.

Beyond the control layers, in federal facilities, exterior envelopes must also address safety and security attributes. :

Seismic Resilience: HPC connections are designed to allow movement while maintaining envelope integrity, while mechanical penetrations and fenestrations are designed with sufficient clearance to accommodate anticipated displacements, making these components a preferred building material to withstand earthquakes. Ductile fiber-reinforced concrete enhances energy absorption during seismic events, minimizing cracking, spalling, and potential falling materials.[2]

Lateral Load, Uplift, and Overturning Resistance (Wind): Achieved through high component and panel strength, while connections and anchors effectively transfer lateral loads to the building structure.

Flood Resilience: HPC construction is inherently water-resistant and can be detailed to be an important component in a flood resilient building by ensuring wall bases and penetrations are designed to resist hydrostatic pressure during flood events or are located above the anticipated flood elevation.

Fire Resistance: Resistance to combustion or smoke development is inherent in HPC, meeting or exceeding code requirements. Penetrations must utilize firestopping materials and listed details that maintain the wall assembly's fire-resistance rating.

Security Attributes: Federal biomedical facilities require enhanced security measures to resist man-made hazards.

Blast Resistant Wall Systems: HPC's strength, ductility, and energy absorption make it ideal for blast-resistant design, with connections allowing load redistribution during overpressure events. Mechanical penetrations should be designed to withstand impacts and blast pressures with tamper-resistant sealing systems.[2,3]

Fenestration Systems (Windows and Doors): HPC-integrated windows and doors provide overpressure, ballistic, impact, and intrusion resistance. Security-rated fenestration systems integrate seamlessly with HPC panels, offering consistent protection across the facade.

Biosafety Considerations: HPC components meet security, blast, and forced entry requirements for high-containment laboratories while maintaining visual appeal and maintainability.

HPC and UPC components have some disadvantages which need to be considered, including high initial cost, specialized handling, transportation challenges, and limited onsite modification. However, by integrating precast HPC components with the four control layers and implementing robust safety and security measures, designers can create building envelopes that meet the stringent requirements of the NIH *DRM* and *BMBL-6* guidelines, ensuring critical facilities maintain their integrity, safety, security, and biosafety performance throughout their lifecycle.

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AI in HVAC Systems for Biomedical Facilities: Optimizing Design, Operations, and Maintenance - Introduction

In biomedical research facilities, reliable and effective HVAC (heating, ventilation, and air conditioning) systems are indispensable for maintaining controlled environments critical for human and animal research, laboratories, and specialized clinical spaces. These systems regulate temperature, humidity, air quality, and airflow to protect sensitive equipment, ensure the safety of researchers and participants, and maintain the integrity of experiments. However, as efficiency and reliability demands rise alongside stricter regulatory requirements, traditional HVAC systems often struggle to meet the complex needs of biomedical environments. The constraints of existing conditions also push the limits of design and equipment. Artificial intelligence (AI) is emerging as a transformative solution, offering innovative ways to enhance system performance, optimize energy usage, and ensure operational reliability. This three-part series explores AI's expanding role in HVAC systems for biomedical facilities: part one is an overview of AI's potential to revolutionize HVAC systems in biomedical research settings, while part two will examine AI's impact on system design optimization and qualification, and part three will highlight AI's role in enhancing system performance through predictive maintenance and real-time management.

Benefits of AI in HVAC Optimization

AI integration into HVAC systems offers numerous advantages tailored to the unique demands of biomedical research facilities:

1. **Energy Efficiency:** AI-driven systems analyze real-time data—such as room occupancy, temperature fluctuations, and research activity levels—to dynamically optimize HVAC performance. This reduces energy consumption and operational costs.[1,2]
2. **Precision Control for Sensitive Environments:** Biomedical facilities often require strict environmental controls to ensure experimental integrity and equipment reliability. AI enables real-time adjustments to maintain precise temperature and humidity levels critical for biosafety labs, cleanrooms, and animal research spaces.[3,4]
3. **Predictive Maintenance**: By analyzing sensor data from HVAC systems, AI predicts potential failures or inefficiencies before they occur. This enables proactive maintenance strategies that reduce downtime and extend equipment lifespans.[2,4]
4. **Regulatory Compliance and Sustainability**: AI ensures compliance with standards such as ASHRAE while helping facilities achieve energy efficiency budgets even as systems age.[2,5]

