TESTIMONY TO THE

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SUBCOMMITTEES ON RESEARCH AND TECHNOLOGY AND ENVIRONMENT

"CALM BEFORE THE STORM: REAUTHORIZING THE NATIONAL WINDSTORM IMPACT REDUCTION PROGRAM"

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A Multi-Pronged Approach to Safe and Resilient Buildings and Communities

Model Building Codes and the International Code Council

Safe and resilient buildings and communities rely on a robust, coordinated system to which the International Code Council and the Alliance for National & Community Resilience (ANCR) are important contributors.

The International Code Council is a non-governmental organization, driven by the engagement of 65,000 members, that is dedicated to helping communities and the building industry provide safe, resilient, and sustainable construction through the development and use of model codes (I-Codes) and standards used in design, construction, and compliance processes. All 50 states, federal agencies, and many global markets choose the I-Codes to set the standards for regulating construction and major renovations, plumbing and sanitation, fire prevention, and energy conservation in the built environment.

The Code Council's model building codes are national "voluntary consensus standards" under Office of Management and Budget (OMB) *Circular A-119: Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment*

Activities and the *National Technology Transfer Advancement Act* (NTTAA), meaning they are developed in an open forum—with a balance of interests represented and due process—that, ultimately, ensures a consensus outcome. Federal agencies (including the Federal Emergency Management Agency (FEMA), National Institute of Standards and technology (NIST) and the Environmental Protection Agency (EPA)), communities, structural engineers and architects, members of the construction industry, and the fire services are active participants in the code development process, ensuring the final consensus result balances cost, safety, and other public interest considerations.

State and local governments adopt, amend, and enforce model building codes to advance policy goals and to ensure the health, safety, and welfare of their residents. The NTTAA directs federal agencies and departments to adopt voluntary consensus standards wherever possible (avoiding development of unique government standards) and use such standards to carry out activities and policy objectives. This system of code development has provided the citizens of the U.S. the highest level of building safety in the world for more than 80 years.

The I-Codes are widely utilized and supported at the federal, state, and local levels. All 50 states use the International Building Code (IBC) as the basis for commercial and multifamily housing construction and safety regulation. The International Residential Code (IRC) is in use or adopted in 49 states. The General Services Administration (GSA) requires the I-Codes for civilian governmental buildings[1] and the Department of Defense (DOD) requires the IBC and IRC for all U.S. military bases.[2] Federal agencies and federally supported research feature prominently in the code development process, including several provisions governing resilience against wind hazards that the National Windstorm Impact Reduction Program (NWIRP) has supported. The IBC, IRC, and the other I-Codes are updated on a three-year cycle to allow the capture of new research and technologies.

[1] GSA, *Facilities Standards for Public Buildings Service* ("GSA P-100") (July 2018).
[2] DOD, *Unified Facilities Criteria, DoD Building Code (General Building Requirements)* (Nov. 2018).

The IBC and IRC include numerous provisions to mitigate homes against high wind risk, by requiring:

- Enhanced nailing patterns (more nails and closer spacing) to ensure roof decks (under shingles) are adequately attached to roof trusses;
- Strengthened connections from the roof to walls to the foundation to keep roofs from blowing off, walls from collapsing, or houses from sliding off their foundations;
- Glazing or coverings like shutters for windows, doors, and other openings like garage doors, so that windborne debris and other projectiles cannot break glass or push in the doors, etc., when under pressure from high wind forces;
- Wind resistance for roof coverings (shingles, tile, etc.) and proper installation methods (ring-shank nails or screws); and
- Tornado shelters in new K-12 schools and emergency responder facilities in the most tornado prone areas.[3]

The Code Council has also codeveloped the *ICC/National Storm Shelter Association (NSSA) Standard 500: Standard for the Design and Construction of Storm Shelters* and developed the *ICC Standard 600: Standard for Residential Construction in High-Wind Regions*, which provides prescriptive requirements for the design and construction of residential structures in high-wind regions that go beyond the requirements within the base residential code. Standard 600 is currently being updated in cooperation with the Insurance Institute for Business and Home Safety (IBHS) to address windstorm and other hazards.

In addition to the model codes, the Code Council provides a family of solutions to state and local governments to support their resilience goals. These solutions include training and certification on codes and standards, product testing and evaluation of compliance with codes and standards, accreditation services for product evaluators and resilience benchmarks.

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[3] FLASH. *Why Americans Aren't Concerned About Building Codes (even though they should be)*. June 2019. http://newsroom.flash.org/commentary/why-americans-arent-concerned-about-building-codes-even-though-they-should-be.htm.

Federal Research in Support of Model Building Codes

Federal agencies and federally supported research feature prominently in the code development process. Federal contributions through the National Earthquake Hazard Reduction Program (NEHRP) and energy efficiency provisions through the Department of Energy (DOE) are summarized below. Wind hazard-specific activities under NWIRP are described in the Notable Success under NWIRP section.

