Florida Commission on Hurricane Loss Projection Methodology

Professional Team Report

2021 Hurricane Standards

Hurricane Florence

Impact Forecasting

On-Site Review

April 3 – 6, 2023

On April 3-6, 2023, the Professional Team conducted an on-site review of the Impact Forecasting (IF), Atlantic Tropical Cyclone – Wind (FCHLPM) Model Version 2.0 on ELEMENTS Version 17.0. The following individuals participated in the review.

IF

Sushma Bhat, Director
David Colbus, Associate Director
William Dong, Ph.D., Associate Director and Tech Lead, Software Development
Radovan Drinka, Global Head of Tropical Cyclone Model Development
Xian He, Ph.D., Senior Scientist
Daniel Head, Director
Steven Jakubowski, President
Yujin Liang, Ph.D., P.E., Director, Catastrophe Model Development
Maria Lomelo, Managing Director, Global Program Director
Chris Long, Director, Software and Analytics
Minchong Mao, FCAS, CCRMP, MAAA, Senior Managing Director, Actuary, Aon Reinsurance Solutions
Nehal Naik, Managing Director, Software Development
Sami Pant, Ph.D., P.E., Senior Scientist
Purvish Patel, Director of Software Quality Assurance
Sri Harshitha Polamuri, Ph.D., Senior Scientist
Venkatesh Ramaiah, Associate Director
Will Skinner, Managing Director, Global Head of Business Development
Hailey Smith, Director – Analytics, Aon Reinsurance Solutions
Radek Solnicky, Senior Scientist
Shruthi Srikantegowda, IND Group Manager Reinsurance Solutions - Technology
Corbin Tucker, Senior Analyst
Vipin Unnikrishnan, Ph.D., Associate Director
Chad Xu, Catastrophe Actuarial Analyst
Karthik Yarasuri, Senior Scientist – Wind Vulnerability

Professional Team

Jimmy Booth, Ph.D., Meteorology
Paul Fishwick, Ph.D., Computer/Information, Team Leader
Stu Mathewson, FCAS, MAAA, Actuarial
Chris Nachtsheim, Ph.D., Statistics
Masoud Zadeh, Ph.D., P.E., Vulnerability
Donna Sirmons, Staff

The Professional Team began the review with an opening briefing and introductions were made. IF provided a detailed explanation of updates to the model.

- Update of HURDAT2 and Sea-Surface Temperature data to the latest vintage
- Update of terrain roughness to be consistent with NLCD 2019 data
- Regeneration of stochastic storm set with outlier handling
- Upgrade of importance sampling to consider maximum windspeeds, Rmax, and decay rate at landfall
- Update of the ZIP Code database to November 2021 data

- Recalibration of vulnerability curves with additional insurance claims data
- New primary construction classes
- Application of secondary modifiers revised
- Update of secondary modifiers and risk characteristics to be dependent on region and year-built bands
- Updated methodology to calculate appurtenant structure loss
- Law and ordinance assumption in vulnerability curves

The audit continued with a review of each standards section.

During the Commission meeting to review the model for acceptability under the 2021 Hurricane Standards, Impact Forecasting is to present the following information in the Trade Secret closed session as specified on page 64 of the *Hurricane Standards Report of Activities as of November 1, 2021*:

1. Detailed information and discussion of Forms V-3 and V-5,
2. Discussion on how the model addresses the impacts of the claims environment, the legal environment, and litigation effects on modeled losses, and
3. Detailed information and discussion of relativities in Form A-6.

Report on Deficiencies

The Professional Team reviewed the following deficiencies cited by the Commission at the January 5, 2023 meeting. The deficiencies were eliminated by the established time frame, and the modifications have been verified.

1. G-1.7, page 30: Unclear. Second and third paragraphs under Geocoding and Software Changes contradict responses to disclosures V-1.1 (page 90) and V-4.1 (page 106).

2. G-2.2, Figure 8, page 39: Incomplete. Several individuals appearing in Figure 8 are not mentioned in Table 2.

3. Form M-1, page 154: Incomplete. List of hurricanes is not provided in F.

4. CI-4, page 135: Incomplete. No response provided for H. (see Report of Activities, page 56).

5. CI-6.A, page 140: Non-responsive. Response is a restatement of the standard (see Report of Activities, page 56).

Professional Team Pre-Visit Letter

The Professional Team's pre-visit letter questions are provided in the report under the corresponding standards. Following is the pre-visit letter preamble.

The purpose of this pre-visit letter is to outline specific issues unique to Impact Forecasting's model submission under the 2021 hurricane standards, and to identify lines of inquiry that

will be followed during the on-site review in order to allow time for adequate preparation. Aside from due diligence with respect to the full submission, various questions that the Professional Team will ask during the on-site review are provided herein. This letter does not preclude the Professional Team from asking for additional information during the review that is not given below or discussed during an upcoming conference call to be held if requested by Impact Forecasting. One goal of the potential conference call is to address your questions related to this letter or other matters pertaining to the on-site review. The overall intent is to help expedite the on-site review and to avoid last minute preparations that could have been undertaken earlier.

The Professional Team will also consider material provided in response to the deficiencies designated by the Florida Commission on Hurricane Loss Projection Methodology (Commission) during the January 5, 2023, meeting.

It is important that all material prepared for presentation during the on-site review be provided to the Professional Team and presented using a medium that is readable by all members of the Professional Team simultaneously.

The Professional Team will begin the review with an opening briefing. Impact Forecasting should then proceed with a detailed explanation of new or extensively updated material related to the model followed by a review of each hurricane standard commencing with responses to the pre-visit letter questions followed by responses to the audit items for each hurricane standard in the *Hurricane Standards Report of Activities as of November 1, 2021*.

If changes have been made in any part of the model or the modeling process from the descriptions provided in the original November 1, 2022, submission, provide the Professional Team with a complete and detailed description of those changes, the reasons for the changes (e.g., an error was discovered), and any revised forms. For each revised form, provide an additional form with cell-by-cell differences between the revised and the original submitted values.

Refer to the On-Site Review chapter of the *Hurricane Standards Report of Activities as of November 1, 2021*, for more details on materials to be presented and provided to the Professional Team. Particular attention should be paid to the requirements under Presentation of Materials. These requirements are reproduced at the conclusion of this letter.

In addition to the 6 items listed under Presentation of Materials, provide upon arrival of the Professional Team, and before the review can officially commence, printed copies of:

1. Flowchart standard documents if internally developed, or references to published standards, and

2. Software engineering practice and coding guidelines if internally developed, or references to published standards.

While the Report of Activities specifies 6 printed copies, an additional Professional Team member will be in attendance. Please have available 7 printed copies of all materials.
The pre-visit questions are grouped by hurricane standards sections.

Editorial Items

Editorial items in the submission documentation were noted by the Professional Team in the pre-visit letter for correction prior to the start of the on-site review in order to facilitate efficiency during the review and to avoid last minute edits. Additional editorial items identified during the review are also included below.

The Professional Team reviewed the following corrections to be included in the revised submission to be provided to the Commission no later than 10 days prior to the meeting to review the model for acceptability. Page numbers below correspond to the initial November 1, 2022 submission document.

1. List of Tables, Table 23, page 9: Hurricane Matthew year corrected.
2. List of Figures, page 10: Figure 1 and Figure 16 titles corrected.
3. G-1.2, page 15: Revised for clarification.
4. G-1.7, page 29: Revised for clarification.
5. G-1.7, pages 31-33: Figures 4-7 regenerated. Additional model updates added. Reference to grid winds added.
6. G-2, pages 34-40: Page heading corrected.
7. G-2.1E, page 35: Disclosure wording corrected.
8. G-2.2, pages 38-39: Table 2, response to B updated, and Figure 8 corrected.
9. G-3, pages 41-43: Removed references to ZIP Code Terrain Factors and ZIP Code Gust Factors. Description of vulnerability tiers updated.
10. M-4.8, pages 58-59: Figure captions updated.
11. S-1.1, page 66-68: *P*-value for annual occurrence updated. Figures 18 and 19 corrected. DeMaria and Kaplan reference date corrected.
12. S-1.2, page 69: Tropical Cyclone Reports reference date corrected.
13. S-4.1, page 84: Final sentence reworded for clarity.
14. S-5.1, pages 85-87: Table 5 and Figure 32 corrected.
15. S-6, page 88: Page heading corrected.
16. S-6.1, page 88: Missing Standard number added to 4.
17. V-1.1, page 90: Last paragraph removed.
18. V-1.3, pages 92-93: Tables 6 and 7 corrected.
19. V-4, pages 105-109: Page heading corrected.
20. V-4.2, page 107: Revised for clarity.
21. A-4.E, page 120: Dates corrected for consistency.
22. A-4.3, page 122: Number of historical hurricanes revised for consistency.
23. CI-3.B, page 133: ISO acronym defined.
24. CI-4.1, page 136: ELEMENTS version corrected in Table 12.
25. CI-5, pages 137-139: Page headings corrected.
26. CI-6, page 140: Page heading corrected.
27. CI-8.1, pages 144-145: Acronyms defined.
28. Form S-4, pages 168-173: Heading corrected.

