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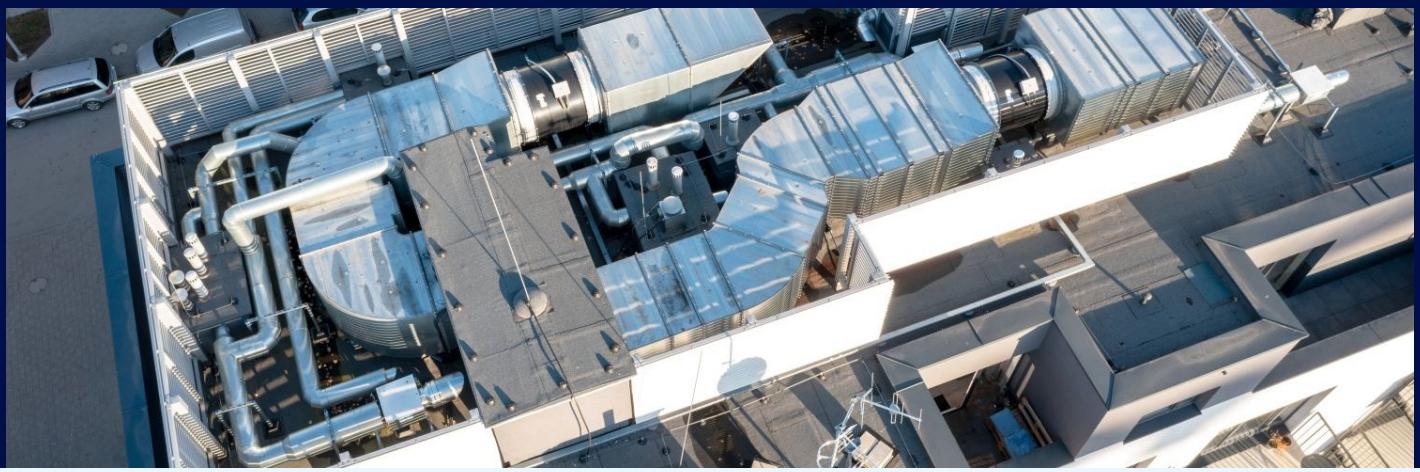
Rooftop equipment securement in high-wind regions



Introduction

Rooftop equipment failures are a recurring source of loss during hurricanes and other high-wind events. Post-storm investigations consistently show that improperly secured rooftop equipment have the potential to become wind-borne debris, puncture roof membranes, cause severe water intrusion, and lead to prolonged operational downtime. In high-wind regions, rooftop equipment should be designed, installed, and maintained to resist uplift, overturning, and lateral forces in accordance with recognized engineering standards and building codes.

This guide summarizes the best industry-accepted practices designed for securing rooftop equipment, drawing from FEMA recovery advisories, ASCE wind load provisions, the International Building Code (IBC), the Florida Building Code (FBC), and Miami-Dade County Approval (MDCA) product requirements.

Vulnerable locations:

- Facilities located in hurricane-prone regions (typically ASCE 7 basic wind speeds for Risk Category II exceeding 115 mph)
- Coastal properties and buildings exposed to open terrain or Exposure C/D
- Critical facilities (healthcare, emergency services, data centers)
- Buildings with large roof areas, low parapets, or lightweight roof systems
- Older buildings where equipment predates current wind design standards
- Facilities with frequent rooftop modifications or retrofits

Rooftop equipment examples:

The following are common types of rooftop-mounted equipment that should have the proper wind-rated securement. Each item should be evaluated for uplift, lateral, and overturning forces, with anchorage designed to transfer loads into the building's structural system.

