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Evaluating Existing Curtain Walls for Modern Wind Hazards

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Closing the Resilience Gap: Evaluating Existing Curtain Walls for Modern Wind Hazards

Essential facilities—including hospitals, emergency operations centers, government buildings, and public safety infrastructure—are expected to remain operational during and after extreme weather events. There are numerous essential facilities across the country with curtain wall systems that have been in service for over 50 years, many of which have not been proactively maintained. Furthermore, the structural and waterproofing components of these curtain walls have experienced age-related deterioration over time. While many of these systems have generally performed well throughout their service lives, they were designed using historical wind loading requirements that differ substantially from those used today.

Over the past several decades, both the built environment and the natural environment have evolved. Modern building codes require higher wind loads and additional windborne debris impact protection for many structures, while severe weather events have become both more frequent and increasingly disruptive across many regions of the United States. Together, these trends create new challenges for existing curtain wall systems that were engineered using earlier less stringent design standards.

Extreme Weather Trends

Extreme weather events continue to increase the demands placed on building enclosure systems throughout the United States. According to the National Oceanic and Atmospheric Administration (NOAA), thousands of severe weather events—including tornadoes, damaging straight-line winds, and hailstorms—occur annually across the southern United States. Thunderstorm wind events account for the majority of reported severe weather activity. According to the NOAA National Climate Report for 2025, there were approximately 5,148 severe weather reports throughout the South region of the United States; 299 tornado reports, 1,812 hail reports, and 3,037 severe wind reports. There were 4,408 severe weather reports across the Southeast region during 2025, which is over 143 percent of the median annual frequency of 3,089 reports during 2000–2024. Thunderstorm related winds accounted for about 86 percent of the severe weather reports.

Looking at the trends for weather events for the United States as a whole, there is a general positive shift of increased precipitation per NOAA weather data collected from 1960 to 2025 (Figure 1). Overall, the data collected by NOAA regarding tropical storm extreme shows a varying spread from 1910 to 2025 (Figure 2).

Contiguous U.S. Extremes in 1-Day Precipitation (Step 4)

Annual (January-December)

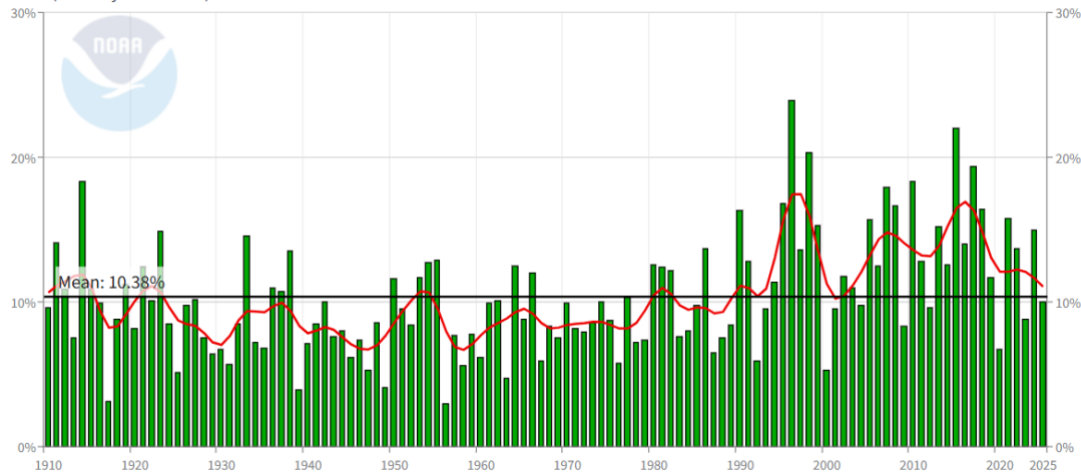


Figure 1: NOAA Precipitation Extremes in U.S. from 1910 to 2025 ^{Note 1}

Source: National Oceanic and Atmospheric Administration (NOAA)

Contiguous U.S. Extremes in Landfalling Tropical Systems (Step 6)

Annual (January-December)

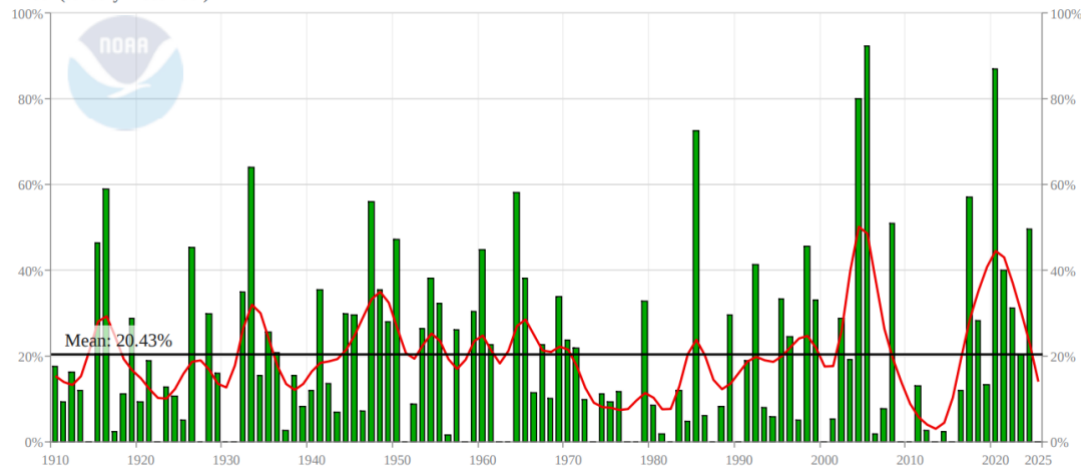


Figure 2: NOAA Landfalling Tropical Storm Extremes in U.S. from 1910 to 2025 ^{Note 1}

Source: National Oceanic and Atmospheric Administration (NOAA)

Notes:

1. The index is calculated as the arithmetic average of values from a specified set of extreme events, weighted by the percent area that experienced the defined conditions. The long-term variation or change of this index represents the tendency for extremes of climate to either decrease, increase, or remain the same.