29. Form S-4, pages 171-172: Corrected date for Irma above Table 22. Corrected Figure 50 title. Added * footnote under Table 22. Table 23 and Figure 51 corrected to be labeled as Hurricane Michael. Table 24 corrected.
30. Form V-2, pages 194-196: Page heading corrected.
31. Form V-4.A, page 198: Table number corrected.
32. Form A-1, pages 202-204: Figures 62-64 corrected.
33. Form A-2, 206-208: Form A-2 corrected.
34. Appendix B, page 297: Additional personnel added.
35. Appendix E, pages 312-313: Added acronyms omitted from the list.

GENERAL HURRICANE STANDARDS – Paul Fishwick, Leader

G-1 Scope of the Hurricane Model and Its Implementation*

*(*Significant Revision)*

A. The hurricane model shall project loss costs and probable maximum loss levels for damage to insured residential property from hurricane events.

B. A documented process shall be maintained to assure continual agreement and correct correspondence of databases, data files, and computer source code to presentation materials, scientific and technical literature, and modeling organization documents.

C. All software, data, and flowcharts (1) located within the hurricane model, (2) used to validate the hurricane model, (3) used to project modeled hurricane loss costs and hurricane probable maximum loss levels, and (4) used to create forms required by the Commission in the Hurricane Standards Report of Activities shall fall within the scope of the Computer/ Information Hurricane Standards and shall be located in centralized, model-level file areas.

D. A subset of the forms shall be produced through an automated procedure or procedures as indicated in the form instructions.

E. Vintage of data, code, and scientific and technical literature used shall be justifiable.

Audit

1. Automated procedures used to create forms will be reviewed.

2. All primary scientific and technical literature that describes the underlying hurricane model theory and implementation (where applicable) should be available for review in hard copy or electronic form. Modeling-organization-specific publications cited must be available for review in hard copy or electronic form.

3. Compliance with the process prescribed in Hurricane Standard G-1.B in all stages of the modeling process will be reviewed.

4. Items specified in Hurricane Standard G-1.C will be reviewed as part of the Computer/ Information Hurricane Standards.

5. Maps, databases, and data files relevant to the submission will be reviewed.

6. Justification for the vintage of data, code, and scientific and technical literature used will be reviewed.

7. The following information related to changes in the hurricane model, since the initial submission for each subsequent revision of the submission, will be reviewed.
   A. Hurricane model changes:
      1. A summary description of changes that affect, or are believed to affect, the personal or commercial residential hurricane loss costs or hurricane probable maximum loss levels,
      2. A list of all other changes, and
      3. The rationale for each change.
   B. Percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named *"hlpm2017c.zip"* for:
      1. All changes combined, and
      2. Each individual hurricane model component and subcomponent change.
   C. For any modifications to Form A-4, Hurricane Output Ranges, since the initial submission, a newly completed Form A-5, Percentage Change in Hurricane Output Ranges, with:
      1. The initial submission as the baseline for computing the percentage changes, and
      2. Any intermediate revisions as the baseline for computing the percentage changes.
   D. Color-coded maps by county reflecting the percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named *"hlpm2017c.zip"* for each hurricane model component change, between:
      1. The currently accepted hurricane model and the revised hurricane model,
      2. The initial submission and the revised submission, and
      3. Any intermediate revisions and the revised submission.

Pre-Visit Letter

1. G-1.B, page 12: Explain the coordination across personnel.

2. G-1.2, page 15: Under Vulnerability Component paragraph 3, explain the "statistical sampling for various wind loading conditions." Discuss how the model accounts for variability on the capacity side, e.g., strength of building material.

3. G-1.3, Figure 2, page 16: Describe how by-passing hurricanes fit into the flowchart. Describe how hurricane tracks from genesis fit into the flowchart.

4. G-1.7, page 29: Explain how the vulnerability curves have been recalibrated based on updated hazard intensities. Explain how this recalibration conforms to Standard G-4.

5. G-1.7, page 30: Explain the basis for "historical claims data is assumed to have a required 25% law and ordinance coverage."

6. G-1.7, page 30: Explain in detail the basis for the changes in methodology to calculate the effect of secondary modifiers and to calculate appurtenant structure loss.

7. G-1.7, Figure 4, page 31: Explain the 10% to 20% increase in Holmes County versus the -10% to -5% decrease in neighboring Walton and Washington Counties.

8. G-1.7, Figure 5, page 31: Explain why DeSoto County has decreased (-5% to 0%) and neighboring Hardee County has increased (10% to 20%) due to changes in the vulnerability component.

9. G-1.7, page 32: Explain the scope and type of software indicated in Figure 6.

10. G-1.7, Figure 7, page 33: Explain the overall change in Hardee County as it relates to the changes due to individual components.

11. G-1.7, pages 29-33: Explain how interim software updates, if performed, over the past two years mesh with Standard G-1.7.

Verified: YES

Professional Team Comments:

Reviewed the model updates, the rationale for each change, and the impact of the changes on loss costs.

Discussed the process used for coordinating personnel across multiple areas.

Reviewed the process and tools used to ensure agreement among databases, data files, and software codes.

Discussed how bypassing hurricanes are included in the Figure 2 flowchart.

Discussed the process for recalibrating the vulnerability curves based on updated hazard intensities.

Discussed the assumption that claims data have 25% law and ordinance included.

Discussed the reasons for the change in loss costs in Holmes, Walton, and Washington Counties in revised Figure 4, Hazard Component Changes.

Discussed the error in mapping that produced the percentage changes from the current acceptable model in Figures 4-7.

Discussed that the revised Figure 6 for Software Only changes includes the change in methodology to calculate appurtenant structure loss and to calculate the effect of secondary modifiers on loss.
Discussed the reasons for the change in loss costs in Sumter and Flagler Counties.

Discussed the reasons for the change in loss costs in Hardee and Putnam Counties in revised Figure 7, Overall Model Changes.

Discussed that no interim software updates have been performed since the current accepted model.

G-2 Qualifications of Modeling Organization Personnel and Consultants Engaged in Development of the Hurricane Model*

*(*Significant Revision)*

A. Hurricane model construction, testing, and evaluation shall be performed by modeling organization personnel or consultants who possess the necessary skills, formal education, and experience to develop the relevant components for hurricane loss projection methodologies.

B. The hurricane model and hurricane model submission documentation shall be reviewed by modeling organization personnel or consultants in the following professional disciplines with requisite experience: structural/wind engineering (currently licensed Professional Engineer), statistics (advanced degree or equivalent experience), actuarial science (Associate or Fellow of Casualty Actuarial Society or Society of Actuaries), meteorology (advanced degree), and computer/information science (advanced degree or equivalent experience and certifications). These individuals shall certify Expert Certification Forms G-1 through G-6 as applicable.

Audit

1. The professional vitae of personnel and consultants engaged in the development of the hurricane model and responsible for the current hurricane model and the submission will be reviewed. Background information on the professional credentials and the requisite experience of individuals providing testimonial letters in the submission will be reviewed.