Like NWIRP, NEHRP brings relevant agencies together to support research and the development of criteria to mitigate a hazard risk—in this case earthquakes. Initially established by the Earthquake Hazards Reduction Act of 1977 (P.L. 95-124), NEHRP has grown into a mature, well-coordinated, robust program. A key component of the Program is the development of the *NEHRP Recommended Seismic Provisions for New Buildings and Other Structures*. The *Provisions* are developed through a consensus process that brings together seismic researchers, structural engineers and other stakeholders to translate the latest findings into design guidance that reduces risk. During this process, additional research needs are identified and brought back to the NEHRP agencies for potential funding. The *Provisions* are used as the primary resource for the professional design standard *ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures*. The 2009 edition of the *Provisions*, FEMA P-750, was largely adopted in ASCE/SEI 7-10. The 2015 edition of the *Provisions*, FEMA P-1050, has been similarly adopted in ASCE/SEI 7-16. ASCE/SEI 7 is incorporated into the International Building Code, the International Residential Code and the International Existing Building Code. Such a process could be effective for the development and implementation of future wind provisions in the I-Codes.

The Code Council also develops the International Energy Conservation Code (IECC), which provides for the energy efficient construction of residential and commercial buildings. The DOE Building Technologies Office (BTO) supports the development and implementation of building energy codes, like the IECC, by providing technical assistance for code development, adoption, and compliance. BTO coordinates with stakeholders to improve model energy codes and

provides technical assistance to states implementing updated energy codes. The purpose of BTO's dedicated Building Energy Codes Program (BCEP) is to "improve building energy efficiency, and to help states achieve maximum savings" by "advancing building codes." BECP, supported by Pacific Northwest National Laboratory, evaluates each new edition of model energy codes to determine energy savings compared to prior versions. This determination triggers a requirement for states to evaluate their current energy code and provide a certification to the DOE Secretary that for commercial buildings they have updated their codes to meet or exceed the updated edition and for residential buildings that they have made a determination as to whether it is appropriate to revise their code to meet or exceed the updated edition.[4] The BECP has also previously proposed code changes to the IECC based on findings from the national labs.

Solutions to Support Community Resilience Goals

The Alliance for National & Community Resilience (ANCR), a cooperative effort of the International Code Council, U.S. Resiliency Council and the Meridian Institute, was born out of the recognition that communities are only as resilient as their weakest link. While building codes are a necessary component of a community's resilience strategy, additional policies and procedures must be in place. Communities function as a complex, interconnected system of systems. Individual systems rarely operate in isolation from one another.

ANCR aims to provide the information that communities need to understand and benchmark their current level of resiliency, identify and understand options available to fill gaps and increase resiliency, and to understand the future benefits to be gained by investing in advance of the next hazard event.

ANCR identified 19 community functions that influence community resilience. These functions cut across the social, organizational and infrastructural aspects of communities. The 19 community functions are captured in Figure 1. The Community Resilience Benchmarks (CRB) system will include benchmarks for the 19 community functions and will provide communities

[4] 42 U.S.C. § 6833.

with a coordinated, comprehensive tool to help facilitate decision making. Businesses and people can also utilize the tool to decide where to invest and where to live.

ANCR's first benchmark, released in January 2019, examines building-related activities.[5] The safety, sustainability and resilience of a community's building stock has a direct correlation to the community's overall resilience. The Buildings Benchmark focuses on the regulatory aspects of assuring the safety and resilience of the physical structures. Building code adoption and enforcement feature prominently in the Buildings Benchmark.

Tackling another resilience challenge before communities, ANCR developed its Housing Benchmark to cover policies associated with the availability and affordability of housing and the associated socio-economic factors.[6] The Housing Benchmark clearly establishes the interconnection between housing affordability and availability and the resilience of buildings. Disasters tend to hit low- and moderate-income families the hardest.[7] Policies seeking to promote affordable housing must ensure the creation and preservation of homes that minimize impacts to their residents and their property from natural hazards.

The ANCR benchmarks are being developed by a team of subject matter experts (SMEs) in each of the functional areas. Where practical, the benchmarks utilize existing standards and guidance to support broad applicability and ease of use. ANCR benchmarks rely on research from programs like NWIRP and the codes and standards the research supports to allow consistent and meaningful evaluations. For example, ANCR is currently assembling subject matter experts to complete its next benchmark—the Water Benchmark. The Water Benchmark will examine a community's potable water, waste water and stormwater management infrastructure and practices. Stormwater management practices are captured in building codes and other policies—resources that are developed based on understanding the impacts from windstorms such as hurricanes, thunder storms and derechos.

[5] https://iccsafe.realmagnet.land/190110-ancr-download
[6] http://media.iccsafe.org/2016_MarComm/16-13282_GR_ANCR_Website/pdf/ANCR_Merged_2.pdf
[7] SAMHSA. Greater Impact: How Disasters Affect People of Low Socioeconomic Status. July 2017.

Through its holistic approach to community resilience and the recognition of fundamental mitigation practices like building codes, ANCR is bringing research and application to the fore in a manageable way.

Figure 1: ANCR Community Functions

The Importance of Addressing Windstorm Risks

Every state is exposed to hazards from one or more windstorm type—tornadoes, tropical cyclones/hurricanes, thunderstorms, nor'easters, winter storms and mountain downslope winds.[8] From 1980 through 2017, windstorms caused over $1 trillion in economic losses and

[8] NWIRP. Strategic Plan for the National Windstorm Impact Reduction Program. September 2018. https://www.nist.gov/system/files/documents/2018/09/24/nwirp_strategic_plan.pdf.

caused over 5,000 fatalities. In 2018 alone, wind-related storms caused approximately $65 billion in damage and 142 deaths.[9]

Over the last ten years tornadoes impacted an average of 23 schools annually. Wind and flood events represent the greatest number of Presidential disaster declarations.[10]