- Exhaust fans and relief air hoods
- HVAC rooftop units (RTUs)
- Condensers (rooftop and elevated)
- Rooftop ductwork
- Boiler and exhaust stacks
- Natural gas piping, condensate drain lines, and electrical conduits
- Satellite dishes and communication antennas
- Lightning protection systems
- Equipment screens and mechanical penthouses
- Electrical service masts and supports

FEMA post-hurricane investigations repeatedly document failures across all of the above equipment types when securement is inadequate. Larger units and elevated frames generate increased overturning moments and uplift forces and therefore require engineered curbs and certified anchorage; lightweight, tall profiles are especially susceptible to uplift and detachment, which can lead to loss of emergency power and prolonged outages after wind events. Small-footprint equipment is frequently added without engineering review and may lack adequate anchorage, while unrestrained piping can fail progressively and damage roof penetrations. Systems should be designed and installed as an integrated assembly, incorporating racking, attachments, piping restraints, and the roof interface, and should account for additional wind loads imposed by screens and platforms on underlying equipment and anchors.

Areas of importance and considerations

- Wind uplift and overturning forces
  - Rooftop equipment is subject to uplift, lateral, and overturning forces, particularly at roof corners and perimeters where wind pressures are highest.
  - Equipment mass alone is typically not sufficient to resist wind loads.
- Anchorage and load path continuity
  - Securement must provide a continuous load path from the equipment to the roof structure.
  - Connections must be capable of transferring design wind loads without relying solely on roof membranes or insulation.
- Roof penetrations and water intrusion
  - Failed equipment often compromises flashing, curbs, and penetrations, resulting in significant interior damage even if the building structure remains intact.
- Design pressures
  - Coastal and hurricane-prone regions require enhanced securement measures to meet high wind area design pressures for a facility.
  - Design pressures vary based on location and other factors that an engineering professional may help determine to apply for the minimum recommended level of protection to a facility.
- Equipment age and modifications
  - Legacy installations may not meet current wind criteria.
  - Field modifications, replacements, or temporary installations often bypass engineered anchorage requirements.

What to do (best practices)

- Design and engineering
  - Ensure rooftop equipment is designed and anchored for site-specific design wind speeds in accordance with current building codes.
  - Use engineered equipment curbs, stands, and frames rated for uplift, shear, and overturning loads.
  - Verify anchorage calculations are sealed by a qualified design professional when required.
- Anchorage and fasteners
  - Secure equipment using mechanical fasteners, anchor bolts, or welded connections appropriate for the supporting structure (steel, concrete, or wood).
  - Use corrosion-resistant hardware suitable for exterior and coastal environments.
  - Ensure fastener size, embedment depth, and spacing meet design requirements.
- Equipment curbs and supports
  - Install equipment on code-compliant, mechanically attached curbs
    - not directly on roof membranes.
  - Ensure curbs are properly flashed and integrated into the roof system.
- Bracing and supplemental restraints
  - Provide lateral bracing or guying for taller or elevated equipment.
  - Secure associated components such as conduit, piping, and ductwork to prevent progressive failure.
- Inspection and maintenance
  - Conduct routine rooftop inspections, particularly before hurricane season.
  - Verify all fasteners, anchors, and restraints are intact, tight, and free of corrosion.
  - Document inspections and corrective actions.

What not to do and common failure modes and risks:

The following conditions frequently result in catastrophic rooftop failures.

- Relying on gravity, ballast, or adhesive-only attachment
- Fastening equipment only to roof membranes or insulation
- Using undersized or widely spaced fasteners
- Failing to secure access panels, fan cowlings, or enclosures
- Placing condensers on plastic pedestals without mechanical anchorage
- Ignoring corrosion, fatigue, or degraded fasteners
- Installing rooftop ductwork without wind-rated supports.

Improperly secured equipment can become wind-borne debris, puncture roofing systems, cause interior flooding, injure occupants, and significantly increase property loss and downtime.