2. Forms G-1, General Hurricane Standards Expert Certification; G-2, Meteorological Hurricane Standards Expert Certification; G-3, Statistical Hurricane Standards Expert Certification; G-4, Vulnerability Hurricane Standards Expert Certification; G-5, Actuarial Hurricane Standards Expert Certification; G-6, Computer/Information Hurricane Standards Expert Certification, and all independent peer reviews of the hurricane model under consideration will be reviewed. Signatories on the individual forms will be required to provide a description of their review process.

3. Incidents where modeling organization personnel or consultants have been found to have failed to abide by the standards of professional conduct adopted by their profession will be discussed.

4. For each individual listed under Disclosure 2.A, specific information as to any consulting activities and any relationship with an insurer, reinsurer, trade association, governmental entity, consumer group, or other advocacy group within the previous four years will be reviewed.

Pre-Visit Letter

12. G-2.2B, page 38: Provide resumes of the new personnel.

Verified: YES

Professional Team Comments:

Reviewed resumes of new personnel:

- Poozkiunnath Sukumaran Arun, M.Tech in Remote Sensing, Biria Institute of Technology, Mesra, Ranchi, India; B.E. in Civil Engineering, Pune University, Pune, India
- David Colbus, M.A. in Climate and Society, Columbia University, New York City, NY; B.A. in Anthropology, University of Miami, Coral Gables, FL
- Radovan Drinka, M.S. in Physics, Comenius University, Bratislava, Slovakia
- Pooja Maan, M.B.A. in Finance, IBS (ICFAI Business School), Hyderabad, India; B.Com. Kurukshetra University, Thanesar, India
- Jinil Moses V, M.Tech. in Remote Sensing, Bharathidasan University, Tiruchirappalli, India; M.S. in Applied Geology, Anna University, Chennai, India; B.S. in Geology, Manonmaniam Sundaranar University, V.O.C. College, Tutucorin, India
- Sri Harshitha Polamuri, Ph.D. in Civil Engineering, Clemson University, Clemson, SC; M.Tech. in Structural Engineering, JNTUH College of Engineering, Hyderabad, India; B.S. in Civil Engineering, JNTUH College of Engineering, Hyderabad, India
- Corbin Tucker, M.S. in Applied Mathematics, University of Illinois at Urbana-Champaign, Champaign, IL; B.S. in Mathematics, Tennessee Technological University, Cookeville, TN
- Chad Xu, M.S. in Actuarial Science, Temple University, Philadelphia, PA; M.S., University of Dayton, Dayton, OH; B.S. in Applied Mathematics, Jiangsu Second Normal University, Nanjing, China

Discussed the process for training new employees.

Discussed that there were no departures of personnel attributable to professional misconduct.

G-3 Insured Exposure Location

A. ZIP Codes used in the hurricane model shall not differ from the United States Postal Service publication date by more than 24 months at the date of submission of the hurricane model. ZIP Code information shall originate from the United States Postal Service.

B. ZIP Code centroids, when used in the hurricane model, shall be based on population data.

C. ZIP Code information purchased by the modeling organization shall be verified by the modeling organization for accuracy and appropriateness.

D. If any hurricane model components are dependent on ZIP Code databases, a logical process shall be maintained for ensuring these components are consistent with the recent ZIP Code database updates.

E. Geocoding methodology shall be justified.

Audit

1. Geographic displays for all ZIP Codes will be reviewed.
2. Geographic comparisons of previous to current locations of ZIP Code centroids will be reviewed.
3. Third party vendor information, if applicable, and a complete description of the process used to validate ZIP Code information will be reviewed.
4. The treatment of ZIP Code centroids over water or other uninhabitable terrain will be reviewed.
5. Examples of geocoding for complete and incomplete street addresses will be reviewed.
6. Examples of latitude-longitude to ZIP Code conversions will be reviewed.
7. Hurricane model ZIP Code-based databases will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed the modeler's geographic information system (GIS) approach.

Discussed the ZIP Code database update and the associated data processing procedures.

Reviewed geographical comparison of Tier assignment zones to ZIP Codes between the current accepted model and the model under review.

Reviewed the methodology for population-weighted windspeeds to represent ZIP Code windspeeds for both stochastic and historical storms. Discussed that there was no change in methodology from the current accepted model.

Discussed how the ZIP Code data from third-party vendors are validated.

Reviewed examples of geocoding for complete and incomplete street addresses.

Reviewed examples of assigning ZIP Codes to latitude-longitude points.

G-4 Independence of Hurricane Model Components

The meteorology, vulnerability, and actuarial components of the hurricane model shall each be theoretically sound without compensation for potential bias from other components.

Audit

1. The hurricane model components will be reviewed for adequately portraying hurricane phenomena and effects (damage, hurricane loss costs, and hurricane probable maximum loss levels). Attention will be paid to an assessment of (1) the theoretical soundness of each component, (2) the basis of the integration of each component into the hurricane model, and (3) consistency between the results of one component and another.

2. All changes in the hurricane model since the previous submission that might impact the independence of the hurricane model components will be reviewed.

Verified: YES

Professional Team Comments:

There was no evidence to suggest one component of the model was adjusted to compensate for another component.

G-5 Editorial Compliance

The submission and any revisions provided to the Commission throughout the review process shall be reviewed and edited by a person or persons with experience in reviewing technical documents who shall certify on Form G-7, Editorial Review Expert Certification, that the submission has been personally reviewed and is editorially correct.

Audit

1. An assessment that the person who has reviewed the submission has experience in reviewing technical documentation and that such person is familiar with the submission requirements as set forth in the *Hurricane Standards Report of Activities as of November 1, 2021* will be made.

2. Attestation that the submission has been reviewed for grammatical correctness, typographical accuracy, completeness, and no inclusion of extraneous data or materials will be assessed.

3. Confirmation that the submission has been reviewed by the signatories on the Expert Certification Forms G-1 through G-6 for accuracy and completeness will be assessed.
4. The modification history for submission documentation will be reviewed.

5. A flowchart defining the process for form creation will be reviewed.

6. Form G-7, Editorial Review Expert Certification, will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed the process for modifying and reviewing submission documentation.

Reviewed flowchart defining the process for submission form creation.

Editorial items noted in the pre-visit letter and during the review by the Professional Team were satisfactorily addressed. The Professional Team has reviewed the submission per Audit item 3, but cannot guarantee that there are no remaining editorial issues. The modeler is responsible for eliminating editorial errors.

METEOROLOGICAL HURRICANE STANDARDS – Jimmy Booth, Leader

M-1 Base Hurricane Storm Set*

*(*Significant Revision)*

The Base Hurricane Storm Set is the National Hurricane Center HURDAT2 as of June 10, 2021 (or later), incorporating the period 1900-2020. A model may be constructed in any scientifically sound and defensible fashion. However, annual frequencies used in hurricane model validation shall be based upon the Base Hurricane Storm Set, allowing for modifications if justified. Complete additional season increments and updates to individual historical storms that are approved by the National Hurricane Center are acceptable modifications, as are weighting and partitioning of the Base Hurricane Storm Set, if it is justified in current scientific and technical literature.

Audit

1. The modeling organization Base Hurricane Storm Set will be reviewed.

2. A flowchart illustrating how changes in the HURDAT2 database are used in the calculation of hurricane landfall distribution will be reviewed.

3. Changes to the modeling organization Base Hurricane Storm Set from the currently accepted hurricane model will be reviewed. Any modification by the modeling organization to the information contained in HURDAT2 will be reviewed.

4. Reasoning and justification underlying any short-term, long-term, or other systematic variations in annual hurricane frequencies incorporated in the hurricane model will be reviewed.

5. Modeled probabilities will be compared with observed hurricane frequency using methods documented in current scientific and technical literature. The goodness-of-fit of modeled to historical statewide and regional hurricane frequencies as provided in Form M-1, Annual Occurrence Rates, will be reviewed.

6. Form M-1, Annual Occurrence Rates, will be reviewed for consistency with Form S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year, and Form A-2, Base Hurricane Storm Set Statewide Hurricane Losses.

7. Comparisons of modeled probabilities and characteristics from the complete historical record will be reviewed. Modeled probabilities from any subset, trend, or fitted function will be reviewed, compared, and justified against the complete HURDAT2 database. In the case of partitioning, modeled probabilities from the partition and its complement will be reviewed and compared with the complete HURDAT2 database.

