Madani, Mo

From: Plisich, John <John.Plisich@fema.dhs.gov>
Sent: Thursday, March 28, 2024 12:24 PM
To: Madani, Mo
Cc: Evans, Sabrina; Mayers, Jeffrey
Subject: FEMA Proposed Research Topics for FBC 2024 / 2025 Research Program funding consideration
Attachments: FEMA Proposed Research Topics for Consideration by FBC HRAC 28 Mar 24.pdf

Mr. Mo Madani,

Good afternoon.

Please find attached, the ***"FEMA Proposed Research Topics for Consideration by the Florida Building Commission's (FBC) / Hurricane Research Advisory Committee (HRAC); 28 Mar 24"***. This has eleven (11) proposed research projects FEMA is submitting to the FBC / HRAC for the FBC 2024 / 2025 research program funding consideration.

Please confirm receipt, as we know you have an important deadline of 31 Mar 24 for submitting research topics for review and consideration by the HRAC.

Thank you and have a good day.

Bud

John "Bud" Plisich
Civil Engineer / Risk Analysis Branch / FEMA Reg IV Mitigation
Office (770) 220- 5380 Mobile (404) 354-5283
john.plisich@fema.dhs.gov

Federal Emergency Management Agency
fema.gov

FEMA

From: Evans, Sabrina <Sabrina.Evans@myfloridalicense.com>
Sent: Tuesday, March 26, 2024 9:19 AM
To: Madani, Mo <Mo.Madani@myfloridalicense.com>
Subject: HRAC - Reminder
Importance: High

FEMA Proposed Research Topics for Consideration by the

Florida Building Commission's (FBC)

Hurricane Research Advisory Committee (HRAC)

28 Mar 24

The following is a list of eleven (11) FEMA Building Science Disaster Support Program proposed research topics selected from four FEMA Mitigation Assessment Team (MAT) reports' recommendations developed from field observations following recent Presidentially declared disasters. They are being submitted for consideration by the Florida Building Commission's Hurricane Research Advisory Committee (HRAC).

Each proposal meets the following criteria for funding consideration provided by the FBC 2024 / 2025 research work plan.

CRITERIA FOR FUNDING

- Meets Definition of "Research" and/or "Technical Enrichment."
- Within the scope of hurricane resistance research (water and wind resistance).
- Urgency/Immediacy: Needed to support the development of 2023 FBC.

Research proposals are due to the FBC by 31 March 24 in order to be considered for the FBC 2024 / 2025 research funding cycle.

FEMA Proposed research topics:

These research topics are numbered only for reference purposes; they are ***NOT*** listed in priority order as to their importance, preference, difficulty or ease in research, cost or potential greater or lesser mitigation impacts to buildings or communities. Priorities can be determined by the FBC HRAC according to their own purposes. Recommendations are listed by MAT Report. Respective conclusions for each recommendation are also provided for additional context. All of these research proposals are intended, and expected, to help the State of Florida and the Florida Building Commission with improving building performance, reducing vulnerabilities and enhancing building and community resilience.

A) ***FEMA P-2342 Mitigation Assessment Team Report; Hurricane Ian in Florida; Building Performance Observations, Recommendations, and Technical Guidance***; December 2023; https://www.fema.gov/sites/default/files/documents/fema_rm-hurriance-ian-mat-report-12-2023.pdf

1) **Recommendation FL-7c. FEMA, FDEM, and the FBC should consider developing practical criteria for when elevated buildings should be required for new construction within the regulated floodplain.**

The difference in performance of *non-elevated* versus *elevated buildings* in varying conditions was visible in the field and strongly supported by flood insurance

claims data. Practical criteria should be developed and supported by the AHJs for when construction in a regulated floodplain is required to have its lowest elevated floor raised above ground level by walls, posts, piers, pilings, or columns.