Tropical Storms and Hurricanes

Hurricanes primarily impact states along the Atlantic Ocean and Gulf of Mexico as well as Hawaii and territories in the Caribbean and the Pacific. Recent hurricanes and tropical storms including Harvey ($125 billion estimated damage), Maria ($90 billion), Irma ($50 billion),

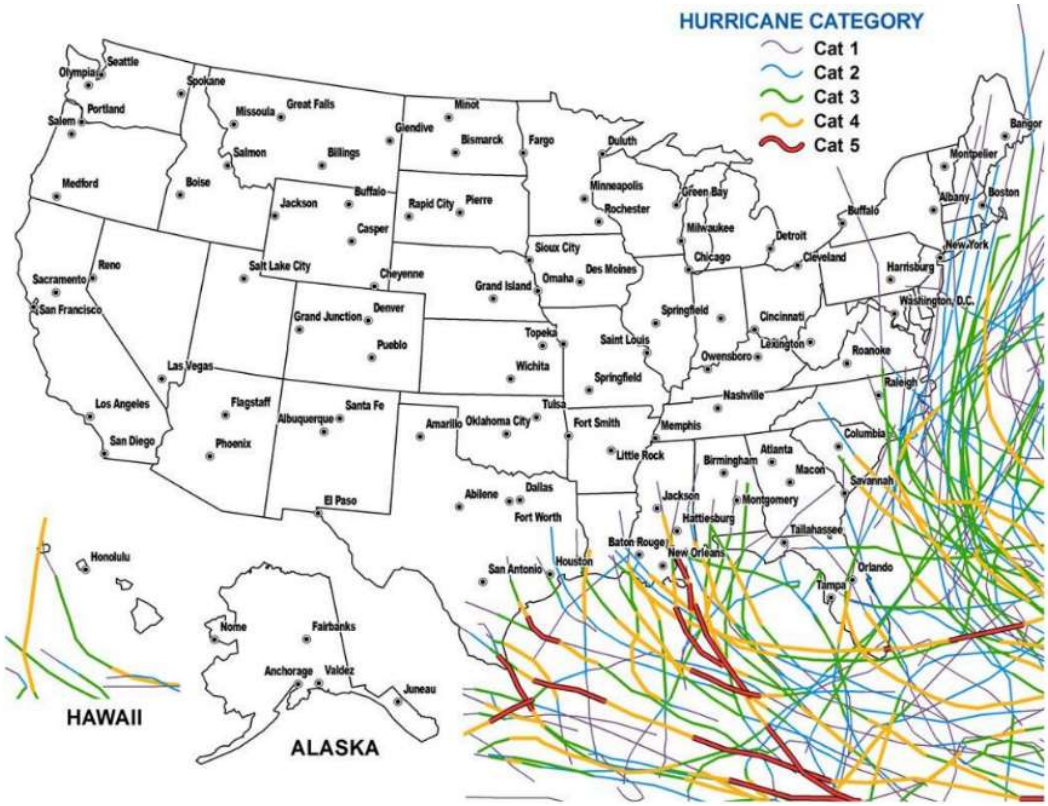

Figure 2: Hurricane tracks from 1950 to 2014 mapped by intensity (NWIRP Strategic Plan)

[9] https://www.ncdc.noaa.gov/billions/overview

[10] Congressional Research Service. Stafford Act Declarations 1953-2016: Trends, Analyses, and Implications for Congress. August 28, 2017.

Michael ($25 billion), Sandy ($70 billion) and Katrina ($150 billion and over 1,200 fatalities) have been embedded into the American story.[11]

Tornadoes and Thunderstorms

While tornadoes are possible in every state, the vast majority have been concentrated from the Continental Divide to the east coast. Over the last ten years, tornadoes have caused an average loss of over $10 billion per year. According to Property Claim Services (PCS®), tornadoes accounted for 40 percent of inflation-adjusted insured catastrophe losses from 1997 to 2016. In 2018 insured losses from U.S. tornadoes and thunderstorms totaled $14.1 billion, down from