Verified: YES

Professional Team Comments:

Discussed the model changes associated with both the extension and updates to HURDAT2.

Discussed the addition of HadISST sea surface temperature (SST) data for 2019 and 2020 to the historical storm set.

Reviewed the methodology to reduce the effects of outliers in regression models.

Reviewed graphical comparisons among the historical, the current accepted model, and the model under review of the annual landfall statistics for Florida landfall gates.

Reviewed the methodology for reducing the number of stochastic storm tracks and for adjusting landfall frequency.

Discussed that the stochastic catalog and windfield model are not partitioned or weighted with respect to time, i.e., no explicit accounting for climate change.

Reviewed comparisons of modeled to observed landfall frequencies for Florida and neighboring states.

Reviewed comparisons of historical and modeled distributions of forward speed, heading angle, central pressure, and maximum sustained winds. Reviewed the goodness-of-fit Kolmogorov-Smirnov test results.

M-2 Hurricane Parameters and Characteristics*

*(*Significant Revision)*

Methods for depicting all modeled hurricane parameters and characteristics, including but not limited to windspeed, radial distributions of wind and pressure, minimum central pressure, radius of maximum winds, landfall frequency, tracks, spatial and time variant windfields, and conversion factors, shall be based on information documented in current scientific and technical literature.

Audit

1. All hurricane parameters used in the hurricane model will be reviewed.

2. Graphical depictions of hurricane parameters as used in the hurricane model will be reviewed. Descriptions and justification of the following will be reviewed:
   a. The dataset basis for the fitted distributions, the methods used, and any smoothing techniques employed,
   b. The modeled dependencies among correlated parameters in the windfield component and how they are represented, and
   c. The asymmetric structure of hurricanes.

3. The treatment of the inherent uncertainty in the conversion factor used to convert the modeled vortex winds to surface winds will be reviewed and compared with current scientific and technical literature. Treatment of conversion factor uncertainty at a fixed time and location within the windfield for a given hurricane intensity will be reviewed.

4. Scientific literature cited in Hurricane Standard G-1, Scope of the Hurricane Model and Its Implementation, may be reviewed to determine applicability.

5. All external data sources that affect model-generated windfields will be identified, and their appropriateness will be reviewed.

6. Description of and justification for the value(s) of the far-field pressure used in the hurricane model will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed comparisons of modeled and historical Vmax.

Reviewed the flowchart, variable mapping, and code for the relative intensity model.

Reviewed comparison of historical to modeled inland decay rate for Hurricane Jeanne (2004).

Discussed the asymmetry factor added to the stochastic storm windfield.

Discussed the conversion factor used to convert surface winds to gradient level winds.

Discussed the relationship between Vmax and central pressure deficit.

Discussed that the 5X5 grid is used for mapping HURDAT2 data to the model, except for Vmax and Rmax, which are not gridded before being used for fitting distributions.

Discussed the use of the standard deviation of the error from the regression analysis in their stochastic model.

Discussed that the SST for modeling relative intensity accounts for both the month and year of the SST in the historical events.

M-3 Hurricane Probability Distributions*

*(*Significant Revision)*

A. Modeled probability distributions of hurricane parameters and characteristics shall be consistent with historical hurricanes in the Atlantic basin.

B. Modeled hurricane landfall frequency distributions shall reflect the Base Hurricane Storm Set used for category 1 to 5 hurricanes and shall be consistent with those observed for each coastal segment of Florida and neighboring states (Alabama, Georgia, and Mississippi).

C. Hurricane models shall use maximum one-minute sustained 10-meter windspeed when defining hurricane landfall intensity. This applies both to the Base Hurricane Storm Set used to develop landfall frequency distributions as a function of coastal location and to the modeled winds in each hurricane which causes damage. The associated maximum one-minute sustained 10-meter windspeed shall be within the range of windspeeds (in statute miles per hour) categorized by the Saffir-Simpson Hurricane Wind Scale.

Saffir-Simpson Hurricane Wind Scale

Category	Winds (mph)	Damage
1	74 – 95	Minimal
2	96 – 110	Moderate
3	111 – 129	Extensive
4	130 – 156	Extreme
5	157 or higher	Catastrophic

Audit

1. Demonstration of the quality of fit extending beyond the Florida border will be reviewed by evaluating results for appropriate coastal segments in Alabama, Georgia, and Mississippi.

2. The method and supporting material for selecting stochastic storm tracks will be reviewed.

3. The method and supporting material for selecting storm track strike intervals will be reviewed. If strike locations are on a discrete set, the hurricane landfall points for major metropolitan areas in Florida will be reviewed.

4. Any modeling-organization-specific research performed to develop the functions used for simulating hurricane model variables or to develop databases will be reviewed.

5. Form S-3, Distributions of Stochastic Hurricane Parameters, will be reviewed.

Pre-Visit Letter

13. M-3.3, pages 53-54: Explain in detail the robust regression methodology to deal with outliers.

Verified: YES

Professional Team Comments:

Reviewed the methodology to reduce outlier effects.

Reviewed comparisons of standard and robust least-squares fit for different grid cells.

Reviewed goodness-of-fit tests for forward speed, heading angle, central pressure, maximum sustained winds, and Rmax for tracks over Florida and neighboring states.

Discussed the methodology for creating stochastic storm tracks.

Reviewed the probability distributions and data sources provided in Form S-3.

Discussed that the 2X2 grid is used for validation purposes.

Discussed the model fit for Alabama/Mississippi and Georgia.

Discussed that offshore locations are used for the comparisons to allow like-for-like comparison between the model and observations.

Discussed landfall statistics for the Florida Keys.

M-4 Hurricane Windfield Structure*

*(*Significant Revision)*

A. Windfields generated by the hurricane model shall be consistent with observed historical storms affecting Florida.

B. The land use and land cover (LULC) database shall be consistent with National Land Cover Database (NLCD) 2016 or later. Use of alternate datasets shall be justified.

C. The translation of land use and land cover or other source information into a surface roughness distribution shall be consistent with current state-of-the-science and shall be implemented with appropriate geographic-information-system data.

D. With respect to multi-story buildings, the hurricane model shall account for the effects of the vertical variation of winds.

Audit

1. Any modeling-organization-specific research performed to develop the windfield functions used in the hurricane model will be reviewed. The databases used will be reviewed.

2. Any modeling-organization-specific research performed to derive the roughness distributions for Florida and neighboring states will be reviewed.

3. The spatial distribution of surface roughness used in the hurricane model will be reviewed.

4. The previous and current hurricane parameters used in calculating the hurricane loss costs for the LaborDay03 (1935) and NoName09 (1945) hurricane landfalls will be reviewed. Justification for the choices used will be reviewed. The resulting spatial distribution of winds will be reviewed with Form A-2, Base Hurricane Storm Set Statewide Hurricane Losses.

5. For windfields not previously reviewed, detailed comparisons of the hurricane model windfield with Hurricane Charley (2004), Hurricane Wilma (2005), Hurricane Irma (2017), and Hurricane Michael (2018) will be reviewed.

6. Representation of vertical variation of winds in the hurricane model, where applicable, will be reviewed.

7. Form M-2, Maps of Maximum Winds, will be reviewed.

Verified: YES

Professional Team Comments:

Discussed the updated terrain roughness taken from the National Land Cover Database (NLCD) 2019.

Reviewed scatter plot comparison of the change in ZIP Code terrain factor.

Reviewed graphical comparisons of the surface roughness changes resulting in terrain factor increases and terrain factor decreases.

Reviewed maps of the spatial distribution of the model surface roughness and of the terrain factor.

Discussed that roughness length and terrain factor are calculated on the ~1km x ~1km grid.

Discussed that terrain factor is used to account for two processes: modification of the wind based on local terrain and modification based on upstream wind factors.

Discussed the model treatment of fetch.

Discussed that winds are only saved in the model at 10-meter height, but that the gradient level wind is calculated in the model as part of the Willoughby parameterization.

Reviewed maps of the spatial distribution of winds for the LaborDay03 (1935) and NoName09 (1945) storms.

Reviewed comparisons of historical to modeled windfields for Hurricane Charley (2004), Hurricane Wilma (2005), Hurricane Irma (2017), and Hurricane Michael (2018).