- Clear definition of the problem to be researched: NFIP Insurance claim payouts for elevated vs non-elevated homes clearly show elevated homes (using the NFIP definition of elevated) had far less insurance claim payouts. Structures that are on structural fill are not considered as being an "elevated building" from a flood insurance perspective, although they can still be built to comply with NFIP regulatory requirements from a floodplain management perspective. **What practical criteria, parameters can be developed to require new construction or SI / SD structures to be built as an "elevated building" per 44 CFR 59.1 definition, within the regulated floodplain?**

Conclusion FL-7 Most of the flood damage observed outside of areas that experienced hydrodynamic loads, was to building materials.

Building material damage can be costly. It can also make buildings unhabitable for lengthy periods of time without proper remediation.

- Additional technical data/research in support of the research topic:
  - FEMA P-2342 H. Ian MAT Chapter 3 Flood Related Observations Section 3.1 Comparison of Coastal Construction in the 1970s and 2010's; Section 3.9 Comparison of Elevated and Non-Elevated Single-Family Houses
  - Appendix C: Hurricane Ian NFIP Claims Analysis Technical Advisory has information from 12 selected Areas of Interest observed by the MAT having varying flood sources in Desoto, Lee, and Collier counties with most of them (nine) in Lee County. Parcel data were gathered for over 2,800 properties across the 12 areas and NFIP policy information was collected for over 1,200 of these properties (about a 45% penetration rate for flood insurance take-up across the areas). Parcel data attributes included the year built and size of the house in square feet. The size of each house was used to help quantify a claim per square foot of house, because the average size of a single-family house has increased over time. Technical Advisory is also published as a standalone document at https://www.fema.gov/sites/default/files/documents/fema_rm-nfip-claims-analysis-ian-case-study-12-2023.pdf.
  - **Per 44 CFR 59.1 ELEVATED BUILDING:**
    For insurance purposes, an elevated building is a non-basement building that has its lowest elevated floor raised above ground level by foundation walls, shear walls, posts, piers, pilings, or columns.
    - Buildings elevated on fill are not considered elevated from an NFIP insurance perspective. Furthermore, the NFIP claims data has shown increased damage occurs for those buildings that do not meet this Elevated Building definition.

2) **Recommendation FL-20b. Industry groups, interested stakeholders, and/or academia should study whether and how surviving front-row structures with surviving walls below the BFE impact neighboring structures.**

The MAT observed numerous instances where large scour holes were adjacent to surviving front-row structures with surviving walls below the BFE. In some instances, the scour extended to the neighboring house's foundation. Research could include whether and to what extent channelized flow between buildings increases flow velocity and scour. Industry groups and interested parties (e.g., FEMA Building Science Branch, DHS Science and Technology Directorate, NIST's Disaster and Failure Studies Program, NSF, NOAA Sea Grant, IBHS, ASCE, and FBC), as well as academia, should consider collaborating to determine whether these surviving structures with surviving walls result in negative impacts to neighboring structures by altering flow characteristics. The blockage allowance in FBC Section 3109.3.2.2 and FEMA's free-of-obstruction requirements should be evaluated.

- Clear definition of the problem to be researched: Surviving front-row structures may have had both beneficial and detrimental impacts to surrounding structures. Based on MAT observations, surviving front-row structures may have provided varying levels of shielding (protection) to the inland structures on the backside of the surviving structure. The level of protection may be inversely linked to the openness of the surviving building's foundation. However, the surviving structures were also observed to be potentially linked to excessive neighboring scour. To what extent and how exactly, do surviving front-row structures to the coast that also had surviving walls below the BFE, positively or adversely impact neighboring structures?

Conclusion FL-20 Surviving front-row structures may have had both beneficial and detrimental impacts to surrounding structures.

Based on MAT observations, surviving front-row structures may have provided varying levels of shielding (protection) to the inland structures on the backside of the surviving structure. The level of protection may be inversely linked to the openness of the surviving building's foundation. However, the surviving structures were also observed to be potentially linked to excessive neighboring scour.

