What Current and Future Research Would Help Our Business

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Catastrophe Engineering and Analytics

SO…. WHAT IS "OUR BUSINESS"

- Support the business needs of property insurance component of BHSI
  - Refine the catastrophe view used during the underwriting process (rate adequacy)
  - Interact with the claims team during disasters to help them anticipate potential losses
  - Work with actuarial teams to understand the overall aggregated risk related to our entire portfolio
- Develop custom data and models that are specific to the types of businesses we insure
- Act as corporate thought leaders for issues related to natural catastrophes

WHY DO WE FIND WHIP TO BE A VALUABLE RESOURCE?

- We have talented experts working on these problems, but we are not directly connected to the latest science and engineering
- Our Team has limited bandwidth and specific work to complete

CATASTROPHE RISK EVALUATION

Catastrophe analysts

- Perform catastrophe modeling
- Adjust views for considerations beyond generic construction types
- Evaluate additional risk factors to contribute to strategic underwriting

WHIP benefits to us

- Improvement in vendor models such as Verisk trickle down to our analytics
- New findings can be incorporated into our internal adjustments

OTHER UNMODELED FACTORS TO CONSIDER

Trees: Blow downs in close proximity to a building can increase the risk to the structure

- Blow downs can occur at relatively low wind speed when the soil is saturated with rainfall
- Highly wooded areas can have longer periods without power

Rainwater intrusion: Water that gets into a structure via wind damaged windows, roofs, siding, etc.

- Large percentage of loss in weaker storm events is related to contents damage and related repairs

Windborne debris: Objects like signage, roof material, lawn furniture can become airborne and increase damageability at higher wind speeds

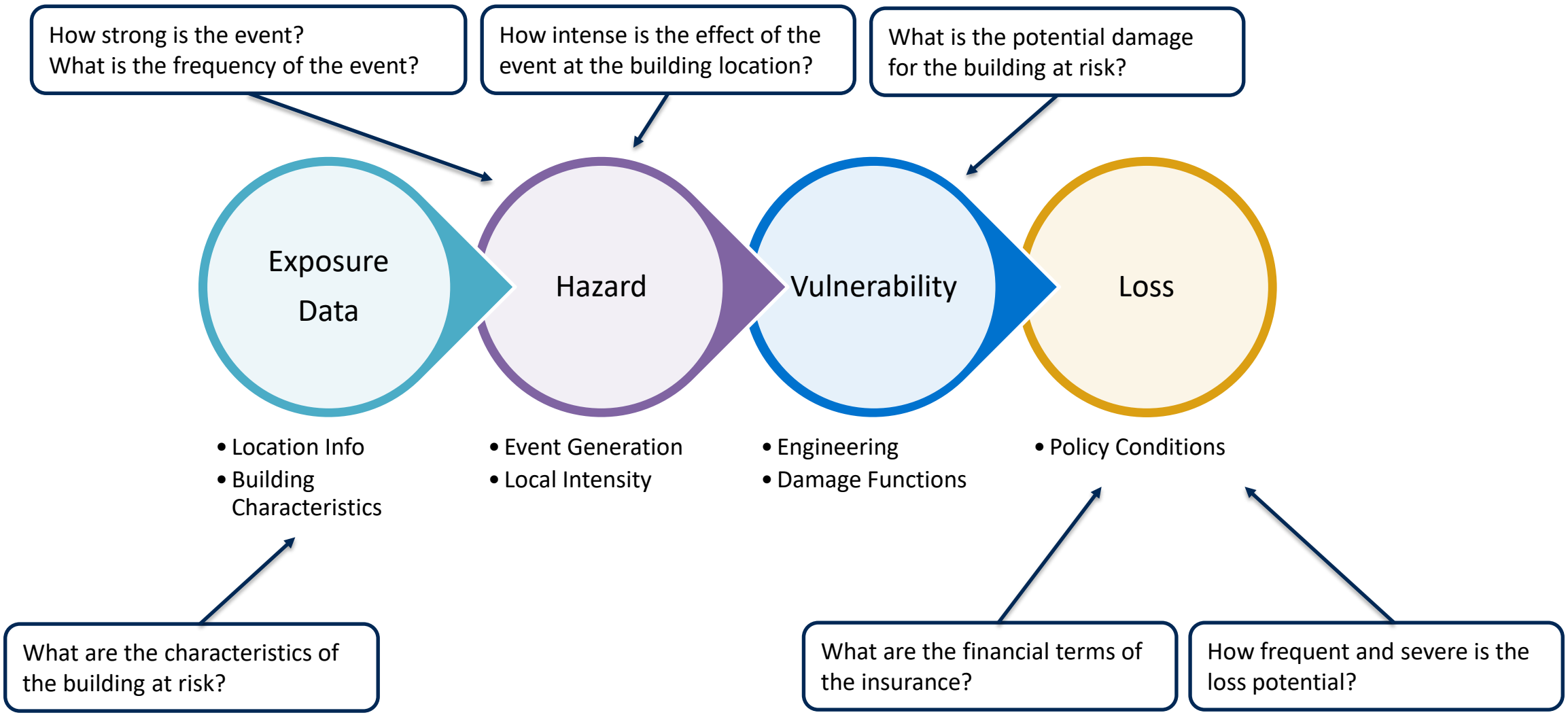
- Shutters and impact resistant glass provide some protection
- Look for potential sources of debris (open lot construction, industrial facilities)