Reviewed the Form M-2 maps of maximum windspeeds for historical events, the 100-year and 250-year return period windspeeds.

M-5 Hurricane Landfall and Over-Land Weakening Methodologies*

*(*Significant Revision)*

A. The hurricane over-land weakening rate methodology used by the hurricane model shall be consistent with historical records and with current state-of-the-science.

B. The transition of winds from over-water to over-land within the hurricane model shall be consistent with current state-of-the-science.

Audit

1. The variation in over-land decay rates used in the hurricane model will be reviewed.

2. Comparisons of the hurricane model weakening rates to weakening rates for historical Florida hurricanes will be reviewed.

3. The detailed transition of winds from over-water to over-land (i.e., hurricane landfall, boundary layer) will be reviewed. The region within 5 miles of the coast will be emphasized. Color-coded snapshot maps of roughness length and spatial distribution of over-land and over-water windspeeds for Hurricane Andrew (1992), Hurricane Jeanne (2004), and Hurricane Irma (2017) at the closest time after landfall will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed regression fits for inland decay rates for regions influencing Florida landfalls using historical data.

Reviewed comparisons between modeled and historical over-land decay rates.

Reviewed comparisons of the modeled windfield with historical observed windspeeds for Hurricane Andrew (1992), Hurricane Jeanne (2004), and Hurricane Irma (2017).

Reviewed the track variables used in calculating the decay-rate constant.

Discussed re-intensification for tracks that make landfall and then move back over water.

M-6 Logical Relationships of Hurricane Characteristics*

*(*Significant Revision)*

A. The magnitude of asymmetry shall increase as the translation speed increases, all other factors held constant.

B. The mean windspeed shall decrease with increasing surface roughness (friction), all other factors held constant.

Audit

1. The logical relationship between windspeed and surface roughness will be reviewed.
2. Form M-2, Maps of Maximum Winds, will be reviewed.
3. Form M-3, Radius of Maximum Winds and Radii of Standard Wind Thresholds, and the modeling organization sensitivity analyses will be reviewed.
4. Justification for the relationship between central pressure and radius of maximum winds will be reviewed. The relationships among intensity, Rmax, and their changes will be reviewed.
5. Justification for the variation of the asymmetry with the translation speed will be reviewed.
6. Methods (including any software) used in verifying these logical relationships will be reviewed.
7. Time-based contour animations (capable of being paused) of windfield distributions demonstrating scientifically-reasonable windfield characteristics and logical relationships will be reviewed.

Pre-Visit Letter

14. Form M-3, page 162: Explain the change in outer radii >40mph values from the current accepted model.

Verified: YES

Professional Team Comments:

Discussed the changes in Form M-3 due to changes in the form in the 2021 Report of Activities.

Reviewed the calculation for Rmax.

Discussed the modeled relationship between central pressure and Rmax.

Discussed the relationships among intensity, Rmax, and their changes.

Discussed the variability observed in the relationship between central pressure and Rmax.

Viewed animations showing the wind evolution and its sensitivity to changes in track forward speed (for wind asymmetry purposes) and, separately, changes in terrain factor.

STATISTICAL HURRICANE STANDARDS – Chris Nachtsheim, Leader

S-1 Modeled Results and Goodness-of-Fit*

*(*Significant Revision)*

A. The use of historical data in developing the hurricane model shall be supported by rigorous methods published in current scientific and technical literature.

B. Modeled and historical results shall reflect statistical agreement using current scientific and statistical methods for the academic disciplines appropriate for the various hurricane model components or characteristics.

Audit

1. Forms S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year; S-2, Examples of Hurricane Loss Exceedance Estimates; and S-3, Distributions of Stochastic Hurricane Parameters, will be reviewed. Justification for the distributions selected, including for example, citations to published literature or analyses of specific historical data, will be reviewed. Justification for the goodness-of-fit tests used will also be reviewed.

2. The modeling organization characterization of uncertainty for windspeed, damage estimates, annual hurricane loss, hurricane probable maximum loss levels, and hurricane loss costs will be reviewed.

3. Regression analyses performed will be reviewed, including for example parameter estimation, graphical summaries and numerical measures of the quality of fit, residual analysis and verification of regression assumptions, outlier treatment, and associated uncertainty assessment.

Pre-Visit Letter

15. S-1, pages 67-74: Explain why the *p*-values are getting lower across the board.

16. S-1.1, Figure 19, page 68: Justify the fit. Although the K-S test rates this as a "pass," it is clear from the figure that for the 25% strongest storms in this cell, the central pressure is on the high side. Provide additional plots of cells, including cell 27N/80W from the current accepted model.

17. S-1.6, Figure 24, page 74: Justify the model Rmax distribution given that it appears to be biased on the low side (measured distribution appears stochastically larger than the modeled distribution).

Verified: YES

Professional Team Comments:

Reviewed scatter plot and linear fit for the change in average ZIP Code terrain factor.

Reviewed comparison between modeled and historical central pressure distributions.

Reviewed comparison of the Rmax distribution for the current accepted model and the model under review.

Reviewed the goodness-of-fit test of the negative binomial distribution to the annual frequency of landfalls as given in Form S-1.

Reviewed the use of t tests for goodness-of-fit testing for model vulnerability functions. Discussed alternative approaches.

Reviewed Form S-3.

S-2 Sensitivity Analysis for Hurricane Model Output

The modeling organization shall have assessed the sensitivity of temporal and spatial outputs with respect to the simultaneous variation of input variables using current scientific and statistical methods in the appropriate disciplines and shall have taken appropriate action.

Audit

1. The modeling organization's sensitivity analysis will be reviewed in detail. Statistical techniques used to perform sensitivity analysis will be reviewed. The results of the sensitivity analysis displayed in graphical format (e.g., color-coded contour plots with temporal animation) will be reviewed.

2. Form S-6, Hypothetical Events for Sensitivity and Uncertainty Analysis, will be reviewed, if applicable.

Verified: YES

Professional Team Comments:

Reviewed the sensitivity analysis for hurricane loss costs and hourly windspeeds in Form S-6.

Reviewed animations of the sensitivity analysis results for central pressure, Rmax, forward speed, shape parameter, far field pressure, and inland decay rate for Category 1, 3, and 5 hurricanes.

S-3 Uncertainty Analysis for Hurricane Model Output

The modeling organization shall have performed an uncertainty analysis on the temporal and spatial outputs of the hurricane model using current scientific and statistical methods in the appropriate disciplines and shall have taken appropriate action. The analysis shall identify and quantify the extent that input variables impact the uncertainty in hurricane model output as the input variables are simultaneously varied.

Audit

1. The modeling organization uncertainty analysis will be reviewed in detail. Statistical techniques used to perform uncertainty analysis will be reviewed. The results of the uncertainty analysis displayed in graphical format (e.g., color-coded contour plots with temporal animation) will be reviewed.

2. Form S-6, Hypothetical Events for Sensitivity and Uncertainty Analysis, will be reviewed, if applicable.

Verified: YES

Professional Team Comments:

Reviewed the uncertainty analysis for hurricane loss costs and hourly windspeeds in Form S-6.

Reviewed animations of the uncertainty analysis results for central pressure, Rmax, forward speed, shape parameter, far field pressure, and inland decay rate for Category 1, 3, and 5 hurricanes.

S-4 County Level Aggregation

At the county level of aggregation, the contribution to the error in hurricane loss cost estimates attributable to the sampling process shall be negligible.

Audit

1. The accuracy associated with Nassau County will be reviewed. The contribution of simulation uncertainty via confidence intervals will be reviewed.

Pre-Visit Letter

18. S-4.1, page 84: Explain in more detail the *modified* importance sampling procedure.

Verified: YES

Professional Team Comments:

Discussed discretization procedure for landfalling and bypassing events.

Discussed that the contribution attributable to the sampling process is negligible.

S-5 Replication of Known Hurricane Losses*

*(*Significant Revision)*

The hurricane model shall estimate incurred hurricane losses in an unbiased manner on a sufficient body of past hurricane events from more than one company, including the most current data available to the modeling organization. This standard applies separately to personal residential and, to the extent data are available, to commercial residential. Personal residential hurricane loss experience may be used to replicate structure-only and contents-only hurricane losses. The replications shall be produced on an objective body of hurricane loss data by county or an appropriate level of geographic detail and shall include hurricane loss data from Hurricane Irma (2017) and Hurricane Michael (2018), to the extent data are available for these storms.