Future Trends in AI for Biomedical HVAC Systems

Emerging trends highlight how AI will continue to evolve as a tool to optimize HVAC systems for biomedical environments:

1. **Machine Learning Integration:** Advanced machine learning algorithms will enhance AI's ability to adapt dynamically to changing facility needs by analyzing historical data alongside real-time inputs.[1,4]
2. **AI for Energy Source Adaptability:** Future AI systems will integrate various energy sources—such as solar or geothermal—into HVAC operations to further reduce the cost of facility operation.[2,4]
3. **Enhanced HVAC Design Tools:** AI-powered design platforms will allow engineers to simulate system performance before implementation, ensuring optimal configurations tailored to specific uses like animal facilities or cleanrooms.[4,5]
4. **Real-Time Adaptation:** AI will offer real-time control over airflow, temperature, humidity, and pressurization based on live data to ensure stability and control of critical environmental parameters required by scientific equipment, animal colonies, and regulatory compliance.[1,3]

Conclusion

AI is reshaping HVAC systems in biomedical facilities by improving energy efficiency, regulatory compliance, and operational reliability. These advancements promise significant benefits for researchers by enabling environments optimized for cutting-edge biomedical research while reducing costs and environmental impact. In the next article of this series, we will explore how AI is already impacting the design process for HVAC systems in biomedical settings—focusing on system qualification and performance review.

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AI in HVAC Design for Biomedical Facilities: Optimizing Design, Qualification, and Review for Precision and Compliance

In biomedical research facilities, HVAC systems are essential for maintaining the controlled environments necessary for research, clinical trials, and laboratory operations. Designing HVAC systems that support optimal air quality, temperature regulation, and humidity control—while also meeting strict energy efficiency and regulatory standards—can be complex and overwhelming.

AI is transforming HVAC design in biomedical settings by offering intelligent tools that assist with system optimization, qualification, and performance review. By leveraging vast amounts of data and predictive algorithms, AI ensures that HVAC systems are designed to meet the specific needs of biomedical environments, from research labs to animal facilities and healthcare environments.

AI-Assisted HVAC Design Benefits

1. **Design Assistance**: AI tools help engineers and designers assess historical environmental data and simulate different design configurations to optimize HVAC systems for energy efficiency, environmental control, and regulatory compliance. These tools can adjust airflow, temperature, and humidity settings based on specific requirements.[1,2,3,4,5,6]
2. **Design Optimization**: AI simulations enable designers to assess multiple design scenarios, optimizing performance and efficiency. This is especially important in complex biomedical environments, such as cleanrooms and laboratories, where precise conditions are crucial for experimental integrity.[1,2,7]
3. **Design Qualification**: AI helps ensure that HVAC designs meet stringent regulations for laboratory safety, energy efficiency, and air quality. By analyzing design specifications and verifying that they comply with codes and standards such as ASHRAE, AI can identify potential issues early in the design process.[3,5]
4. **Design Review**: AI-driven design review tools analyze HVAC system models, highlighting inefficiencies and compliance risks. By predicting how a system will perform under real-world conditions, these tools allow designers to make adjustments before implementation, reducing costly changes post-installation.[8]

Case Studies in AI-Driven HVAC Design

1. **Case Study 1**: In a healthcare facility, AI-driven HVAC design tools helped optimize the ventilation system, improving air quality while reducing energy costs by 20%. The system was fine-tuned to ensure the right balance of airflow, temperature, and humidity for patient care areas and surgical rooms.[8]
2. **Case Study 2**: A biomedical research laboratory used AI to optimize its HVAC system design, reducing energy consumption by 30% while maintaining strict temperature and humidity control. The AI system also helped ensure compliance with laboratory safety standards for ventilation and air quality.[9]
3. **Case Study 3**: AI-assisted design of HVAC systems for an animal research facility led to more efficient airflow management, reducing energy usage by 18% and improving temperature regulation in animal holding areas, crucial for maintaining animal welfare and study accuracy.[10]

Conclusion

AI is revolutionizing the design process for HVAC systems in biomedical facilities. From assisting with system optimization to ensuring regulatory compliance, AI plays a crucial role in enhancing system performance and operational efficiency. The next article will delve into how AI supports HVAC operations and maintenance in biomedical facilities, ensuring the continuous optimal performance of these critical systems.