- If available, technical data/research in support of the research topic
  - FEMA P-2342 H. Ian MAT Chapter 3 Flood Related Observations Section 3.1 Comparison of Coastal Construction in the 1970s and 2010's, Section 3.2 Performance of Breakaway Walls; Section 3.4 Scour and Erosion;
  - ATC (Applied Technology Council). n.d. *Coastal Inundation in Developed Regions: Experimental Results and Implications for Engineering Practice.* ATC 149. 2022; https://www.atcouncil.org/atc-149

3) **Recommendation FL-21. FEMA should collaborate with OFAs, academia, and building science industry partners to study what may have caused the increased survival rates for the shore-perpendicular CMU breakaway walls.**

There are numerous possible explanations for the increased survival of the CMU breakaway walls. The study should explore possible reasons for the observed difference, including, but not limited to, the walls experienced less than their design conditions, the presence of flood openings, the walls were designed above the allowable design load, or possibly that the wood-framed breakaway walls were designed to minimum standards; whereas, the CMU breakaway walls were designed to higher allowable standards (prescriptive vs. simplified vs. performance-based design methods). The study should include considerations relative to wave attack direction and whether shore-perpendicular walls were designed with the same load assumptions as shore-parallel walls.

Based on the study findings, FEMA should consider any necessary changes or additions to the guidance associated with breakaway walls. For example, additional guidance may be required for load assumptions for breakaway walls based on their orientation to the shore and likelihood of direct wave attack. The results of the analysis should be incorporated into future minimum NFIP design and construction requirements.

- Clear definition of the problem to be researched: Shore-perpendicular CMU breakaway walls sustained less damage and exhibited increased survival when compared to shore-perpendicular wood-framed breakaway walls. **What are the primary and secondary factors that help increase survival rates for shore-perpendicular CMU breakaway walls?**

Conclusion FL-21 Shore-perpendicular CMU breakaway walls sustained less damage when compared to shore-perpendicular wood-framed breakaway walls.

CMU breakaway walls perpendicular to the shoreline in low-rise buildings exhibited increased survival over wood-framed breakaway walls.

- If available, technical data/research in support of the research topic
  - FEMA P-2342 H. Ian MAT Chapter 3 Flood Related Observations Section 3.1 Comparison of Coastal Construction in the 1970s and 2010's; Section 3.2 Performance of Breakaway Walls, Section 2.4 Scour and Erosion

4) **Recommendation FL-28. The Florida Building Commission should consider funding more research in collaboration with academia and industry groups, such as ARMA, NRCA, and IBHS, to determine why asphalt shingle damage, particularly on aged asphalt shingle roofs, is often observed to be widespread.**

Such research should, at a minimum, include consideration of developing a new or revised test method for wind resistance of asphalt shingles to provide improved resistance to wind loads and study of potential installation, workmanship, and manufacturing issues; the effects of aging; potential effects related to transportation and delivery of the product to the site; and the lack of thorough "in-progress" inspections. A similar recommendation was made in both the Hurricane Irma and Hurricane Michael MAT reports.

- Clear definition of the problem to be researched: Asphalt shingle roof coverings for many residential buildings appeared to have inadequate resistance to wind loads. The amount of damage varied widely at each site visited. Data analysis of roof covering performance in the discrete clusters assessed by the MAT found that 90% of the asphalt shingle roofs older than 7 years sustained visible damage. Given that Hurricane Ian wind speeds were far less than design-level wind speeds, this is significant. **What new or revised test procedures should be considered to improve the wind resistance of asphalt shingles? What role does installation, workmanship, and manufacturing play in their performance and how might these be improved? What are the effects of aging and how can these effects be reduced? What potential adverse effects might transportation and delivery of the product to the site have? How can we reasonably and cost effectively improve the performance of asphalt shingles to high wind events? What factors from above are the most impactful and how can we most cost effectively remedy them? Similar recommendations were made in both the Hurricane Irma and Hurricane Michael MAT reports.**

  Conclusion FL-28 Asphalt shingle roof coverings for many residential buildings appeared to have inadequate resistance to wind loads.

  The amount of damage varied widely at each site visited. Data analysis of roof covering performance in the discrete clusters assessed by the MAT found that 90% of the asphalt shingle roofs older than 7 years sustained visible damage. Given that Hurricane Ian wind speeds were far less than design-level wind speeds, this is significant.