Audit

1. The following information for each insurer and hurricane will be reviewed:
   a. The validity of the hurricane model assessed by comparing projected hurricane losses produced by the hurricane model to actual observed hurricane losses incurred by insurers at both the state and county level,
   b. The version of the hurricane model used to calculate modeled hurricane losses for each hurricane provided,
   c. A general description of the data and its source,
   d. A disclosure of any material mismatch of exposure and hurricane loss data problems, or other material consideration,
   e. The date of the exposures used for modeling and the date of the hurricane,
   f. An explanation of differences in the actual and modeled hurricane parameters,
   g. A listing of the departures, if any, in the windfield applied to a particular hurricane for the purpose of validation and the windfield used in the hurricane model under consideration,
   h. The type of cover applied in each hurricane to address:
      1. Personal versus commercial
      2. Residential structures
      3. Manufactured homes
      4. Commercial residential
      5. Condominiums
      6. Structures only
      7. Contents only
      8. Time element,
   i. The treatment of demand surge or loss adjustment expenses in the actual hurricane losses or the modeled hurricane losses, and
   j. The treatment of flood losses (including hurricane storm surge losses) in the actual hurricane losses or the modeled hurricane losses.

2. The following documentation will be reviewed:
   a. Publicly available documentation referenced in the submission in hard copy or electronic form,

b. The data sources excluded from validation and the reasons for excluding the data from review by the Commission (if any),
c. An analysis that identifies and explains anomalies observed in the validation data, and
d. User input data for each insurer and hurricane detailing specific assumptions made with regard to exposed property.

3. The confidence intervals used to gauge the comparison between historical and modeled hurricane losses will be reviewed.

4. Form S-4, Validation Comparisons, will be reviewed.

5. The results of one hurricane event for more than one insurance company and the results from one insurance company for more than one hurricane event will be reviewed to the extent data are available.

Pre-Visit Letter

19. S-5.1, pages 86-87: Provide Table 5 with the actual values rather than scaled values along with a scatterplot of these unscaled values.

20. S-5.1, Table 5, page 87: Explain why the Claims and Modeled Loss for 2020 Hurricanes Eta, Isaias, Sally and Zeta are combined. Provide the Modeled and Claims for these storms separately as given in Figure 32 (page 85).

21. S-5.1, Table 5, page 87: Explain why Modeled Loss is zero for Hurricane Hermine for Company D with over $1M in Claims, whereas Modeled Loss is $504,602 corresponding to about $116,000 Claims for Company F.

22. S-5.1, pages 86-87: Explain the differences between hurricane claims data in Table 5 relative to Table 4 as given in the current accepted model.

23. Form S-4, Table 23, page 172: Explain the differences compared to the current accepted model (e.g., wood frame for company actual went from 0.04% to 0.309% and modeled went from 0.04% to 0.395%.)

24. Form S-4, page 173: Explain why the plotted data in Figure 52 changed while Table 24 is the same as given in the current accepted model.

Verified: YES

Professional Team Comments:

Reviewed scatterplot of actual versus modeled losses with unscaled values by client and event.

Discussed that the claims and modeled losses for 2020 Hurricanes Eta, Isaias, Sally, and Zeta were combined in Table 5. Reviewed the data separated for these events.

Reviewed the corrected modeled loss for Hurricane Hermine (2016) in Table 5.

Reviewed the modeled loss and claims data in Tables 4 and 5 with unscaled values.

Discussed the error in labeling Table 23 in Form S-4.

Discussed that Table 24 was not correctly updated with new data.

Reviewed maps comparing modeled losses to claims by county.

Discussed the treatment of claims data used for model validation.

Reviewed comparisons of modeled losses to claims by client and policy type, and by event and policy type.

Reviewed comparisons of modeled losses to claims by coverage and client, and by coverage and event for personal residential, mobile homes, commercial residential, and condominiums.

Reviewed comparisons of modeled losses to claims by client and event for structure, contents, and time-element.

Reviewed comparison of modeled losses to claims for Hurricane Wilma (2005).

S-6 Comparison of Projected Hurricane Loss Costs*

*(*Significant Revision)*

The difference, due to uncertainty, between historical and modeled annual average statewide hurricane loss costs shall be reasonable, given the body of data, by established statistical expectations and norms.

Audit

1. Form S-5, Average Annual Zero Deductible Statewide Hurricane Loss Costs – Historical versus Modeled, will be reviewed for consistency with Hurricane Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 7.

2. Justification for the following will be reviewed:
   a. Meteorological parameters,
   b. The effect of by-passing hurricanes,
   c. The effect of actual hurricanes that had two landfalls impacting Florida,
   d. The departures, if any, from the windfield, vulnerability functions, or insurance functions applied to the actual hurricanes for the purposes of this test and those used in the hurricane model under consideration, and
   e. Exposure assumptions.

Verified: YES

Professional Team Comments:

Discussed that hurricane parameters are treated the same in the historical and stochastic storm sets.

Discussed the effects of bypassing and multiple landfalling hurricanes on modeled losses.

VULNERABILITY HURRICANE STANDARDS – Masoud Zadeh, Leader

V-1 Derivation of Building Hurricane Vulnerability Functions*

*(*Significant Revision)*

A. Development of the building hurricane vulnerability functions shall be based on at least one of the following: (1) insurance claims data, (2) laboratory or field testing, (3) rational structural analysis, and (4) post-event site investigations. Any development of the building hurricane vulnerability functions based on rational structural analysis, post-event site investigations, and laboratory or field testing shall be supported by historical data.

B. The derivation of the building hurricane vulnerability functions and the treatment of associated uncertainties shall be theoretically sound and consistent with fundamental engineering principles.

C. Residential building stock classification shall be representative of Florida construction for personal and commercial residential buildings.

D. Building height/number of stories, primary construction material, year of construction, location, building code, and other construction characteristics, as applicable, shall be used in the derivation and application of building hurricane vulnerability functions.

E. Hurricane vulnerability functions shall be separately derived for commercial residential building structures, personal residential building structures, manufactured homes, and appurtenant structures.

F. The minimum windspeed that generates damage shall be consistent with fundamental engineering principles.

G. Building hurricane vulnerability functions shall include damage as attributable to windspeed and wind pressure, water infiltration, and missile impact associated with hurricanes. Building hurricane vulnerability functions shall not include explicit damage to the building due to flood (including hurricane storm surge and wave action).

Audit

1. Modifications to the building vulnerability component of the hurricane model since the currently accepted hurricane model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications and their impacts on the building vulnerability component.

2. Comparisons of the building hurricane vulnerability functions with the currently accepted hurricane model will be reviewed.

3. Historical data in the original form will be reviewed with explanations for any changes made and descriptions of how missing or incorrect data were handled. When historical data are used to develop building hurricane vulnerability functions, the goodness-of-fit of the data will be reviewed. Complete reports detailing loading conditions and damage states for any laboratory or field-testing data used will be reviewed. When rational structural analysis is used to develop building hurricane vulnerability functions, such analyses will be reviewed for a variety of different building construction classes. Laboratory or field tests and original post-event site investigation reports will be reviewed.

4. All scientific and technical literature, reports, and studies used in the continual development of the building hurricane vulnerability functions must be available for review in hard copy or electronic form.

5. Multiple samples of building hurricane vulnerability functions for commercial residential building structures, personal residential building structures, manufactured homes, and appurtenant structures will be reviewed. The magnitude of logical changes among these items for a given windspeed and validation materials will be reviewed.

6. Justification for the construction classes and characteristics used will be reviewed.

7. Validation of the building hurricane vulnerability functions and the treatment of associated uncertainties will be reviewed.

8. Documentation and justification for the effects on the building hurricane vulnerability functions due to local and regional construction practices, and statewide and local building codes and their enforcement will be reviewed. If year of construction or geographical location of building is used as a surrogate for building code and code enforcement, complete supporting information for the number of year of construction groups used as well as the year-band and geographical regions of construction that separate particular groups will be reviewed.