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AI in HVAC Operations and Maintenance

In biomedical facilities, including those governed by the National Institutes of Health (NIH), heating, ventilation, and air conditioning (HVAC) systems must maintain exacting standards to support research, patient care, and regulatory compliance. The NIH Design Requirements Manual (DRM) requires environmental stability, energy efficiency, and system resiliency.[1] Artificial Intelligence (AI) is rapidly transforming HVAC operations and maintenance by integrating real-time data from sensors, weather feeds, and building management systems to dynamically optimize environmental conditions, enhance reliability, and reduce energy use.

From Preventative to Predictive Maintenance

Predictive maintenance is a major step beyond traditional, schedule-based, or reactive approaches which can result in unnecessary service calls and critical system downtime. AI models trained on historical and real-time operational data can detect early signs of component degradation, alerting facility managers before failures occur. This enables timely, targeted maintenance that minimizes disruptions and extend the life cycle of HVAC assets, critical in biomedical facilities where environmental failures can compromise research or clinical outcomes, human safety and comfort, and facility damage.[2,3] In one case study, implementation of predictive AI maintenance algorithms in a medical research facility reduced HVAC system failures by 40%, resulting in fewer emergency interventions and greater stability for temperature-sensitive protocol.[4]

Fault Detection and Diagnostics

AI-powered analytics can also streamline fault detection by continuously monitoring performance against dynamic baselines. When anomalies occur—such as a drop in airflow, compressor inefficiency, or a sensor failure—the system flags the deviation and may suggest a likely root cause. These automated diagnostics reduce technician troubleshooting time and prevent cascading failures in tightly controlled environments.[2,3,4] One healthcare facility documented a 15% reduction in HVAC-related operational costs after deploying AI-based diagnostic tools, primarily due to earlier detection and streamlined service workflows.

Energy Management

Integrating AI with occupancy sensors, weather forecasts, and utility pricing models allows HVAC systems to dynamically optimize energy use. Adjustments to setpoints and operational schedules minimize waste while maintaining conditions essential for biomedical research and patient care. This intelligent energy management approach supports sustainability goals and regulatory compliance, often delivering substantial operational cost savings.[2,3] A biomedical vivarium at Michigan State University employed AI-enhanced HVAC zoning and reported a 25% reduction in annual HVAC energy use while meeting full compliance with AAALAC and BSL-3 environmental controls.[5] Bazazzadeh, Hoseinzadeh, Mohammadi, & Garcia (2025) have also demonstrated how AI surrogate models can predict optimal HVAC strategies under projected climate change scenarios, improving long-term operational resilience.[2]

Automated Compliance Monitoring

AI is also proving essential in meeting the stringent compliance requirements of regulated spaces. By continuously tracking environmental parameters and comparing them to predefined setpoints, AI can flag developing trends that threaten regulatory limits before violations occur. This capability is particularly valuable in aseptic processing facilities and clinical trial suites, where even minor deviations can have significant consequences.[1] In applied settings reviewed by Labib & Nagy (2023), automated compliance systems reduced deviation events by over 30%, enabling biomedical facilities to maintain regulatory alignment with minimal manual oversight.[3]

Conclusion

AI and machine learning will increasingly integrate with HVAC systems in biomedical facilities, enabling smarter room environment control, predictive maintenance, and compliance automation. Advances will incorporate renewable energy sources and life cycle sustainability assessments, ensuring biomedical HVAC systems adapt to evolving regulations and environmental challenges, including climate change impacts.[2,4] AI is not just an efficiency tool but a vital component for ensuring operational resilience, regulatory compliance, and sustainability in HVAC systems. As AI technologies mature, their deployment will be essential to meet the stringent demands of biomedical research environments, supporting both scientific progress and patient safety.

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Animal Locker Room Design Considerations

Designing an animal research facility (ARF) requires a comprehensive understanding of various standards and guidelines. For NIH-funded projects, the NIH *Design Requirements Manual* (*DRM*), *Biosafety in Microbiological and Biomedical Laboratories (BMBL)*, and the *Guide for the Care and Use of Laboratory Animals* (*Guide*) serve as primary references. The *DRM* covers space requirements, environmental controls, and layout, while the *BMBL* addresses essential biosafety protocols, and the *Guide* describes currently accepted standards in the care and housing of animals used in research.

