Design Guide

Data Centers

Integrated Building Envelopes

Data centers demand integrated building envelopes that deliver airtightness, watertightness, and long-term durability. Early identification of performance drivers ensures system continuity, redundancy, and resilience. This guide outlines key considerations to support high-performance designs. Refer to the data center design guide checklist for a complete list of project considerations. Contact Carlisle Design Services for more information at Design.Services@Carlisle.com.

Table of Contents

Define Building Performance 1
Facility Tier Classifications 1
Analyze Site and Environmental Conditions 2
Site Conditions 2
Wind Exposure and Weather Extremes 2
Account for Operational Demands 2
Operational Demands 3
Anticipate Continuous Insulation 3
Continuous Insulation 3
Design for Redundancy and Resilience 3
Integrated Building Envelope Performance 3
Below Grade Waterproofing Systems 3
Above Grade Waterproofing Systems 4
Roofing Systems 4
Critical Tie-ins 5
Coordinate Specifications for Integrated Performance 5
Key Specification Sections 5
Specification Coordination Strategies 5
Plan for Verification Compliance 6
Quality Assurance and Quality Control 6

Define Building Performance

Facility tier classifications define expected building performance redundancy and fault tolerance. Identifying project specific goals, key performance drivers, and operational expectations helps determine owner expectation pathways.

Facility Tier Classifications

Uptime Institute Data Cener Tier Classifications	
Tier I	• Protects against human error disruptions. • Requires complete shutdown for preventative maintenance and repairs. • Does not protect against unexpected failure or outages.
Tier II	• Redundancies for power and cooling to plan and protect during maintenance disruptions. • Components can be removed without shutdown. • Does not protect against unexpected failure or outages.
Tier III	• Redundant distribution paths in building design and operations. • Data center to be concurrently maintained in critical environments. • Does not require shutdown for equipment maintenance or replacement.
Tier IV	• Redundant capacity and distribution paths to prevent unexpected failure or outages. • Several independent and physically isolated systems to avoid system compromises. • Provides fault tolerances to avoid IT operation disruptions.

Design Guide

Data Centers

Integrated Building Envelopes

Key considerations
Common critical systems and environmental sensitivities • IT Equipment, electrical infrastructure, cooling systems, fire suppression systems, monitoring and control systems, and humidity control systems
Design sensitivities and building envelope implications • Coordinate mechanical pressurization strategies, validate compartmentalization, specify entry filtration and seals, and protect envelope integrity during construction. • Conduct energy modeling, require envelope commissioning, and coordinate HVAC humidity control to identify dew point location and prevent condensation within assemblies. • Assess moisture requirements, conduct watertightness testing, and install integrated leak detection systems. • Review isolation strategies and specify resilient insulation systems for vibration-prone areas.
Maintenance protocols • Identify operational requirements and protect roofing systems from damage during equipment maintenance.

Analyze Site and Environmental Conditions

Site conditions, building performance characteristics, wind loads, and fire resistance are important considerations and code requirements because they influence integrated wall assembly designs, cladding attachment methods, roof wind uplift resistance, and perimeter edge metal detailing.

Site Conditions

Soil conditions
Geotechnical reports help identify site challenges and soil conditions. Findings such as expansive or unstable soils, radon, or high-water tables provide a clear path towards structural and waterproofing goals.
Soil conditions that may affect structural, waterproofing, or drainage strategies: • Expansive or unstable soils • Methane, chloride, hydrocarbons, radon, saltwater, or sulfates • Hydrostatic pressure
Energy modeling
Carlisle Design Services offers data center energy modeling analysis for roofs and exterior walls to evaluate building envelope performance under real-world climate conditions. Contact Carlisle for modeling support to meet design goals.

Wind Exposure and Weather Extremes

Site specific risks
Increased demand for data centers can require building placement in areas that anticipate high winds or weather challenges. Designing for long-term performance means designing for future unknowns. Even Tier I and Tier II data centers must prepare for regionally specific threats including hurricanes, snow loads, high-level solar exposure, hail, seismic activity, floods, wildfires, and tornados.