- If available, technical data/research in support of the research topic
  - FEMA P-2342 H. Ian MAT Chapter 4 Wind Related Observations: Section 4.1 Estimated Wind Speeds / Design Wind Speeds; Section 4.2.4 Roof Coverings
  - FEMA P-2077 Mitigation Assessment Team Report; Hurricane Michael in Florida; Building Performance Observations, Recommendations, and Technical Guidance; February 2020; https://www.fema.gov/sites/default/files/2020-07/mat-report_hurricane-michael_florida.pdf
    - Chapter 4. Wind-Related Observations: Residential has information on poor roof covering performance for residential structures beginning on page 4-1 with more specific observations in section 4.2.1 of the of FEMA P-2077. Furthermore, FEMA P-2023 which is the MAT Report for Hurricane Irma in Florida, also has this same recommendation (Recommendation FL-9a) just below.
    - Conclusion FL-14 The roof coverings for many residential buildings appeared to have inadequate resistance to wind loads; the loss of the primary roof covering contributed to significant water infiltration in many buildings.

        - Recommendation #FL-14b. Industry groups should assess the causes for the widespread asphalt shingle roof covering loss that was observed by the MAT.
    - FEMA P-2023; Mitigation Assessment Team Report Hurricane Irma in Florida; Building Performance Observations, Recommendations, and Technical Guidance December 2018; https://www.fema.gov/sites/default/files/2020-07/mat-report_hurricane-irma_florida.pdf
        - Conclusion FL-9 The MAT observed evidence of inadequate resistance to wind loads for roof coverings of residential buildings.
        - Recommendation FL-9a. Industry groups should investigate the causes for the widespread asphalt shingle roof covering loss that was observed by the MAT.
        - Observations on roof covering performance for residential structures begins on page 4-6, with more specific observations of asphalt shingle roof coverings in Section 4.2.1.1.
    - Recommend researchers coordinate with the Florida insurance commission to gather much more detailed data on this issue.

5) **Recommendation FL-10a. FEMA should consider submitting code change proposals or supporting code change proposals from other stakeholders—such as IBHS, Asphalt Roofing Manufacturers Association (ARMA), National Roofing Contractors Association (NRCA), and other aligned groups to the IBC, IRC, and the FBC—to require testing of hip and ridge roof coverings for asphalt shingle roof coverings.**

   The IBC, IRC, and the FBC require asphalt shingles to be tested for wind loads in accordance with ASTM D7158 or ASTM D3161. Underwriters Laboratories (UL) 2375, *Outline of Investigation for Hip and Ridge Shingles* (2016), provides a methodology to use a modified version of ASTM D3161 to test hip and ridge shingles for wind resistance. As an alternative to testing, a prescriptive solution that includes the use of an appropriate adhesive should be developed and included in the IBC, IRC, and FBC.

   - Clear definition of the problem to be researched: Research is needed to help develop a test method for hip and ridge asphalt roof coverings, as ASTM D3161 currently does not test these components.

   Conclusion FL-10 Hip and ridge roof coverings for many residential buildings appeared to have inadequate resistance to wind loads. Failure of hip and ridge roof coverings on asphalt shingle and metal panel roof coverings was widespread and the most common roof covering failure observed by the MAT. While some asphalt shingle manufacturers test hip and ridge shingles to a modified version of ASTM D3161, the IBC, IRC, and FBC do not specifically require testing of hip and ridge asphalt shingles or metal panel roof coverings.

   - If available, technical data/research in support of the research topic

- FEMA P-2342 H. Ian MAT Chapter 4 Wind Related Observations: Section 4.2.4 Roof Coverings

6) **Recommendation FL-10b. FEMA should consider submitting code change proposals or supporting code change proposals from other stakeholders—such as IBHS, Metal Construction Association (MCA), NRCA, and other aligned groups to the IBC, IRC, and the FBC—to require testing of hip and ridge roof coverings for metal panel roof coverings.** The ANSI/MCA FTS-1, *Test Method for Wind Load Resistance of Flashings Used with Metal Roof Systems* (2019), specifies wind load resistance testing of hip covers on metal panel roof systems in addition to other edge/flashing metal.