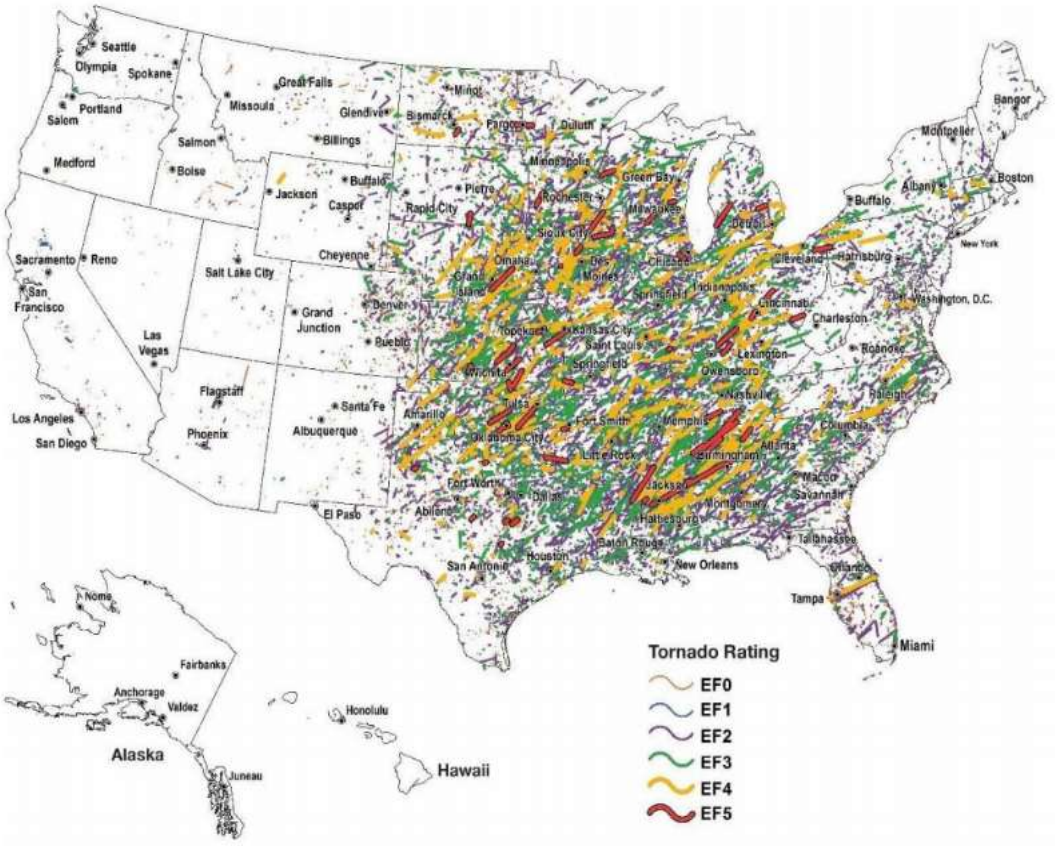

Figure 3: Tornado tracks from 1950 to 2014 mapped by intensity (NWIRP Strategic Plan)

[11] NWIRP. Strategic Plan for the National Windstorm Impact Reduction Program. September 2018. https://www.nist.gov/system/files/documents/2018/09/24/nwirp_strategic_plan.pdf.

$18 billion in 2017. According to Munich Re, 56 severe thunderstorm events occurred in 2018 resulting in 66 fatalities and approximately $18.8 billion in losses.[12]

The number of tornadoes fell to 1,124 in 2018 from 1,429 in 2017, according to the National Oceanic and Atmospheric Administration (NOAA). The 2017 total was the highest since 2011, when there were 1,691 tornadoes, including two spring events that resulted in more than $14 billion in losses. There were 10 direct fatalities from tornadoes in 2018, compared with 35 in 2017, according to NOAA.

Preliminary NOAA reports show there were 1,431 tornadoes in 2019 through November compared to 1,060 for the same period in 2018. Tornadoes killed 38 people from January to November 2019, compared with nine people for the same period in 2018. [13]

Responding to the Risks

Research Support for Mitigation

Fortunately, there are strategies to help the nation mitigate windstorm risks. The Congressionally established National Institute of Building Sciences (NIBS) examined various mitigation strategies to determine their cost effectiveness. In its *Natural Hazard Mitigation*

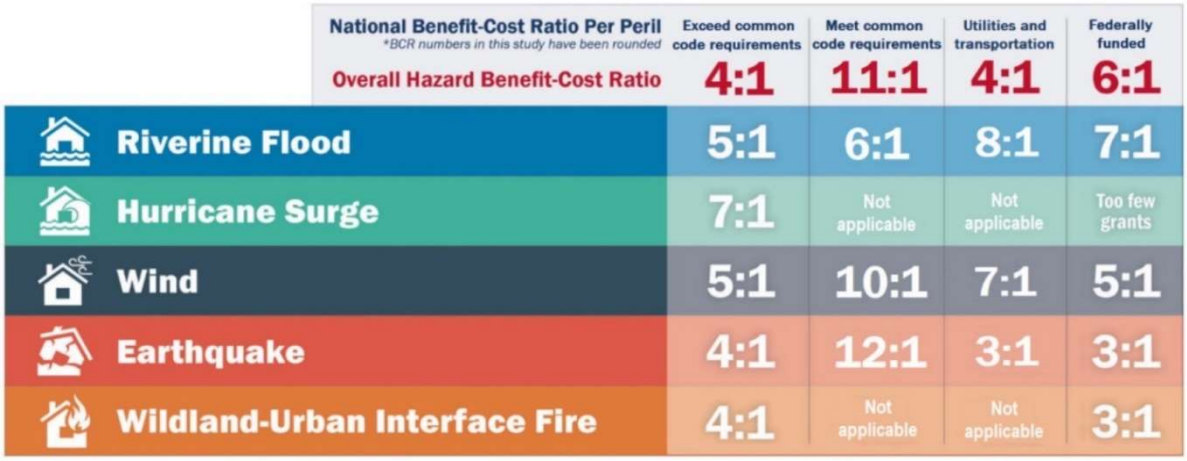

Figure 4: National benefit-cost ratios of hazard mitigation (NIBS 2019)

[12] Insurance Information Institute. Facts + Statistics: Tornadoes and Thunderstorms. Accessed December 2, 2019. https://www.iii.org/fact-statistic/facts-statistics-tornadoes-and-thunderstorms.
[13] Ibid.

Saves 2019 Interim Report, NIBS found that adopting the 2018 editions of the International Building Code and International Residential Code provided $10 in mitigation benefits against hurricane winds per $1 invested.[14] Unfortunately, communities that have not updated to the 2018 codes have not captured the full benefit, leaving highly cost-effective mitigation practices on the table. Federal mitigation programs offered by FEMA, the Economic Development Administration (EDA) and the Department of Housing and Urban Development (HUD) generated $5 in mitigation savings against hurricane winds for every dollar invested. Unfortunately, due to the lack of adequate mapping of tornado risk, researchers were unable to conduct a similar analysis for tornado mitigation strategies (although tornado risk maps are being developed under the NWIRP program).