Locker rooms play a critical role in maintaining safety, cleanliness, and well-being for both animals and staff. To design effectively, the project team must perform a comprehensive risk assessment; identify specific users (e.g., researchers, technicians, maintenance staff); determine user needs (e.g., personal protective equipment [PPE], clothing changes, hygiene protocols); develop a detailed Basis of Design (BOD); and identify potential hazards and appropriate mitigations.

ARF locker rooms can vary significantly in size and features based on the program, the required biosafety level, the type of species to be housed, and whether more than one species is present in the facility. The most basic is a simple room with lockers, but programmatic requirements may require a changing/locker room, a locker/shower room, or a locker room with shower and restroom facilities.

Location

The location of the locker room must address BOD requirements and the functional zoning of the ARF. The locker room should be located near the animal areas for efficiency and convenience but sufficiently distanced enough to minimize contamination risk. If the locker room is a barrier between the animal areas and the rest of the facility, it is required to be near ventilation and decontamination zones/utilities as needed to support contamination control (including odor as a contaminant). This configuration may require all personnel to enter through the locker room, doff street clothes, shower, and don a facility-specific uniform (usually scrubs) and PPE prior to entering the animal areas. This process is reversed upon exiting.

Layout

There are several requirements for a basic layout: room size, space for changing, storage (lockers), hygiene (handwashing and showering), and circulation. The circulation of people and materials should minimize distance and congestion but allow for maneuverability. The workflows for people, equipment, and clean/soiled materials passing through the locker room must be distinctly defined. In addition to the circulation criteria, there should be an allowance for all other required components that could impact access and operational protocols. Equipment and furniture often include storage for PPE, containers for soiled items, lockers, and benches.

The ARF should develop risk-based SOPs to define the required PPE, which is the last line of protection for staff and animals in the hierarchy of controls. PPE may be as simple as lab coats and disposable gloves or include protective headgear, hearing protection, safety shoes/foot protection, respirators/masks, safety eyewear, and special protective clothing. There should be enough space for the storage, donning, and doffing of PPE before entering and exiting the ARF. PPE storage should be separate from the storage for the staff's street clothing.

Safety, Privacy, and Security

To ensure safety and the flow of personnel, the locker room must be well-lit with consideration for the placement of lockers and/or benches so they do not obstruct pathways or impede egress to exit(s). For privacy, consider providing separation by gender or individual changing areas. The design must prevent direct sightlines from public spaces into the locker/changing rooms. For basic security, lockers may have secure access (e.g., card swipe or combination locks). The locker room may be required to have controlled access, especially if it is a direct passthrough as part of the facility's biosecurity protocol.

Finishes

All hard surfaces should be constructed of durable, smooth, moisture-resistant, non-porous, easy-to-clean materials to facilitate routine cleaning and decontamination. Materials must withstand frequent exposure to harsh cleaning agents used in ARFs. For example, seamless epoxy flooring with integral coved bases helps prevent moisture intrusion and microbial growth at the wall-floor interface. Animal facilities may use specialized cleaning agents which can affect the wear of surface materials. Joints, transitions, and voids (cracks, crevices, and hollow areas) that could harbor contamination, pests, and vermin must be solidly filled or completely sealed. Floors must be slip-resistant for safety, seamless, and integral with a coved base. Walls must be moisture- and impact-resistant. There should be a smooth juncture between the wall and the upper edge of the integral coved base. A solid, monolithic base or curb should be provided to support fixed, floor-mounted casework and lockers so that the floor base can be extended around them.

Lockers

The locker material must be resistant to corrosion and harsh cleaning materials and methods. Material options include epoxy-coated metal, stainless steel, or polymer. The selected material will be based upon the required function, appearance, and maintenance.

ARF lockers may have sloped tops or be recessed beneath a bulkhead to prevent unwanted buildup of dirt and discourage the top from being used for excess storage. Lockers should be placed upon a solid stand or platform and be well-sealed to the walls and floor to inhibit pests.

Locker configurations shall be ABA compliant and appropriately sized based on storage and standard operating procedure requirements. Many facilities opt for traditional full-height lockers, while others use oversized

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lockers to house bulky gear or cubby lockers to hold smaller equipment (which can be stacked for multi-tiered storage). PPE and workwear may be required to be stored separately from personal clothing, which would necessitate additional storage.