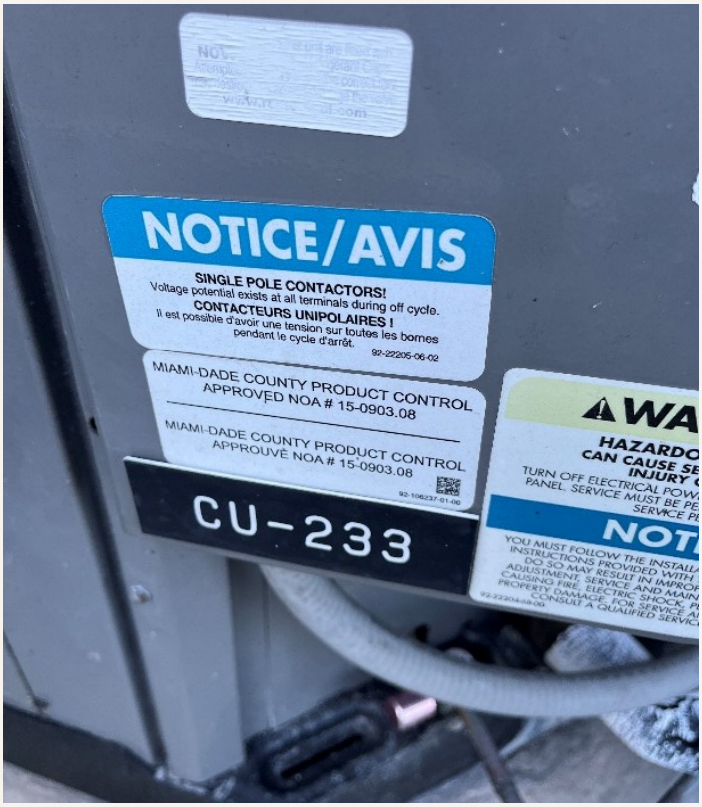
Immediate risk improvement securement:

Attachment of
op Equipment in

The following is an embedded FEMA rooftop equipment enhancement securement guide. Securing and enhancing roof top equipment using the FEMA guide may provide immediate solutions and improve conditions prior to hurricane season. A structural engineer should still be procured whenever possible to evaluate securement of roof top equipment.

- Use the above FEMA PDF Table 1 as a reference guide for the minimum securement considerations for your facility. Enhance as noted based on your site's windspeed if greater than Table 1 parameters (Table 1 References ASCE 7-2005 and should convert windspeed to ASCE 7-2022) and the importance of your facility's building envelope and occupancy.
- Immediately visually inspect all roof top equipment for any missing fasteners and replace. Where appropriate, enhance securement at a minimum per the attached FEMA PDF Table 1.
- Replace any missing roof top equipment fasteners with minimum ¼ in. diameter pan head corrosion resistant fasteners per FEMA PDF Table 1.
- For base unit to curb securement, provide attachment stainless steel strips, minimum 1 ¼ inch diameter, wide strapped along unit base and the unit curb with appropriate corrosion resistant fastener.
- Provide stainless steel minimum 1/8 inch diameter cable straps every 1.5 to 2 feet attached to the unit curb or the roof deck using UL listed or FM approved U-anchors and appropriately sealed. Larger equipment should use thicker minimum 3/16 inch diameter stainless steel cable straps. Nonmetal ratchet tie down straps such as polyester, although not best practice, may provide some seasonal short-term installation benefit if installation requirement need is short (immediate protection while awaiting better solution implementation). Nonmetal strapping deteriorates quickly over time.
- Any satellite dishes or very small loose equipment should ideally be removed. Ensure roof top unit areas are clear of debris and fasteners

Secured equipment examples:

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Miami-Dade County
Florida Product Approval
Texas Department of Insurance
Product Control Approved
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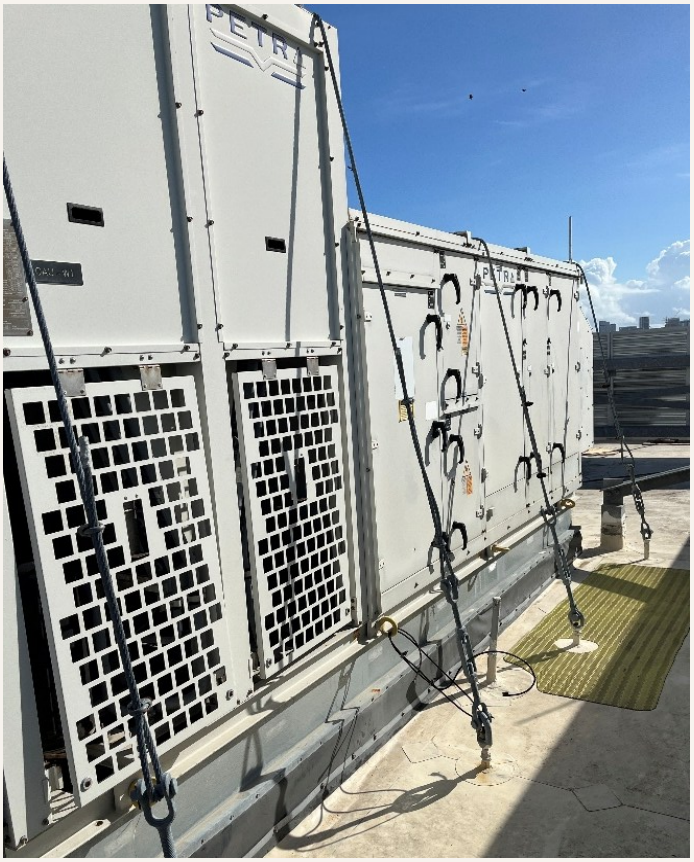
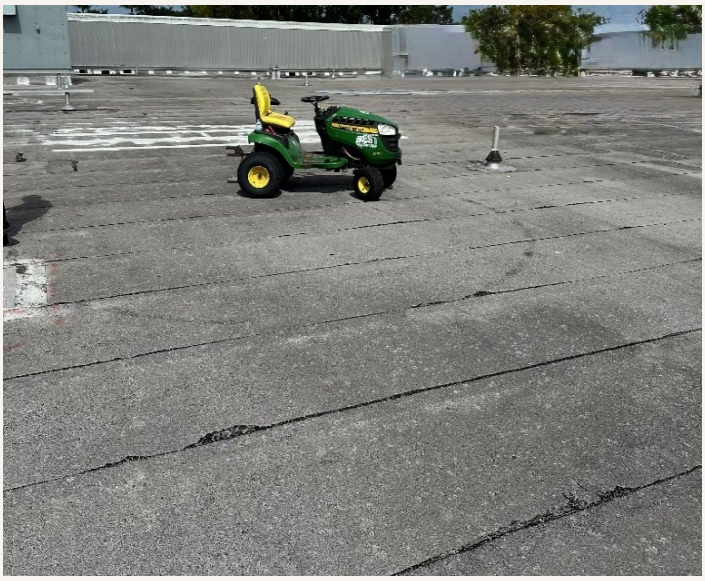


Examples of unsecured equipment



Who should perform the work?

- Licensed mechanical contractors for equipment installation and securement.
- Structural or professional engineers for wind load analysis, anchorage design, and retrofit solutions.
- Qualified roofing contractors for curb installation, flashing, and membrane integration.
- Facility management and risk engineering teams for inspections, documentation, and ongoing maintenance

All work should be performed in accordance with applicable codes and verified through inspection.