9. Validation material for the disclosed minimum windspeed will be reviewed. The computer code showing the inclusion of the minimum windspeed at which damage occurs will be reviewed.

10. The breakdown of new hurricane claims data into number of policies, number of insurers, dates of hurricane loss, amount of hurricane loss, and amount of dollar exposure, separated into personal residential, commercial residential, and manufactured homes will be reviewed. Indicate whether or not the new hurricane claims datasets were incorporated into the hurricane model. Research performed and analyses on the new hurricane claims datasets and the impact on hurricane vulnerability functions will be reviewed.

11. How the claim practices of insurance companies are accounted for when hurricane claims data for those insurance companies are used to develop or to verify building hurricane vulnerability functions will be reviewed. Examples include the level of damage the insurer considers a loss to be a total loss, claim practices of insurers with respect to concurrent causation, the impact of public adjusting, or the impact of the legal environment.

12. The percentage of damage at or above which the hurricane model assumes a total building loss will be reviewed.

13. The treatment of law and ordinance in building hurricane vulnerability functions will be reviewed.

14. A plot comparing building structure and appurtenant structure hurricane vulnerability functions will be reviewed.

15. A plot comparing appurtenant structure hurricane vulnerability functions with insurance claims data will be reviewed.

16. Form V-1, One Hypothetical Event, and the process for completing the form with respect to building damage will be reviewed.

Pre-Visit Letter

25. V-1.B, page 89: Provide examples and the basis for "the uncertainties in both loading and resistance for each component" being "accounted for using appropriate probabilistic distributions."

26. V-1.E, page 89: Provide justification for appurtenant structure vulnerability functions being modeled "separately using the same vulnerability functions as for buildings."

27. V-1.1, page 90: Provide a detailed explanation of the items listed under V-1.1.

28. V-1.3, Table 7, pages 92-93: Explain the differences in claims for each hurricane versus claims values given in Table 5 (pages 86-87).

29. V-1.6, page 94: Describe how uncertainties associated with building vulnerability functions are derived for wood frame and manufactured home constructions.

30. V-1.7, page 94: Provide reconnaissance reports for Hurricane Matthew (2016), Hurricane Irma (2017), and Hurricane Michael (2018).

31. V-1.8, page 94: Explain the increase in number of building vulnerability functions from the current accepted model.

32. V-1.8, Table 8, pages 95-96: Provide a comparison of building vulnerability functions for wood frame and manufactured home constructions located in the 3 tiers and year-built 2010 and 2020.

33. V-1.8, Table 8, page 96: Explain how the location of manufactured homes within Florida might affect its building vulnerability function.

34. V-1.10, Figure 34, page 97: Provide the plot in linear scale. Explain the nature of the data, e.g., construction types and year built.

35. Form V-1, page 193: Provide a plot of Part A compared to Part A as given in the current accepted model for Building, Contents, and Time Element.

Verified: YES

Professional Team Comments:

Reviewed the new construction classes for masonry veneer, reinforced masonry, and unreinforced masonry.

Reviewed comparisons of the vulnerability curves between the current accepted model and the model under review.

Discussed the secondary modifiers update to account for regional and temporal variability of construction practices and Florida Building Code changes.

Discussed the change in methodology for appurtenant structure sampling.

Reviewed scatter plot of actual and modeled appurtenant structure damage ratios with claims data.

Discussed that the vulnerability curves were recalibrated with new claims data.

Reviewed comparison of modeled losses to claims by hurricane event with recalibrated vulnerability functions.

Discussed the process for recalibrating the vulnerability curves based on updated hazard intensities.

Discussed the assumption that claims data have 25% law and ordinance included. Reviewed examples of wood frame and masonry vulnerability curves for 0%, 25%, and 50% law and ordinance.

Reviewed example probability distribution functions for uncertainties of wind pressure and wind resistance capacity.

Discussed that appurtenant structures are modeled using the same vulnerability functions as the primary building structures.

Reviewed samples of building vulnerability functions for the new primary constructions: masonry veneer, reinforced masonry, and unreinforced masonry.

Reviewed comparison of secondary uncertainty distributions for wood frame and manufactured home claims.

Reviewed post-event reconnaissance report for Hurricane Michael (2018).

Reviewed comparisons of building vulnerability functions for wood frame and manufactured homes in Tier 1, Tier 2, and Tier 3 for year-built 2010 and 2020.

Discussed association of HUD zones to model tiers.

Discussed how the location of manufactured homes in Florida affect the assigned building vulnerability function.

Reviewed an example of manufactured home vulnerability functions by tier.

Reviewed scatter plot of modeled to claims manufactured home damage ratio by windspeed.

Reviewed comparison of the Form V-1 building, contents, and time-element vulnerability functions to the current accepted model.

Reviewed documentation for Florida Claims Processing and Handling.

Reviewed documentation on the methodology for development of vulnerability functions.

Discussed that the changes in Form V-1 from the current accepted model are due to the changes in vulnerability functions.

V-2 Derivation of Contents Hurricane Vulnerability Functions*

*(*Significant Revision)*

A. Development of the contents hurricane vulnerability functions shall be based on at least one of the following: (1) insurance claims data, (2) tests, (3) rational engineering analysis, and (4) post-event site investigations. Any development of the contents hurricane vulnerability functions based on rational engineering analysis, post-event site investigations, and tests shall be supported by historical data.

B. The relationship between the hurricane model building and contents hurricane vulnerability functions shall be consistent with, and supported by, the relationship observed in historical data.

Audit

1. Modifications to the contents vulnerability component of the hurricane model since the currently accepted hurricane model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications and their impact on the contents vulnerability component.

2. Comparisons of the contents hurricane vulnerability functions with the currently accepted hurricane model will be reviewed.

3. Multiple samples of contents hurricane vulnerability functions will be reviewed.

4. To the extent that historical data are used to develop mathematical depictions of contents hurricane vulnerability functions, the goodness-of-fit of the data to fitted models will be reviewed.

5. Justification for changes from the currently accepted hurricane model in the relativities between hurricane vulnerability functions for building and the corresponding hurricane vulnerability functions for contents will be reviewed.

6. Justification and documentation for the dependence of contents hurricane vulnerability functions on construction or occupancy type will be reviewed.

7. Documentation and justification of the method of derivation and underlying data or assumptions related to contents hurricane vulnerability functions will be reviewed.

8. Validation of the contents hurricane vulnerability functions and the treatment of associated uncertainties will be reviewed.

9. Form V-1, One Hypothetical Event, and the process for completing the form with respect to contents damage will be reviewed.

Pre-Visit Letter

36. V-2.4, page 101: Explain the increase in the number of contents vulnerability functions from the current accepted model.

37. V-2.4, page 101: Provide contents hurricane vulnerability functions for wood frame, masonry, and manufactured home, one set for construction built in 1980 and one set for construction built in 2020.

Verified: YES

Professional Team Comments:

Discussed that there were no changes made to the contents vulnerability functions from the current accepted model.

Reviewed comparisons of contents vulnerability functions for wood frame, masonry, and manufactured homes for year-built 2010 and 2020.

Discussed that contents vulnerability is a function of building damage ratio.

Discussed that the three relationships between contents damage ratios and building damage ratios have not changed from the current accepted model.

Reviewed goodness-of-fit test between modeled and claims mean contents damage ratios.

Discussed the treatment of uncertainties in contents vulnerability functions.

V-3 Derivation of Time Element Hurricane Vulnerability Functions*

*(*Significant Revision)*

A. Development of the time element hurricane vulnerability functions shall be based on at least one of the following: (1) insurance claims data, (2) tests, (3) rational engineering analysis, and (4) post-event site investigations. Any development of the time element hurricane vulnerability functions based on rational engineering analysis, post-event site investigations, and tests shall be supported by historical data.

B. The relationship between the hurricane model building and time element hurricane vulnerability functions shall be consistent with, and supported by, the relationship observed in historical data.

C. Time element hurricane vulnerability function derivations shall consider the estimated time required to repair or replace the property.

D. Time element hurricane vulnerability functions shall include time element hurricane losses associated with damage to the infrastructure caused by a hurricane.