MODEL DEVELOPMENT AND DATA ANALYTICS

Risk scientists and engineers

- Develop additional models, tools, and data sets for use in the catastrophe analysis process
- Research individual risks to better understand potential loss exposure (not just physical data, but also business interruption due to storm related impacts)
- Develop new risk metrics and insurance products (i.e., parametric insurance)

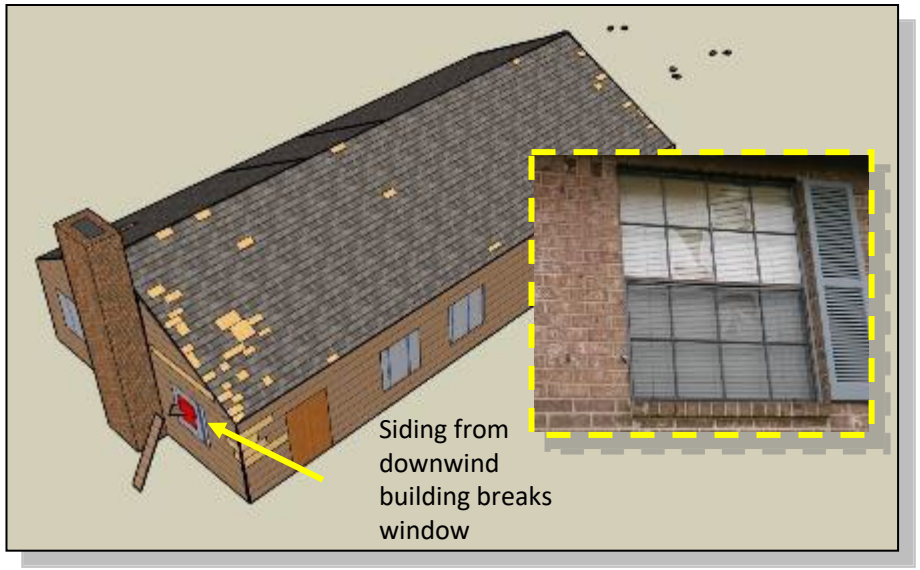
CAT EVALUATION FRAMEWORK



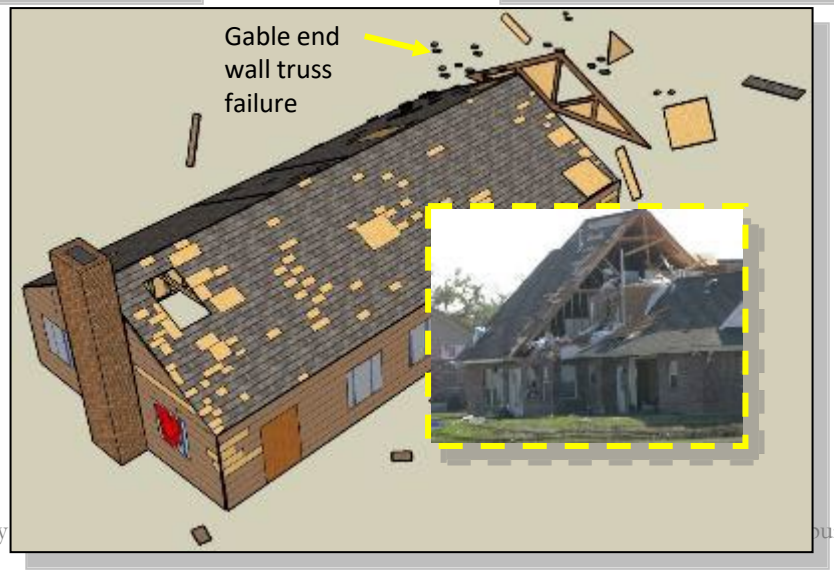
DAMAGE ESCALATES AS WIND SPEED INCREASES