   - Clear definition of the problem to be researched: Research is needed to help develop an appropriate test method for hip and ridge metal panel roof coverings.

Conclusion FL-10 Hip and ridge roof coverings for many residential buildings appeared to have inadequate resistance to wind loads. Failure of hip and ridge roof coverings on asphalt shingle and metal panel roof coverings was widespread and the most common roof covering failure observed by the MAT. While some asphalt shingle manufacturers test hip and ridge shingles to a modified version of ASTM D3161, the IBC, IRC, and FBC do not specifically require testing of hip and ridge asphalt shingles or metal panel roof coverings.

   - If available, technical data/research in support of the research topic

FEMA P-2342 H. Ian MAT Chapter 4 Wind Related Observations: Section 4.2.4 Roof Coverings

7) **Recommendation FL-30. The Florida Building Commission, in collaboration with academia and industry groups such as IBHS, should consider funding research to determine whether the use of spray foam insulation in the attic is effective in limiting water intrusion through ventilated or failed soffit panels as a secondary benefit.**

For favorable climates, the use of spray foam insulation in the attic area may be effective in separating the attic space from the soffit area, thereby limiting the amount of wind-driven rain that can enter the attic space through ventilated or failed soffit panels.

   - Clear definition of the problem to be researched: The use of spray foam insulation in attics to create an unvented attic provided some benefit against water intrusion through soffits on some houses. The MAT observed evidence that spray foam insulation likely prevented water intrusion into some houses where soffit failure occurred. **How effective is spray foam insulation in the attic, as a secondary benefit, in limiting water intrusion through ventilated or failed soffit panels?**

Conclusion FL-30 The use of spray foam insulation in attics to create an unvented attic provided some benefit against water intrusion through soffits on some houses. The MAT observed evidence that spray foam insulation likely prevented water intrusion into some houses where soffit failure occurred.

- If available, technical data/research in support of the research topic
  - FEMA P-2342 H. Ian MAT Chapter 4 Wind Related Observations: Section 4.1 Estimated Wind Speeds / Design Wind Speeds; Section 4.2 Building Envelop

B) ***FEMA P-2077 Mitigation Assessment Team Report; Hurricane Michael in Florida; Building Performance Observations, Recommendations, and Technical Guidance***; February 2020; https://www.fema.gov/sites/default/files/2020-07/mat-report_hurricane-michael_florida.pdf

8) Recommendation #FL-16. Industry groups and academia should perform research on commonly used ridge vent products to better determine the causes of ridge vent failure and develop solutions.

More research should be considered by industry groups (e.g., manufacturers, insurance organizations—IBHS, builders, trade associations—NRCA) to determine why ridge vent failure was observed to be widespread and whether these failures were the result of design, installation, testing (including for wind-driven rain infiltration), inspection, manufacturing, or other issues. Information to help improve the performance of ridge vents in high-wind areas can be found in Hurricane Michael in Florida Recovery Advisory 2, Best Practices for Minimizing Wind and Water Infiltration Damage (in FEMA P-2077, 2019a).

- Clear definition of the problem to be researched: The failure of ridge vents contributed to significant water infiltration at many sites. The loss of ridge vents can expose large openings in the roof deck to water infiltration. Water infiltration can cause extensive interior damage, contribute to the growth of mold and mildew, and result in degraded building function or downtime until repairs are made. **What are the primary and secondary factors that cause ridge vents to fail and what can be done to mitigate these failures to prevent or minimize water-infiltration?**

Conclusion FL-16 The failure of ridge vents contributed to significant water infiltration at many sites.

The loss of ridge vents can expose large openings in the roof deck to water infiltration. Water infiltration can cause extensive interior damage, contribute to the growth of mold and mildew, and result in degraded building function or downtime until repairs are made.

- If available, technical data/research in support of the research topic

- Chapter 4. Wind-Related Observations: Residential has information on poor roof covering performance for residential structures beginning on page 4-1 with more specific observations in section 4.2.1.1 on ridge vents. Information to help improve the performance of ridge vents in high-wind areas can be found in Hurricane Michael in Florida Recovery Advisory 2, *Best Practices for Minimizing Wind and Water Infiltration Damage* (in FEMA P-2077, 2019) but more research is needed as to their failure and how best to mitigate them.