For essential facility owners and asset managers, these trends highlight the importance of evaluating whether existing building envelope systems remain capable of providing the level of functional performance expected during the modern era of extreme weather events.

Evolution of Wind Design Standards

For most of the 1900s, there were three predominant building codes in the United States, that each focused on the geographical concerns of their associated regions. These codes were the Basic National Building Code, Standard Building Code, and Uniform Building Code. The first consensus wind load design criteria were published in ANSI A58.1-1972 by the American National Standard Institute (ANSI) in 1972.

Prior to the adoption of ANSI A58.1 in 1972, wind loading provisions varied considerably among regional building codes. Buildings constructed before this period were frequently designed for substantially lower wind pressures than those required by today's standards. Since then, advances in wind engineering research have resulted in progressively refined and more accurate design methodologies, culminating in the ASCE 7, Minimum Design Loads for Buildings and Other Structures, consensus standard provisions referenced by the current International Building Code.

Houston, Texas provides a useful example of this evolution. Before statewide adoption of the International Building Code, municipalities generally relied on earlier editions of the Uniform Building Code. As design standards evolved, required wind pressures for exterior wall components increased considerably.

Table 1 compares representative exterior wall design negative wind pressures for a 150-foot-tall essential facility in Houston under various historical design standards.

Design Standard	Year Published	Wind Pressure (PSF)
1958 UBC	1958	-20
1970 UBC	1970	-55
ANSI A58.1-1972	1972	-35 (Interior) / -75 (Corner)
ASCE 7-05	2005	-43 (Interior) / -79 (Corner)
ASCE 7-10	2012	-44(Interior) / -80 (Corner)
ASCE 7-16	2016	-44(Interior) / -80 (Corner)
ASCE 7-22	2022	-43(Interior) / -79 (Corner)

Table 1: Negative Wind Pressure Comparison based on historic codes and standards for a 150-foot tall essential facility building located in Houston, Texas

Notes:

1. All wind pressures shown as ASD. For purposes of comparison, the wind pressure shown for ASCE 7-10 and ASCE 7-16 were translated from LRFD to ASD values.
2. All wind pressures shown are leeward wind pressures.

The wind pressure analysis shown in Table 1 is based on a 150-ft tall essential facility building in Houston, Texas, utilizing Exposure Category C, where applicable. The reference exterior wall component, for the wind pressure comparison example summarized in Figure 1, is a 55-inch x 55-inch window glazing panel, as shown in Figure 3.



Figure 3: Example of glazing panels analysed for the comparative wind load analyses based on the historical building code evolution as shown in Table 1

While the specific values vary depending on building geometry, geographic area, and whether the component is located in an interior or corner zone, curtain wall systems designed before ANSI A58.1 were generally designed for wind load demands that can be up to approximately 4x lower than those required by modern consensus standards and building code requirements. In addition to higher wind loads, modern codes now include windborne debris impact requirements for specific types of buildings located within hurricane-prone regions.

The Resilience Gap for Existing Curtain Wall Systems

The increasing severity of weather events, combined with more rigorous modern design standards and building code requirements, creates a resilience gap for many existing buildings. This does not necessarily indicate that pre-1972 curtain wall systems are unsafe. Rather, it reflects that the environmental hazards and performance expectations have changed since these systems were originally engineered and constructed.

During a code-level wind event, curtain wall systems designed using historic criteria may experience demands that approach or exceed their original design capacity. If localized glazing failures occur due to elevated wind pressures or windborne debris, internal building pressures increase significantly as the building transitions from an enclosed condition to a partially enclosed condition. This pressure amplification increases loading on the remaining curtain wall system and may contribute to progressive glazing failures across the building envelope.

For essential facilities, these failures extend beyond the façade itself. Loss of units can allow wind-driven rain to enter occupied spaces, damage critical equipment, interrupt clinical or emergency operations, and require portions of the facility to be temporarily evacuated or closed. In these cases, operational disruption may represent a greater consequence than the physical damage to the curtain wall.

Although changing hazard levels represent the primary driver for evaluation, the existing condition of the curtain wall should also be considered. Components such as gaskets and sealants naturally require periodic replacement throughout the service life of the system. Figure 3 provides an example of a deteriorated gasket on an aged curtain wall system. Deferred maintenance may further reduce system performance during severe weather events and should be addressed as part of any resilience assessment.



Figure 3: Example of gasket cracking deterioration at a 1965 curtain wall system

Critical infrastructure asset Owners and their trusted consulting partners have the opportunity to get ahead of future potential failures by preparing our aged curtainwall systems for more powerful extreme weather events that seem to be occurring at a greater frequency. It is critical that these curtainwall systems be evaluated to determine the need for possible retrofits to mitigate potential

operational disruptions now rather than when it is too late. These evaluations also allow essential facility Owners to proactively program these retrofits and allocate necessary budgetary resources to provide a structured pathway to maintain and restore these critical curtain wall systems.

REFERENCES

1. “National Climate Report - Annual 2025 | State of the Climate | National Centers for Environmental Information (NCEI).”. NOAA, <https://www.ncei.noaa.gov/access/monitoring/monthly-report/national/202513#ann-extremes>.
2. “U.S. Climate Extremes Index (CEI) | Extremes | National Centers for Environmental Information (NCEI).” NOAA, <https://www.ncei.noaa.gov/access/monitoring/cei/graph/us>.