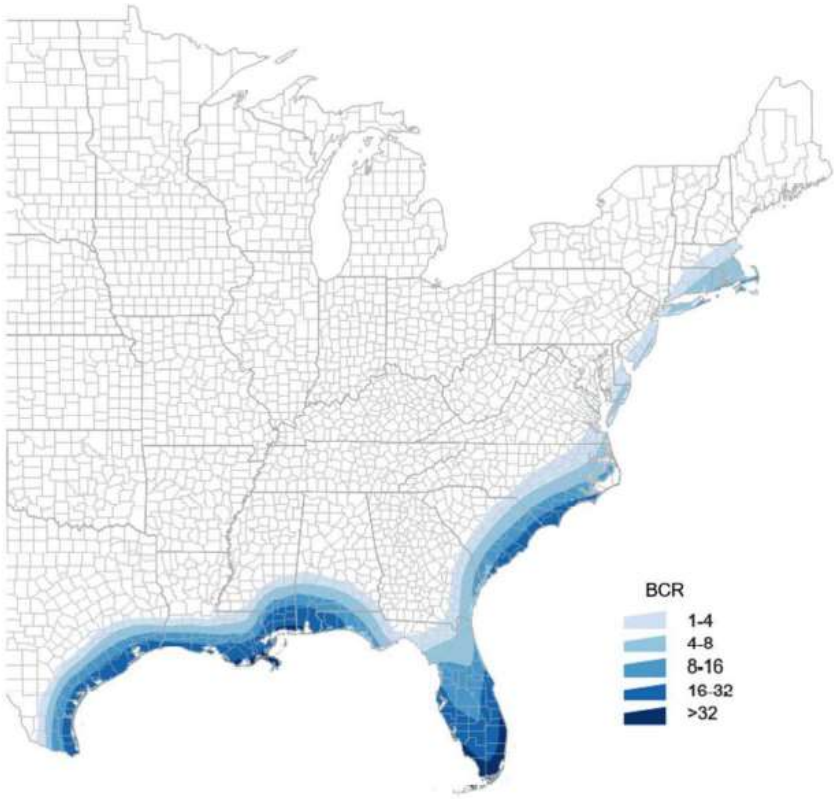

Figure 5: Benefit cost ratio of hurricane wind mitigation through compliance with the 2018 IRC and IBC (by wind band) relative to 1990 requirements. (NIBS 2019)

[14] http://www.nibs.org/mitigationsaves.

Other studies have examined the benefits of building codes in reducing the impacts of hazard events (many of them with strong wind components). A FEMA analysis from 2014 estimated approximately $500 million in annualized loss avoided in eight southeastern states due to the adoption of modern building codes.[15] In the eight years following Florida's adoption of a statewide building code, the code's adoption and application reduced windstorm actual losses by as much as 72 percent.[16] Effective and well-enforced building codes in Missouri reduced hail damage to homes by 10 to 20 percent on average.[17]

Investing in the application of existing mitigation tools like codes and standards is incredibly cost effective and reduces the burden on taxpayers and the federal treasury during disaster response and recovery while also minimizing casualties and property damage from these devastating events. NWIRP supported efforts to bring research to practice will produce new strategies for hazard mitigation that continue to bring down risk and add to the economic case for proactive efforts to reduce the impacts of windstorms.

Variability in Code Adoption and Federal Support Efforts

States and localities are responsible for the adoption of building codes and must adopt model codes for those codes to have effect. Communities amend model codes and utilize different code vintages. The corresponding heterogeneity in building requirements has consequences for our national resilience. According to FEMA, despite the benefits modern codes provide, more than two-thirds of communities facing damaging wind, hurricane, tornado, seismic, or flood hazards have not adopted disaster-resistant codes.[18] Modern building codes require storm shelters for schools in tornado prone regions. Yet of the 21 states that regularly face tornado risk, only about a third require tornado shelters for schools.

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[15] FEMA, Phase 3 National Methodology and Phase 2 Regional Study Losses Avoided as a Result of Adopting and Enforcing Hazard-Resistant Building Codes (2014).

[16] Simmons, K.M., et. al., Economic Effectiveness of Implementing a Statewide Building Code: The Case of Florida, Land Economics (2018).

[17] Czajkowski, J. & Simmons, K., *Convective Storm Vulnerability: Quantifying the Role of Effective and Well-Enforced Building Codes in Minimizing Missouri Hail Property Damage*, Land Economics (2014).

[18] Mitigation Framework Leadership Group, *National Mitigation Investment Strategy* (Aug. 2019). "Disaster-resistant codes" is defined as the two most recently published editions of the IRC and IBC.

Based on the variation in community resilience nationally, NIBS research, the recognition that continued federal post-disaster recovery funding is not sustainable and other factors, Congress and relevant federal agencies have undertaken efforts to shift the focus to pre-disaster investments. Many of these efforts rely on building codes as a strong component.

Recognizing modern model building codes' implications for disaster mitigation and the stewardship of federal post-disaster recovery expenditures, FEMA's strategic plan stresses: "[d]isaster resilience starts with building codes, because they enhance public safety and property protection." In the Plan's very first objective, FEMA highlighted the importance of the Agency's "advocate[ing] for the adoption and enforcement of modern building and property codes."[19] FEMA has deemed adherence to current model codes to be so important that it will not fund rebuilding of public facilities post-disaster if that construction would otherwise be built to outdated standards.[20] State and local adoption of up to date building codes is a budgetary performance metric for the Agency.