9) Recommendation #FL-21b. The State of Florida and FDEM should consider re-evaluating EHPA criteria and re-assess safety of existing EHPAs, particularly those designed prior to the 6th Edition FBC (2017).

While new EHPAs are required by the 6th Edition FBC (2017) to be designed and constructed in accordance with the hurricane wind load provisions of ICC 500, structural criteria for EHPA as designed and constructed prior to 6th Edition FBC (2017) were less stringent and non-mandatory. The State of Florida and FDEM should consider reassessing existing EHPAs that were designed and constructed prior to the 6th Edition FBC (2017) to identify and retrofit their vulnerabilities or explore incentivizing local authorities to replace the more vulnerable aging EHPAs with new EHPAs, or better yet, storm shelters or safe rooms.

- Clear definition of the problem to be researched: The Bay County HESs, which the County identified through assessment and mitigation of existing spaces, incurred significant damage during Hurricane Michael and exposed shelter occupants to hurricane hazards. The Calhoun County HESs, which were designed to meet earlier EHPA criteria, incurred significant damage as well. Based on damage observations, roof systems of both types of HESs are particularly vulnerable to high winds. **Given numerous EHPA's and HES's over the years have been documented to have poor performance, what are some criteria or additional prioritized criteria or actions which can be performed to increase the protection provided by EHPAs, especially already existing and older EHPA's and HES structures?**

Conclusion FL-21 The HESs observed by the MAT demonstrated significant vulnerabilities to high-wind hazards.

The Bay County HESs, which the County identified through assessment and mitigation of existing spaces, incurred significant damage during Hurricane Michael and exposed shelter occupants to hurricane hazards. The Calhoun County HESs, which were designed to meet earlier EHPA criteria, incurred significant damage as well. Based on damage observations, roof systems of both types of HES are particularly vulnerable to high winds.

- If available, technical data/research in support of the research topic
  - Chapter 2. Building Codes, Standards, and Regulations: Section 2.4, which begins on page 2-21 provides background information on Florida's State Shelter Emergency Shelter Mandate and the resulting different types

of shelters throughout the state. Section 5.2.3 which starts on page 5-44 discusses the observations made by the MAT for HESs visited during their deployment.

- Another potential source of information may be Florida's Department of Emergency Management, as they charged with updating the Statewide Emergency Shelter Plan (SESP), and may have data on the structural and planning criteria for each shelter, as well as any information on its past performance during an event.
- FEMA P-2342 H. Ian MAT Chapter 5 Critical Facility Related Observations: Section 2.4 Florida Evacuation Shelter Program; Section 5.3 Hurricane Evacuation Shelters
    - Conclusion FL-36 At least one HES observed by the (H. Ian) MAT demonstrated significant vulnerabilities to high-wind events.
    - Recommendation FL-37a. FEMA and FDEM should consider submitting a code change proposal to the FBC to expand EHPA construction requirements. The EHPA design and construction requirements could be expanded to include alterations or repairs of existing educational facilities and new public facilities with assembly spaces. In addition, FDEM and/or local emergency management agencies should consider both region-level and county-level shelter demand versus capacity data when making EHPA exemption decisions.

C) ***FEMA P-2023; Mitigation Assessment Team Report Hurricane Irma in Florida; Building Performance Observations, Recommendations, and Technical Guidance December 2018***; https://www.fema.gov/sites/default/files/2020-07/mat-report_hurricane-irma_florida.pdf

10) Recommendation FL-12a. Industry groups and/or academia should study debris generation and strikes to protective systems during hurricanes to determine whether the wind speed triggers for the ASCE 7 wind-borne debris region are appropriate.

Industry groups and/or academia should study debris generation and associated debris strikes to protective systems from the 2017 hurricane, as well as for future storms, to determine whether the current wind speed triggers for the wind-borne debris region as defined in ASCE 7 are appropriate. Data collected and analyzed during the study can be used to make recommendations on ASCE 7-required protection of windows and glazed doors.