Supporting technical documentation:

Miami-Dade County: Notice of Acceptance (NOA) and product control:

Miami-Dade NOA certificates are among the most stringent regional approvals in the US, especially for construction products and rooftop equipment exposed to hurricane force winds

- Miami-Dade County issues NOAs showing that a specific product has been tested and approved for extreme wind loads typical of the High Velocity Hurricane Zone (HVHZ). These tests simulate wind pressures and performance so products can be installed in compliance with Miami-Dade and HVHZ region designated standards.
- An NOA, or compliance with wind loads outlined in the FBC, is required for rooftop equipment and support intended to resist hurricane wind loads in Miami-Dade and Broward Counties, including equipment stands, mechanical supports, ducts, screening, and certain HVAC components.
- Although NOAs are a Miami-Dade County program, they are widely accepted by building officials and designers statewide as evidence of compliance with Florida's high wind performance requirements.
- Miami-Dade maintains an online Product Control Search database where approved products, including rooftop mechanical supports, are listed with NOA file numbers and installation details.

Key takeaway: Rooftop equipment and attachments intended for use in HVHZ must carry valid Miami-Dade NOA certifications or equivalent evidence of wind load performance to be permitted and inspected

FBC

The Florida Building Code is the statewide regulatory framework for building design, including wind resistance requirements that apply to rooftop equipment support and securement.

Wind load and structural design

- The FBC incorporates ASCE 7 wind load standards for determining design wind pressures that all structural elements and attached equipment must resist. ASCE 7 is referenced throughout the FBC for wind load calculations applicable to rooftop assemblies and equipment support. See FBC 2023 (8th Edition) Section 1620.6 and Chapter 29 of ASCE 7.
- In HVHZ — which includes Miami-Dade and Broward counties — wind design speeds are the highest in the state (Miami-Dade Risk Category II example ~175 mph), and products must meet these more rigorous wind criteria.

Product approvals and testing

- FBC requires the use of approved products and assemblies for wind-resistance performance. These may include Florida Product Approval (state) or Miami-Dade NOA certifications demonstrating compliance with FBC wind and impact test standards (where applicable).
- Load-resisting systems for rooftop equipment must satisfy the FBC's structural design provisions (Chapter 16) and comply with testing standards reflected in product approvals.

Installation and securement

- Although FBC does not prescribe specific anchor types for every rooftop device, it requires that equipment and its fastening systems be designed to meet the wind loads from ASCE 7 and FBC sections on structural design, ensuring equipment remains secured under labeled design pressures.

What these codes mean for rooftop equipment securement:

- Use products and support equipment with validated wind resistance ratings under the FBC or Miami-Dade NOA system.
- Ensure rooftop equipment anchors and supports are designed to transmit ASCE 7 wind loads into the structure.
- For projects in Miami-Dade County (HVHZ), equipment must have NOA certification or engineer-sealed documentation showing wind performance compliance.
- At permitting, provide approved product documentation confirming that rooftop equipment, curbs, or support stands meet local wind design pressures.
- Following manufacturer specifications and installation instructions

References:

- FEMA – Hurricane Katrina Recovery Advisory (includes “Attachment of Rooftop Equipment in High-Wind Regions”)
- FEMA – Design Guide for Improving Critical Facility Safety from Flooding and High Winds (FEMA 543):
- FEMA – Hurricanes Irma and Maria in Puerto Rico MAT Report (references PR recovery advisories incl. rooftop equipment):
- International Building Code – Chapter 15 (Roof Assemblies and Rooftop Structures) (example: 2021 IBC Chapter 15 page):
- ASCE 7-22 – Chapter 29 (Rooftop Structures and Equipment):
- FM Data Sheets 1-15, 1-28, 1-29, 1-52
- SPRI – Rooftop Equipment Attachment White Paper (PDF)

Summary:

Rooftop equipment failures are mitigatable when wind loads are properly calculated, and equipment is anchored using engineered, code-compliant methods. Securement requires more than fastening equipment to curbs, it demands a continuous load path, appropriate hardware, supplemental restraint where necessary, and adherence to FEMA, ASCE, IBC, FBC, and Miami-Dade County standards. Proactive evaluation and retrofit of rooftop equipment significantly reduce wind-related losses, better protect building envelopes, and improve post-storm resilience

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