Congress shares FEMA's position. Twice last year Congress passed, and the President signed into law, measures that incentivize the adoption and application of modern model building codes through enhanced federal cost shares for post disaster rebuilding, new grants for states and localities both pre- and post-disaster and by making pre-disaster mitigation grant applicants more competitive based on their adoption of up to date model codes.[21]

Requiring adherence to current building codes through federal programs tracks the just released National Mitigation Investment Strategy (NMIS). The NMIS, released by the FEMA-chaired Mitigation Framework Leadership Group (MitFLG), presents a unified national strategy on mitigation investment that reduces risks posed by natural hazards and increases the nation's resilience to disasters. The MitFLG is composed of 14 federal agencies and departments as well as state, tribal and local officials and is charged with coordinating the strategy's implementation. One of the most critical recommendations in the strategy is "[u]p-to-date

[19] FEMA's 2018-2022 Strategic Plan (2018).
[20] Public Assistance Program and Policy Guide, FP 104-009-2 (2018).
[21] Disaster Recovery Reform Act of 2018 (within the Federal Aviation Administration Reauthorization Act of 2018, P.L. 115-254) and the Bipartisan Budget Act of 2018 (P.L. 115-123)

building codes and standard criteria should be required in federal and state grants and programs."[22]

The impact of investments made under NWIRP in advancing criteria in codes and standards can be amplified through the federal investments already being made in encouraging code adoption and enforcement. Without a concerted effort to advance wind provisions, such a multiplying effect is lost.

Notable Successes under NWIRP

With the limited funding available to date, NWIRP has fostered several notable successes in advancing wind hazard mitigation.

NWIRP's collaborative focus encouraged the creation of FEMA publications P-320 and P-361, which captured the latest science on the design and construction of storm shelters to protect building occupants in a tornado or hurricane, and which served as precursors to the subsequent *ICC/NSSA Standard 500: Standard for the Design and Construction of Storm Shelters*. This standard was voluntary within the 2009 IBC, but with the support of the NWIRP agencies and risk data they brought to bear, beginning in 2015 the IBC has required that new K-12 schools and emergency responder facilities in the most tornado prone areas include storm shelters compliant with ICC/NSSA Standard 500. FEMA's hazard mitigation grant programs recommend funding storm shelter construction, which also generates some of the greatest benefit-cost analyses (BCAs) under the Agency's BCA tool. The greatest success achieved by this joint effort: there have been no fatalities in properly designed and constructed safe rooms.

A second notable success is the current effort by NIST and NOAA to develop a standard on how to measure tornado wind speeds. As an extension of these efforts, NIST is developing tornado risk maps and associated building design procedures that will ultimately be incorporated into codes and standards to better scope building resilience requirements to risk profiles. These design procedures will be the first tornado design procedures developed worldwide. This

[22] https://www.fema.gov/national-mitigation-investment-strategy.

project was initiated following the Joplin, Missouri tornado of 2011. These maps have the potential to unlock opportunities for additional research into specific design measures and benefit cost analysis. This includes an examination by NIBS to determine the cost effectiveness of mitigation measures against tornado risk.

Additional updates to codes and standards made by the NWIRP agencies have been successful, including the development of new design wind speed maps that have been incorporated into the 2018 IRC and IBC that dictate minimum structural design to mitigate against wind risk by geography. Following Hurricane Maria, as Puerto Rico worked to update to the 2018 I-Codes, FEMA, NOAA and NIST collaborated under NWIRP to incorporate updated local wind maps for Puerto Rico's new code.

NWIRP Funding and Reauthorization

Despite the significant impacts of windstorms and the potential to reduce damage to property, loss of life and injuries through NWIRP, appropriated funding for the program has been limited. Such an approach has multiple drawbacks:

- Potential windstorm-related projects must compete with other programs (some deemed to have higher priority) for limited money;
- Projects that do get funded are prioritized based on their ability to meet other agency objectives, thus limiting the strategic nature of efforts intended by NWIRP;
- NWIRP is unable to establish a "brand" which centers wind hazard-related research and expertise and helps build a workforce with wind-hazard expertise (see further discussion below); and
- Program agency staff have limited opportunities to build rapport and establish the true collaboration intended by Congress.

The authorization levels provided in the 2015 reauthorization bill ($21,400,000 annually: $5,332,000 for FEMA, $9,682,000 for the National Science Foundation (NSF), $4,120,000 for NIST and $2,266,00 for NOAA) represent a reasonable level of funding for an early-stage, multi-

agency, multi-faceted program. Despite the progress to date, ramping up to the program's full potential will require regular appropriations over the next few years. An active authorization, along with champions, both in Congress and the Administration, are critical toward ensuring regular investments.

In contrast to NWIRP, Congress appropriated $164.5 million for program activities of the NEHRP in FY2019.[23] The 2018 NEHRP reauthorization act authorizes appropriations for NEHRP activities from FY2019 to FY2023, for a total amount of about $760 million over the five-year span, or approximately $152 million annually.