Account for Operational Demands

Data center operational demands are dependent upon tier classification and owner expectations for reliably. Understanding project specific operational goals and maintenance requirements influence system selection, detailing, and long-term maintainability.

Design Guide

Data Centers

Integrated Building Envelopes

Operational Demands

Heavy equipment loads and maintenance access
Facilities that require uninterrupted cooling and operations may integrate heavy equipment on roof or deck areas. Integrating thermal and reflective surfaces in these areas can reduce heat gain and support HVAC efficiency.
Considerations • Common heavy equipment considerations: chillers, cooling towers, and generator exhausts. • Prevent leaks around conduits, ducts, and anchors with robust systems and detailing.
Maintenance access • Provide safe, non-invasive access for inspection and repairs to maintain roofing warranty eligibility. • Typical access points: walkways, roof hatches, and removable panels.

Anticipate Continuous Insulation

Continuous insulation (CI) promotes thermal stability and protects against minor temperature fluctuations that can impact equipment performance and cooling efficiency. Identify challenges to avoid interrupted thermal control.

Continuous Insulation

Implement uninterrupted thermal control
• Extend insulation continuously across below-grade, walls, and roof assemblies to prevent thermal breaks. • Identify minimum thermal resistance requirements. • Common thermal bridging challenges: slab-to-wall, wall-to-roof, penetrations, framing and cladding supports.

Design for Redundancy and Resilience

Integrated air, thermal, and water barriers maintain envelope continuity to protect sensitive equipment from moisture, temperature shifts, and air leakage to environmental stability, energy efficiency, and uptime.

Integrated Building Envelope Performance

Design resources
Understanding how air leakage, watertightness, thermal resistance, and protection against wind and fire can affect integrated building envelope performance is key to establishing a baseline for operational expectations. Refer to the data center design guide checklist for a list of integrated building envelope performance design resources.

Below Grade Waterproofing Systems

Define building use below grade
Categorizing below grade areas by building use helps define risk tolerance at specific locations within a building envelope. This allows designers to analyze waterproofing system types best suited by project specific area needs in addition to key considerations described in this section. • Clarifications including occupied space, unoccupied space, or vehicle use steer the conversation to system specific solutions.
Key considerations
Take note of site requirements that lead to common waterproofing challenges. Addressing site expectations during early design phases helps structural and waterproofing teams collaborate to maximize performance and avoid costly changes.

Common side conditions that require structural and waterproofing team collaboration:

- Underslab waterproofing, slab anchors, support of excavation (SOE), SOE retention anchors and tiebacks, rakers, walers, subbase considerations, site dewatering plan, and elevator pits.

Include waterstops and drainage strategies as an integrated waterproofing system solution.

Above Grade Waterproofing Systems

Define building use at deck(s)

Roof decks are typically associated with occupiable or high-traffic areas such as pedestrian zones, vehicular paths, solar panel installations, and vegetative roofs. Understanding how a deck interfaces with the building helps assess risk tolerance for the spaces below. For instance, decks over occupied areas often require higher performance standards than those over unoccupied spaces.

Refer to the roofing systems section of this guide for roofing system specific information.

Key considerations

- Common deck types: Cast-in place concrete and pre-cast concrete
- Provide minimum slope requirements to meet local building code. Contact Carlisle for flat deck applications.
- Common overburden types: Concrete, pavers, and traffic coatings
- Electronic leak detection (ELD) options: quality control (passive) or in-place systems (continuously monitored)

Integrated Wall Systems

Integrated wall system materials

Refer to the data center design guide checklist for common wall system components. Contact Carlisle for a complete list of NFPA 285 compliant wall assemblies.

Consider UV exposure limitations and extreme weather conditions during construction.

Roofing Systems

Define building use at roof(s)

Roofing systems are expected to perform far beyond weather protection. These critical areas are the first line of defense over entire building footprints. Careful consideration of roofing system types, thermal protection, and perimeter edge metal attributes depend on site location, wind speed calculations, and fire protection requirements.