- Clear definition of the problem to be researched: Hurricanes Irma in FL and Ian in FL were both well below design level windspeed events. ASCE 7-required protection of windows and glazed doors in the wind-borne debris region appears to have been widely applied. However, the few instances of observed damage to protected glazed openings occurred in areas where estimated wind speeds were well below the 130 mph wind-borne debris triggers for which ASCE 7 requires glazed opening protection. This suggests that wind-borne debris was generated at

wind speeds well below the 130-mph trigger. **What wind speed trigger is appropriate for the ASCE 7 wind-borne debris region for Florida?**

Conclusion FL-12 The MAT observed evidence of wind-borne debris, but very few instances of glazed openings being breached.

ASCE 7-required protection of windows and glazed doors in the wind-borne debris region appears to have been widely applied. However, the few instances of observed damage to protected glazed openings occurred in areas where estimated wind speeds during Hurricane Irma were well below the 130 mph wind-borne debris trigger for which ASCE 7 requires glazed opening protection. This suggests that wind-borne debris was generated at wind speeds well below the 130-mph trigger.

- If available, technical data/research in support of the research topic
  - Section 2.3.1 Wind Loads and Wind Design in the FBC for background information.
  - Chapter 4. Wind-Related Observations: Residential: Section 4.2, which begins on page 4-6, provides background information on the performance of residential buildings envelopes and also discusses wind-borne debris observations made by the MAT in Section 4.2.4 Glazed Openings and Opening Protection Systems, starting on page 4-24.
  - Could check if data is available through any insurance consortiums, especially those which are FL-specific and able to share their data
  - IBHS
  - NSF/StEER

D) ***FEMA P-2022 Mitigation Assessment Team Report; Hurricane Harvey in Texas; Building Performance Observations, Recommendations, and Technical Guidance; February 2019***
https://www.fema.gov/sites/default/files/2020-07/mat-report_hurricane-harvey-texas.pdf

11) **Recommendation TX-22a. FEMA should work with industry partners to evaluate whether ASTM testing requirements for debris impacts and wind pressures should be adjusted.**

Using damage observations made after Hurricane Harvey, the FEMA Building Science Branch should collaborate with industry partners and identify trends in damages (e.g., interior finishes subject to water intrusion/wind driven rain) that are potentially a result of inadequate testing requirements. For example, ASTM E1886, the standard for glazing protection systems impacted by missiles and exposed to cyclic pressure differentials, does not consider water leakage after debris impact, nor does it consider debris impact to the framing around the opening. The current testing standard evaluates missile impacts to the window, but the framing around the glazing is not impacted during testing.

- Clear definition of the problem to be researched: In MAT efforts for Texas and two in Florida, numerous instances were observed of windows being damaged from windborne debris that were subjected to winds far less than design level windspeeds and well below windborne debris trigger points. Multiple damage

observed indicates the performance measures in current testing requirements may need to be re-evaluated and adjusted, especially with respect to limiting infiltration of wind-driven rain. **What adjustments are needed to ASTM E1886 and ASTM E1996 (or other standards) regarding required impact locations on tested products to better address glazing and glazing protection systems impacted by wind-borne debris? This research should include consideration of requiring missile impacts to the framing around the opening and effects of wind driven rain after the missile impact and cyclic loading tests.**

Conclusion TX-22 Current testing standards may need to further consider debris impact.

In multiple locations, the MAT observed broken laminated glass that remained in the frame, but allowed water infiltration; the leakage may have been related to flashing deficiencies, glass breakage, or both. The MAT also observed one instance where a window subframe blew out of the main window frame because windborne debris impacted a jack stud; the stud was pushed inward, which caused the main window frame to twist. While the products observed were tested for the region in which they were installed, the damage indicates the performance measures in current testing requirements may need to be reevaluated and adjusted, especially with respect to limiting infiltration of wind-driven rain.

- If available, technical data/research in support of the research topic
  - See section 4.1.6 Windows and Shutters
  - See section 4.1.8 Debris Impacts