Opportunities and NWIRP Recommendations

While NWIRP can point to successes, there are opportunities to further enhance the reach of the Program and address the current and pending impacts presented by windstorms. These opportunities largely fit under the existing Program priorities as outlined in the 2015 reauthorization, but as a future reauthorization is considered, the Code Council believes the following efforts should be highlighted.

- **NWIRP should be reauthorized for a period of at least five years to maximize the impact on research and application of research into codes and standards.** Like NEHRP, a five-year reauthorization for NWIRP is preferable. The model code development process operates on a three-year cycle. A five-year timeframe for NWIRP would allow time for development of code change proposals and educating participants in the code development process on the intent of the changes. Once the model code is updated, state and local governments generally start their update process—a time when technical assistance on NWIRP recommended specific changes and general support for updating the code is needed. Research cycles are also more consistent with a five-year authorization window. Complex engineering and social science research, as well as workforce development, are ideally carried out in three-year increments. Once findings

[23] NEHRP. 2005-2019 NEHRP Agency Budgets. https://www.nehrp.gov/pdf/2005-2019%20NEHRP%20Agency%20Budgets%20from%20SDiaz%20for%20website_2019.pdf

are fully developed, translating the results to action in the form of criteria or other guidance takes addition time. Authorization levels should be maintained, consistent with those in the prior reauthorization. Dedicated funding at these levels must be appropriated to allow effective execution of the program, build the program's brand and support achievement of its objectives.

- **The U.S. Department of Housing and Urban Development (HUD) should be designated as an NWIRP program agency with responsibility for reducing the impacts of windstorms on manufactured housing.** HUD should also be formally included on the Interagency Coordinating Committee on Wind Impact Reduction.

  Manufactured housing is built on a permanent chassis and subject to requirements of the Manufactured Home Construction and Safety Standards developed by the Department of Housing and Urban Development (HUD) rather than the state or local building code.[24] Manufactured homes are often seen as an affordable option for low- and middle-income households. Unfortunately, a disproportionate amount of fatalities from windstorms occur in manufactured homes.[25,26] HUD's participation would help ensure windstorm research findings are translated to design, construction and installation requirements for inclusion under the HUD Manufactured Home Construction and Safety Standards.

- **NWIRP agencies should work with codes and standards developers to advance standards and guidance for the evaluation and retrofit of existing buildings.**

  The natural turnover in the nation's building stock is estimated at one to two percent annually. The greatest immediate exposure to windstorm impacts is in today's existing

[24] This is in contrast to modular, pre-fabricated or panelized homes which must comply with the building code in place at the final building site.
[25] Ashley, W. S., 2007: Spatial and temporal analysis of tornado fatalities in the United States: 1880-2005.American Meteorological Society - Journals Online: Weather and Forecasting, 22, 1214-1228.
[26] Sutter, D., and K. M. Simmons, 2010: Tornado fatalities and mobile homes in the United States. Natural Hazards, 53, 125-137.

buildings. However, guidance on the retrofit of existing structures to withstand windstorm events can be improved. Building owners, designers and contractors need tools to evaluate vulnerabilities and identify cost-effective strategies to reduce those vulnerabilities.

Research is needed to build upon and expand retrofit standards for windstorm risk. The International Existing Building Code (IEBC) currently includes retrofit guidelines for gable ends and roof deck fastening, but this guidance could be more comprehensive.

- **NWIRP agencies should undertake research into future intensity, duration and frequency of windstorm events and advance the incorporation of findings into guidance for designers, owners and operators of buildings and infrastructure.**

  The design, construction and operation of today's built environment is largely based on the science and experiences of the past. Yet, the future requirements for buildings and other infrastructure are likely to be vastly different. Natural hazard events are changing in frequency, intensity and impact. This new paradigm requires that the planning, design, construction and operations workforce has the tools to address these new types of challenges.

  Several codes and standards developers are working to ensure codes provide requisite protection of buildings and their occupants during the buildings' lifetimes. The Code Council recently announced an initiative with code development organizations from Canada, Australia and New Zealand to collaborate and share knowledge, research and best practices to further prepare the building industry for increasingly severe weather events.[27] The American Society of Civil Engineers (ASCE) has also begun to examine how its standards and the design process itself must evolve.

  NWIRP can play an important role in addressing climate resilience by bringing representatives from the climate science and building science community together. This

[27] https://www.iccsafe.org/about/periodicals-and-newsroom/the-international-code-council-launches-global-initiative-on-building-resilience/

effort would build understanding of the types of information the building industry needs to effectively address these changing risks and the climatic information that climate scientists can provide.[28] NWIRP is in a unique position to assist in the development of solutions given its agencies represent both research and applied sectors. Additional agencies with expertise and experience in this area that should be integrated into such an effort include NASA, the Federal Highway Administration, General Services Administration, U.S. Army Corps of Engineers, Department of Defense and the U.S. Global Change Research Program.

- **Support increased economics research to inform codes and standards development and the adoption of such criteria and social science research to support decision making.**

  Achieving resilience requires the engagement and expertise of multiple disciplines including economics and social sciences. Engineering-based solutions should not be developed in a vacuum. Effective deployment requires understanding the economic factors that influence decision making and the messages and communication that will drive action. More robust benefit cost analysis will support better decision making both in research and the deployment of specific mitigation measures.

  Public education on risk and vulnerabilities associated with windstorms and other hazards will help create awareness and drive demand for wind-resistant features including adoption of up-to-date building codes and retrofits of existing buildings. Social scientists must be engaged to help formulate the educational messages and identify the most effective outlets for dissemination.