Environmental Considerations

Locker rooms require adequate ventilation, air quality, temperature control, and humidity control to remove odors and maintain air quality and staff comfort.

Conclusion

Locker room design is an integral component of animal research facilities. The ARF design intent shall be developed in consultation with veterinarians, animal care/maintenance staff, and stakeholders and documented in a BOD. Furthermore, it is essential for the designer to incorporate the appropriate codes, standards, and guidelines, inclusive of the ARF's operational and functional design requirements.

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The formulae $\frac{\partial \rho U_i}{\partial t}+\frac{\partial}{\partial x_j}(\rho U_i U_j)=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial U_i}{\partial x_j}\right)+g_i(\rho-\rho_0)$ *for building* $\frac{\partial}{\partial x_j}(\rho \overline{U_i}\,\overline{U_j})=-\frac{\partial \overline{P}}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial \overline{U_i}}{\partial x_j}-\rho\overline{u_i' u_j'}\right)+g_i(\rho-\rho_0)$ *state of the art* $\frac{\partial}{\partial x_i}(\rho\overline{U_i}\,\overline{H})=\frac{\partial}{\partial x_i}\left(\lambda\frac{\partial \overline{T}}{\partial x_i}-\rho\overline{u_i' h'}\right)$ *biomedical research facilities.*

Fall Protection

Per OSHA data, falls are the leading cause of death in construction and operation and maintenance (O&M) activities – in 2023 alone, the U.S. Bureau of Labor Statistics (BLS) reported 423 out of 1,075 construction fatalities were due to falls, despite being preventable.[1] During construction, work often involves activities including unprotected edges and openings, elevated platforms, or scaffoldings. During O&M activities, maintenance technicians often require ladders or lifts to gain access to ceiling panels, ductwork, and equipment above the ceiling. Given the risks of fall are present for both construction and O&M, OSHA requires fall protection when work is performed at elevations of six feet during construction (see 29 C.F.R. 1926.501)[2] and at four feet in general industry settings (see 29 C.F.R. 1910.28),[3] which include most O&M activities.

Fall Protection Systems

There are three types of fall protection systems used to minimize the risk of falls during construction and O&M:

- **Fall Prevention**: Typically, this is the safest approach, as this system removes fall hazards by using physical controls such as guardrails to prevent workers from falling to lower levels (see 29 C.F.R. 1926.502(b)).[4]
- **Fall Restraint (Travel Restraint)**: When implementing fall prevention is not feasible, this system prevents workers from accessing areas with fall hazards. A fall restraint system consists of a body belt or harness connected to a fixed-length lanyard and anchorage point. When used properly, a fall restraint will not allow workers to fall from any distance even when fully extended.
- **Fall Arrest**: Designed to safely stop (or arrest) a fall that has already happened. Examples of fall arrest systems include safety nets (see 29 C.F.R. 1926.502 (c)) and personal fall arrest systems (PFASs) (see 29 C.F.R. 1926.502(d)).[4] A PFAS consists of a full body harness, an anchorage point, lanyard, and lifeline that prevents workers from hitting the surface below. Fall arrest systems should be the last resort because a fall is already in progress and workers will still be exposed to the force and possible trauma resulting from the fall itself.

Best Practices for Fall Protection

Most fall fatalities are preventable. By adhering to OSHA standards and best safety practices for fall protection, fall hazards can be eliminated or minimized to keep workers safe. Here are some best practices to ensure the effectiveness of fall protection.

- **Risk Assessment:** Conduct facility- and job-specific risk assessments to identify potential fall hazards and select the right fall protection system. Plan any high-risk O&M activities during facility shutdown to reduce impacts on product integrity.
- **Selection and Inspection:** The best type of fall protection is dependent on the type of activities and where the activities are being performed. When possible, prioritize passive protection such as fall prevention (e.g., guardrails) over an active protection (e.g., fall arrest/restraint) system. Per ANSI Z359.2-2023, a competent person should inspect each piece of fall protection equipment annually in accordance with the manufacturer's guidelines.
- **Maintenance:** Each part of a fall protection system needs regular maintenance to work effectively. All fall protection equipment should be cleaned regularly and dried properly to remove dirt and grime buildup and stored in cool dry places away from chemicals and heavy objects to extend the life of the equipment.
- **Training:** OSHA requires training for all workers who may be exposed to fall hazards, and this training must be documented and maintained (see 29 C.F.R. 1926.503).[5] Workers must demonstrate full understanding of potential fall hazards in the area and proper use and inspection of each piece of fall protection equipment prior to use.
- **Emergency Rescue Plan:** OSHA requires a written rescue plan for every location where fall protection is required. The plan must ensure prompt rescue of workers if/when they fall or that workers can rescue themselves.