Each decision leads to system specific solutions with real world implications. This is why many critical facilities rely on roofing design references and third-party testing. Refer to the integrated building envelope performance section of the data center design guide checklist for performance design resources.

Key considerations

- Common deck types: steel deck and gypsum roof deck board, structural concrete, steel deck and lightweight insulating concrete
- Provide minimum slope requirements to meet local building code.
- Tapered insulation over flat decks may be used to achieve thermal resistance and roof slope requirements.
- Deck level air and vapor barriers can lead to increased protection and continuous air tightness.
- Pavers may be utilized to protect high traffic maintenance areas.
- Electronic Leak Detection (ELD) options: quality control (passive) or in-place systems (continuously monitored)

Design Guide

Data Centers

Integrated Building Envelopes

Critical Tie-ins

Critical tie-in conditions

Coordinating critical tie-ins in architectural drawings for transition locations and assigning performance verification responsibilities in specifications helps identify potential site challenges. Understanding how systems interact with one another to avoid breaches in air, thermal resistance, and watertightness can be the difference between optimal performance protection and a leaking building envelope system.

Key considerations

- Waterproofing, roofing, and air barrier systems have expanded into a wide variety of technologies and applications. Work closely with product manufacturers to maintain awareness and up to date information.
- Be aware of chemical and adhesion compatibility concerns between materials or sequencing.
- Utilize manufacturer resources to verify standard installation practices and warranty eligibility requirements.
- Work with manufacturers to establish project specific details where standard conditions aren't suitable.

Coordinate Specifications for Integrated Performance

Coordinating critical tie-in responsibility and installation verification can be challenging when transitioning integrated wall assemblies to waterproofing and roofing because it involves multiple systems, trades, and scopes of work. The building envelope air, thermal, and moisture protection industry has grown into a network of building envelope solution providers. This allows design professionals to require manufacturers to take a hands-on approach and provide warrantable conditions at project specific critical areas.

Key Specification Sections

Common Division 01 General Requirements sections to coordinate performance goals

- Section 01 43 39 – Mockups
- Section 01 83 00 – Facility Shell Performance
- Section 01 91 00 – Commissioning

Division 03 Concrete and Division 07 Thermal and Moisture Protection

Refer to the data center design guide checklist for a complete list of typical system specific specification sections.

Specification Coordination Strategies

Section 01 35 13 – Special Project Procedures at Critical Tie-ins

Historically Section 01 35 13 serves as a coordination method for the administrative and procedural requirements for special project procedures. To align with integrated building envelope demands, offering 01 35 13 as a procedural guidance section at critical tie-ins is a natural next step.

This approach empowers designers to identify project specific areas where air and watertight warranty coverage at critical tie-ins matters most and assign responsibility to key players to meet building envelope performance goals.

Building Envelope System Manufacturers

- Provides compatibility warranties where two or more of their systems tie-in together to create a continuous thermal and moisture protection transition.

Owner's Representative or Building Envelope Consultant

- Maintains records related to the building envelope system compatibility warranty at critical tie-ins.

General Contractor

- Coordinates scopes of work and installations to meet building envelope performance requirements.
- Submits building envelope system compatibility warranty application to Building Envelope System Manufacturer.

Installer

- Installs systems in accordance with project specific specification section and manufacturer requirements.
- Refers to Section 01 35 13 for special project procedures at critical tie-in for coordination requirements.

Plan for Verification Compliance

Verifying performance is essential to reduce risk, support commissioning, and ensure long-term reliability. Understanding manufacturer and installer workmanship warranties at critical tie-ins is key to ensuring accountability and compliance.

Quality Assurance and Quality Control

Mockups

Construct mockups to verify project specific applications and set quality standards for materials and execution. Include transitions, moving joints, penetrations, flashings, and critical tie-ins as part of the mockup.

Site tests and inspections

- Verify substrates prior to installation
- Confirm critical tie-in warranty eligibility
- Conduct building envelope system integrity tests
- Inspect systems and tie-ins prior to covering work
- Include leak detection strategies