  Social science initiatives are also needed to better understand what motivates state and local policymakers to update building codes. What data is needed, what messages resonate, and who is an effective messenger? A robust economic analysis is important

[28] National Institute of Building Sciences. Moving Forward: Findings and Recommendations from the Consultative Council. 2014.

to show the benefits of windstorm impact mitigation strategies and the potential risk of inaction.

- **Create a formal linkage between NWIRP and other federal hazards programs to promote efficiency and increase efficacy.**

  Across the country, citizens are exposed to a variety of hazards, not just windstorms. Communities rarely make decisions in isolation. Federal agencies (including the NWIRP agencies) support programs that address the impacts from other specific hazards and support multi-hazard approaches to increasing resilience.

  Creating formal linkages between the NWIRP and these existing initiatives can help optimize limited funding and amplify the impact of NWIRP activities. In many cases solutions identified to mitigate one type of hazard may inform potential solutions for another hazard. NEHRP has extensive experience in translating research to practice. Lessons learned could be applied to the NWIRP initiatives. Fire programs in the USDA Forest Service and the U.S. Fire Administration and NIST resilience programs could provide additional insight.

  FEMA and the Department of Homeland Security (DHS) have multiple initiatives that look at addressing hazard risk holistically. Assuring consistency in how wind-related risks are handled across agencies and tools is essential. Specific opportunities for increased collaboration include FEMA's HAZUS tool that supports scenario planning, the FEMA Benefit Cost Analysis tool which supports grantmaking and decision making, and the DHS Cybersecurity and Infrastructure Security Agency (CISA) which focuses on threats to critical infrastructure.

  Coordination with mitigation and recovery grant programs from FEMA, HUD, the Small Business Administration, EDA and others would allow grant administrators to prioritize strategies that have the greatest return. Finally, cross programmatic coordination would help support sharing of lessons learned; coordination of codes and standards development, adoption, enforcement and technical assistance messages and strategies;

and potential development of strategies that provide multiple hazard mitigation benefits.

- **Build NWIRP's brand to support achievement of its objectives**

  Unlike NEHRP, NWIRP has no consistent branding. There is no logo that allows easy identification of resources or guidance produced under the Program. The NWIRP web presence is minimal, limited to a few pages hosted by NIST that provide general program management documents—it does not include a compendium of NWIRP technical documents or information on current activities.

  This lack of branding results in multiple challenges for the program:

  - The program's successes go unheralded, undermining efforts to promote future resource investment.
  - To practitioners and state and local policy makers who are unaware of the program, the resources developed by the program agencies appear disjointed or unrelated. There is no clear, "authoritative source" of windstorm mitigation activity within the federal government. This perception undermines the influence of the guidance produced.
  - For potential new entrants into the wind research or resilience workforce, the lack of consistent messaging imparts a perception that the federal government lacks interest in tackling windstorm-related challenges and that there is limited potential in the field.
  - As proposals are made to codes and standards development bodies, the weight of NWIRP as the multi-agency federal initiative to mitigate wind risk may be more effective than individual agency actions (this is particularly true if industry is engaged under the NWIRP banner).
  - Enhanced recognition within program agencies could lead to greater engagement of staff in NWIRP activities and increase opportunities for collaboration and coordination.

- **Strengthen the connection between NWIRP activities and private sector codes and standards developers that will ultimately incorporate NWIRP findings and solutions into guidance for the design, construction, operations and regulatory community.** The prior National Advisory Council on Windstorm Impact Reduction included "industry standards development organizations" as a member category but limited the Committee's role to recommendations for the program itself. A formal liaison role to implementers like the International Code Council, American Society of Civil Engineers (ASCE) and the Insurance Institute for Business and Home Safety (IBHS) would be valuable and could streamline action.

Conclusion

Thank you for the opportunity to provide testimony in support of reauthorization of the National Windstorm Impact Reduction Program (NWIRP). Despite limited funding, the program has achieved considerable success in reducing the impacts of windstorms on human life and property. Reauthorization coupled with dedicated funding will provide the NWIRP agencies with the resources needed to support the development and deployment of hazard mitigation measures commensurate with the risk communities face.

The International Code Council and the Alliance for National & Community Resilience will continue to provide communities with the code, standards and benchmarks they need to be safe and resilient. We stand ready to support the NWIRP agencies in achieving their goals of understanding windstorms and assessing and reducing their impacts.

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Ryan M. Colker is Vice President, Innovation at the International Code Council. He also serves as Executive Director of the Alliance for National & Community Resilience (ANCR), a national coalition working to provide communities with the tools necessary to holistically assess and improve their resilience. Prior to joining ICC, Colker served as Vice President at the National Institute of Building Sciences where he led efforts to improve the built environment through the collaboration of public and private sector industry stakeholders. At NIBS he directed the Consultative Council which develops findings and recommendations on behalf of the entire building community and served as staff director of the Council on Finance, Insurance and Real Estate; the National Council on Building Codes and Standards; the Off-Site Construction Council and the Institute's STEM Education Program. He speaks and writes frequently on emerging issues within the built environment including resilience, building performance, and off-site construction. Colker is the editor of the book *Optimizing Community Infrastructure: Resilience in the Face of Shocks and Stresses.* Previously, he served as Manager of Government Affairs for ASHRAE and Program Director of the Renewable Natural Resources Foundation. He graduated from The George Washington University Law School, and holds a B.A. with honors, in environmental policy from the University of Florida.