Conclusion

Working at heights comes with great risks, sometimes even death, but with proper planning, inspection, maintenance, training, and rescue plans, these risks can be minimized or eliminated. Following OSHA standards and best practices for fall protection can help assure worker safety, and public well-being.

References and Additional Reading

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Delegated Design in the Design Process

As building systems become more complex and specialized, fabricators and product manufacturers play increasingly important roles in the design of building elements. This evolution has promoted project delivery strategies that link design professionals with specialty contractors and allow product manufacturers to leverage their respective expertise. In particular, delegated design transfers the design responsibilities of manufacturer-specific systems or complex building elements from the **Project Designer** (Architect/Engineer of Record, or A/E) to a third-party **Contractor** (Contractor, Fabricator, or Manufacturer). The Project Designer may use this approach to give the Contractor some latitude in how a proprietary or specialized element is built, or to delegate the design of a building element to a subcontractor who has greater expertise with their specialty. This article reviews the general concept of delegated design from a design aspect and is not intended to provide legal advice.

What is Delegated Design?

The Construction Specification Institute defines delegated design as "when a construction contract expressly assigns to the contractor responsibility for the final design (and construction) of a specific element of the completed, functioning project."[1] The 'completed, functioning project' qualifier is important because it distinguishes delegated design from the temporary construction that falls under the construction contractor's means and methods.

Design Roles and Responsibilities

Under delegated design, the Contractor retains a qualified, registered **Delegated Designer** to complete the design of a specified building element**.** The two designers on the project (the Project Designer and the Delegated Designer) typically have no contractual relationship with each other but have complementary design roles and responsibilities which must be clearly defined to avoid schedule, communication, coordination, or design discrepancy or other conflicts.

- The Project Designer is responsible for designing the project as a completed, functioning whole as documented in the construction documents. The construction documents indicate which elements will be delegated design and include all the criteria to which the designated elements must be designed. This includes Delegated Designer qualifications and licensing, performance criteria for the elements, design intent, and submittal requirements.
- The Delegated Designer is responsible for designing the element in a way that is safe, responsible, code compliant, and compliant with the design intent and criteria in the construction documents. The design must be signed and sealed by the Delegated Designer and submitted for review by the Project Designer in accordance with the submittal requirements, which may include drawings, specifications, calculations, certifications, and reports.
- The Project Designer is responsible for reviewing the delegated design but does not assume liability for the Delegated Designer's technical work. The review should confirm that the submission is compliant with:
  - Performance criteria and submittal requirements, including the qualifications of the Delegated Designer and the signing and sealing of appropriate documents.
  - The design intent and the coordination and transition with all adjacent and associated elements.
  - All other criteria in the construction documents.

Specific delegated design performance and design criteria for an element are included in the relevant specification section, and general requirements are included in Specification Section 013573 Delegated Design Procedures.

Examples of Delegated Design

The list of delegated design elements varies by project but may include:

- **Architectural:** Curtain walls, metal panels, wall and roof systems, casework, millwork, waterproofing systems
- **Structural:** Metal stairs, handrails and guardrails, steel connections, precast and/or pre-stressed concrete, foundations
- **Specialty components:** Elevators, escalators, lighting, theater acoustics, fountains, arts
- **MEP:** Fire suppression systems, building automation systems, sprinklers, fire and security alarm systems, accessory parts (hangers and supports for heavy pipes, ducts, and equipment), large chillers and boilers

Conclusion

Delegated design utilizes the expertise of contractors to design proprietary and highly specialized building elements. Essential aspects of success include the definition of criteria (Delegated Designer qualifications, design intent and criteria, submittal requirements) and the complimentary roles of the Project Designer and Delegated Designer.

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