Category 1: Minor loss to roof covering

Category 2: Moderate loss to roof covering and siding

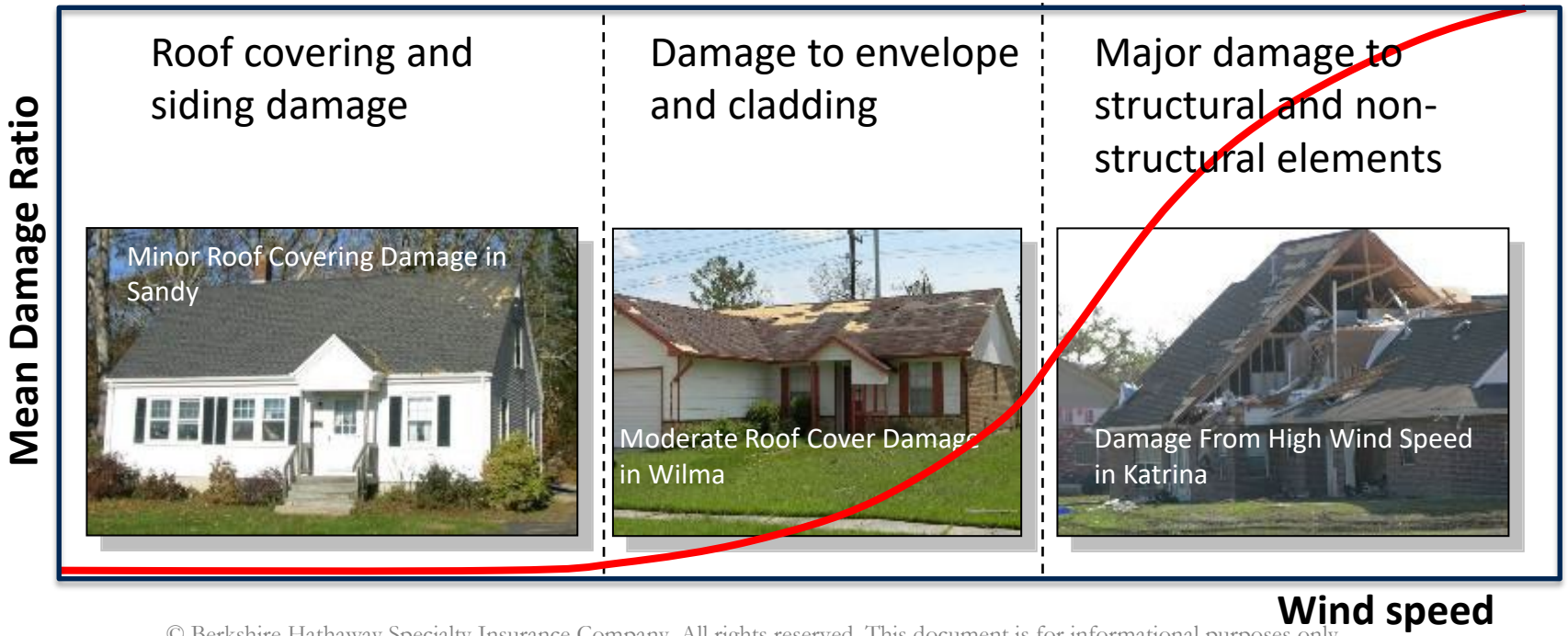


Category 4: Extensive damage to roofs and roof systems may

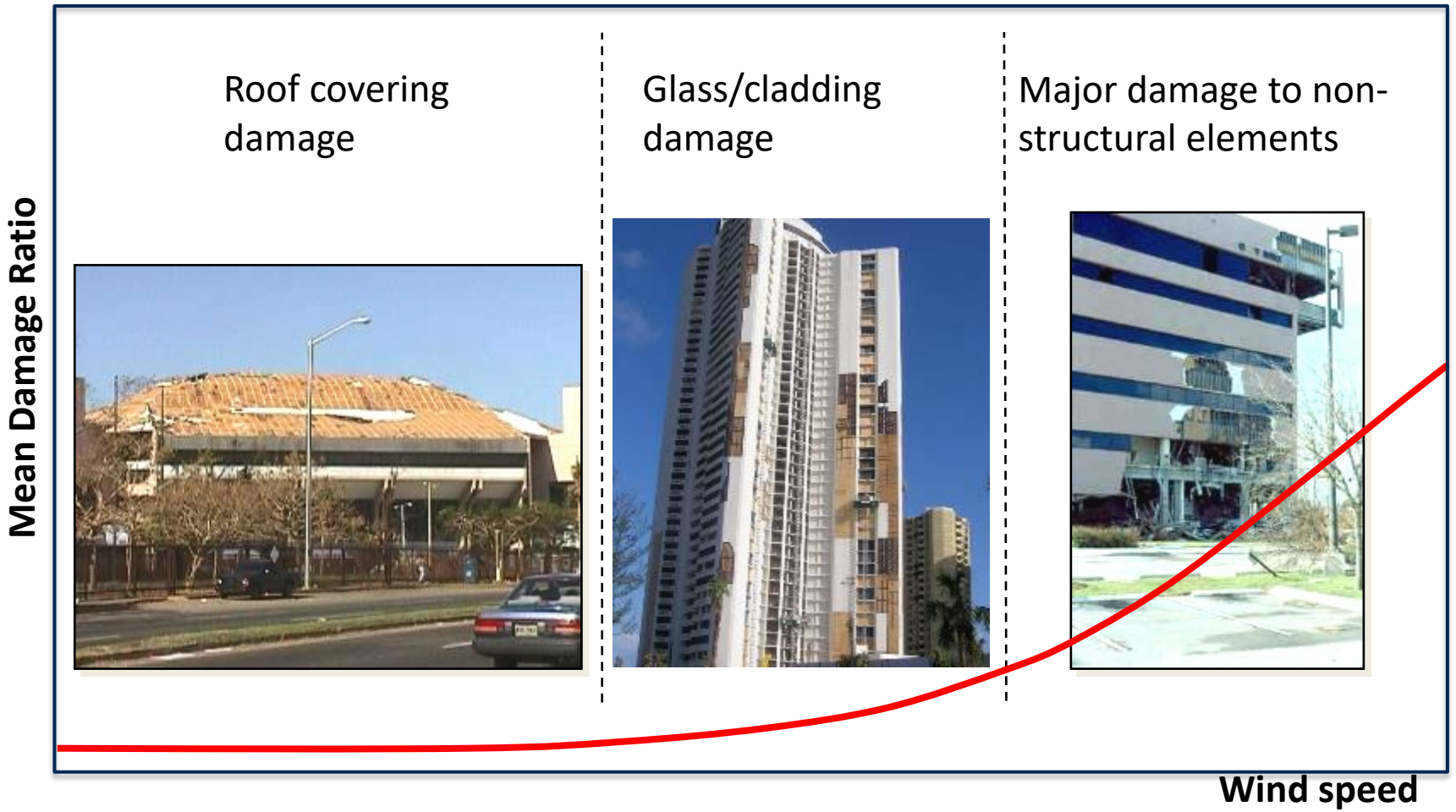


REPRESENTING DAMAGE POTENTIAL IN A MODEL

- Increasing wind speeds result in more extreme forms of structural failure
- Wind borne debris also increases as wind gets stronger, increasing the factors leading to building damage
- Roof corners, windows, and doors (including garage doors) are all important failure points to consider



VULNERABILITY IS DIFFERENT FOR REINFORCED CONCRETE AND STEEL FRAME



CATASTROPHE RISK ASSESSMENT TOOLS

WHIP benefits these efforts by improving our understanding and access to unique data sets

- Rainfall intrusions studies
- Roof performance
- Wind and surge damage estimation
- Tornado wind loads and vulnerability
- Tree damage
- Roof characteristics more/less susceptible to damage
- Damage survey database information

RISK SELECTION

Field engineering allows us to gain insights through inspection of properties

- Perform site surveys for more complex properties
- Develop view of replacement costs
- Consult with model development team to ensure consistency of view

THERE ARE NUMEROUS CHARACTERISTICS THAT AFFECT BUILDING VULNERABILITY

- Openness of the surroundings
- Age of construction
- Construction materials
- Roof attachment and shape
- Roof cover (shingles, tiles, etc.)
- Height of building

BASIC MODELING: EVALUATION OF EXPOSURE CHARACTERISTICS

15 Story Casino, Biloxi – Given as **Light Metal** construction

8 Story Condo, SF – Given as **Short Column condition** in SOV

4 Story Office Building, Seattle – Given as **Tilt-Up construction** in the SOV

LESSONS LEARNED FROM DAMAGE SURVEYS ARE IMPORTANT CHECK POINTS

Ian:

- Building codes seem to be effective in south Florida
  - ➢ local winds were close to design criteria, a CAT 5 would have likely looked very different
- Storm surge and flood impacts are still a problem
- Other regions have not fared as well (e.g., Louisiana)

145 mph * 1.23 Gust factor = 178 mph

155 mph * 1.23 Gust factor = 191 mph

Design wind speeds 160-180 mph

Florida Building Code 2017 Wind Loads

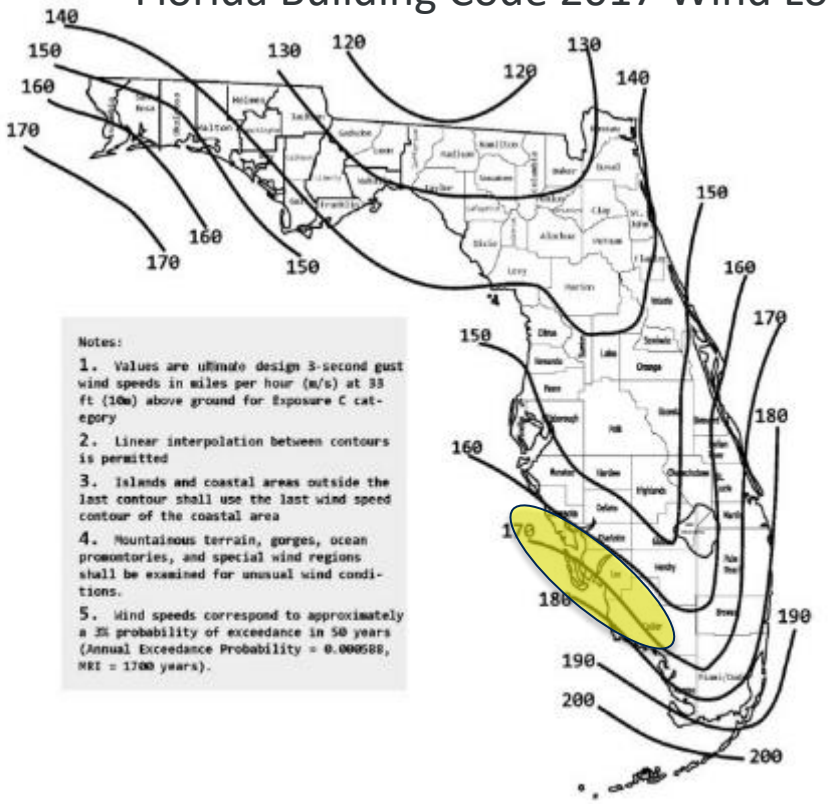


FIGURE 1609.3(2)
ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY III AND IV BUILDINGS AND OTHER STRUCTURES

RISK SELECTION

WHIP helps our field engineering by

- Providing guidance on design criteria that we should be looking for
- Keep the field engineering team current on the latest practices and materials, and what to expect in terms of performance
- Damage surveys help expand our understanding of failures in extreme conditions

Called upon to provide guidance and insight into areas related to natural catastrophes and their impacts

- Climate change
- "Less traditional" hazards… sometimes called "minor cats"
  - Fire/wildfire
  - Storm surge/flood
  - Convective storm/other wind
  - Winter storm/freeze damage
- Building code effectiveness

We see WHIP as a valuable resource to leverage in order to be more thorough and informed in these responses

- Tornado focus
- Storm surge damageability

MANY POSSIBLE FUTURE RESEARCH AREAS THAT WOULD HELP OUR BUSINESS

Thoughts on future areas that would be interesting…

- Extension of some of the current research to larger commercial buildings
- CFD/ virtual wind tunnel type applications, focused on more complex geometries
- Downburst and other non-tornadic winds, what are the similarities and differences to hurricane with same peak gust (assumption is that they are the same).
- Climate change: Building codes are designed on wind load expectations using current wind climatology. How will building codes need to change considering expected wind climatology? Same for storm surge and FEMA flood zones.
- We are also interested in opportunities to educate less technically oriented team members (e.g., underwriters)

SUMMARY

- WHIP research capabilities help to fill an engineering develop needs that we have
- Wind is an important component of catastrophe risk analytics
- Understanding how a building fails sometimes requires a different engineering perspective
- Residential and large commercial considerations are different
- There are a lot of opportunities, the challenge is relating to the broad audience of potential industry use cases

- In addition to expanding membership, we need to maintain the IAB we currently have. To that end, end of the year summary reporting and longer term vision statements will be helpful!