Audit

1. Modifications to the time element vulnerability component of the hurricane model since the currently accepted hurricane model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications and their impact on the time element vulnerability component.

2. Comparisons of the time element hurricane vulnerability functions with the currently accepted hurricane model will be reviewed.

3. Multiple samples of time element hurricane vulnerability functions will be reviewed.

4. Documentation and justification of the method of derivation and underlying data or assumptions related to time element hurricane vulnerability functions will be reviewed.

5. Justification for changes from the currently accepted hurricane model in the relativities between hurricane vulnerability functions for building and the corresponding hurricane vulnerability functions for time element will be reviewed.

6. To the extent that historical data are used to develop mathematical depictions of time element hurricane vulnerability functions, the goodness-of-fit of the data to fitted models will be reviewed.

7. Validation of the time-element hurricane vulnerability functions and the treatment of associated uncertainties will be reviewed.

8. Form V-1, One Hypothetical Event, and the process for completing the form with respect to time element loss will be reviewed.

Verified: YES

Professional Team Comments:

Discussed that there were no changes made to the time-element vulnerability functions from the current accepted model.

Discussed that time-element vulnerability functions are a function of the building damage ratio.

Reviewed goodness-of-fit test between modeled and claims mean time-element damage ratios.

Discussed the treatment of uncertainties in time-element vulnerability functions.

V-4 Hurricane Mitigation Measures and Secondary Characteristics

A. Modeling of hurricane mitigation measures to improve a building's hurricane wind resistance, the corresponding effects on hurricane vulnerability and associated uncertainties shall be theoretically sound and consistent with fundamental engineering principles. These measures shall include fixtures or construction techniques that affect the performance of the building and the damage to contents and shall include:

- ***Roof strength***
- ***Roof covering performance***
- ***Roof-to-wall strength***
- ***Wall-to-floor-to-foundation strength***
- ***Opening protection***
- ***Window, door, and skylight strength.***

B. The modeling organization shall justify all hurricane mitigation measures and secondary characteristics considered by the hurricane model.

C. Application of hurricane mitigation measures that affect the performance of the building and the damage to contents shall be justified as to the impact on reducing damage whether done individually or in combination.

D. Treatment of individual and combined secondary characteristics that affect the performance of the building and the damage to contents shall be justified.

Audit

1. Modifications to hurricane mitigation measures and secondary characteristics in the hurricane model since the currently accepted hurricane model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications, and their impacts on the hurricane vulnerability functions.

2. Comparisons of hurricane mitigation measures and secondary characteristics with the currently accepted hurricane model will be reviewed.

3. Procedures, including software, used to calculate the impact of hurricane mitigation measures and secondary characteristics will be reviewed.

4. Form V-2, Hurricane Mitigation Measures and Secondary Characteristics, Range of Changes in Damage; Form V-3, Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item); Form V-4, Differences in Hurricane Mitigation Measures and Secondary Characteristics; and Form V-5, Differences in Hurricane Mitigation Measures and Secondary Characteristics, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item), will be reviewed.

5. Implementation of individual hurricane mitigation measures and secondary characteristics will be reviewed as well as the effect of individual hurricane mitigation measures and secondary characteristics on damage. Any variation in the change in hurricane damage over the range of windspeeds for individual hurricane mitigation measures and secondary characteristics will be reviewed. Historical data, scientific and technical literature, insurance company hurricane claims data, analysis or judgment based on fundamental engineering principles used to support the assumptions and implementation of the hurricane mitigation measures and secondary characteristics will be reviewed.

6. The treatment of roof age will be reviewed.

7. Implementation of multiple hurricane mitigation measures and secondary characteristics will be reviewed. The combined effects of these hurricane mitigation measures and secondary characteristics on damage will be reviewed. Any variation in the change in hurricane damage over the range of windspeeds for multiple hurricane mitigation measures and secondary characteristics will be reviewed.

8. Hurricane mitigation measures and secondary characteristics used by the hurricane model, whether or not referenced in Form V-2, Hurricane Mitigation Measures, Range of Changes in Damage, and Form V-3, Hurricane Mitigation Measures, Mean Damage Ratios and Hurricane Loss Costs (Trade Secret Item), will be reviewed for theoretical soundness and reasonability.

Pre-Visit Letter

38. V-4.1, page 106: Explain in detail the development of new secondary modifier options.

39. V-4.2, page 107: Explain the change in methodology to calculate the effect of secondary modifiers.

40. Form V-2, page 196: Explain the 0 entries for individual mitigation measures at 160mph for Frame and Masonry compared to combined mitigation measures.

41. Form V-2, page 196: Provide a plot of the reference structure vulnerability function. Explain any changes in the reference structure vulnerability function in Form V-2 as given in the current accepted model.

Verified: YES

Professional Team Comments:

Discussed the change in methodology for applying secondary modifiers to primary vulnerability functions.

Reviewed Form V-3 reference structure loss costs compared to Form A-1 loss costs by coverage for ZIP Code 33921.

Reviewed comparison of the vulnerability curves for the reference structure in Form V-3 and the structure used in completing Form A-1.

Reviewed the new options of individual hurricane mitigation measures and secondary characteristics.

Discussed that the new secondary modifiers were modeled to reflect roof-membrane, wall-to-floor-to-foundation connections, and skylights, to address mitigation measures and secondary characteristics required in the vulnerability forms.

Reviewed an example of adjusting damage vulnerability functions with secondary modifiers.

Reviewed Forms V-2, V-3, V-4, and V-5.

Reviewed comparisons of individual and combined mitigation measures and secondary characteristics with the current accepted model.

Discussed the treatment of roof age in the model.

Reviewed plot of vulnerability curves with multiple secondary modifiers. Discussed that the effects of multiple mitigation measures and secondary characteristics are combined with a multiplicative methodology.

ACTUARIAL HURRICANE STANDARDS – Stu Mathewson, Leader

A-1 Hurricane Model Input Data and Output Reports*

*(*Significant Revision)*

A. Adjustments, edits, inclusions, or deletions to insurance company or other input data used by the modeling organization shall be based upon generally accepted actuarial, underwriting, and statistical procedures.

B. All modifications, adjustments, assumptions, inputs and input file identification, and defaults necessary to use the hurricane model shall be actuarially sound and shall be included with the hurricane model output report. Treatment of missing values for user inputs required to run the hurricane model shall be actuarially sound and described with the hurricane model output report.

Audit

1. Quality assurance procedures, including methods to assure accuracy of insurance or other input data, will be reviewed. Compliance with this standard will be readily demonstrated through documented rules and procedures.

2. All hurricane model inputs and assumptions will be reviewed to determine that the hurricane model output report appropriately discloses all modifications, adjustments, assumptions, and defaults used to produce the hurricane loss costs and hurricane probable maximum loss levels.

3. The hurricane model input forms used to capture data distinguishing among policy form types and their risk elements including location, deductibles, and limits of coverage will be reviewed.

4. The human-computer interface relevant to input data and output reports and corresponding nomenclature used in Florida rate filings will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed the IF FCHLPM Actuarial Forms Exposure Generation Plan outlining the procedures and methods to assure accuracy of the insurance and other input.

Discussed the treatment of input data. Reviewed sample input forms.

Reviewed sample output reports disclosing the assumptions, input data summary, and the model settings used.

Reviewed the analysis options available for Florida ratemaking.

Reviewed the interface and option restrictions for use in Florida rate filings.

A-2 Hurricane Events Resulting in Modeled Hurricane Losses

A. Modeled hurricane loss costs and hurricane probable maximum loss levels shall reflect all insured wind related damages from hurricanes that produce minimum damaging windspeeds or greater on land in Florida.

B. The modeling organization shall have a documented procedure for distinguishing wind-related hurricane losses from other peril losses.

Audit

1. The hurricane model will be reviewed to evaluate whether the determination of hurricane losses in the hurricane model is consistent with this standard.

2. The hurricane model will be reviewed to determine that by-passing hurricanes and their effects are considered in a manner that is consistent with this standard.

3. The hurricane model will be reviewed to determine whether and how the hurricane model takes into account any damage resulting directly and solely from flood (including hurricane storm surge).

4. The documented procedure for distinguishing hurricane wind-only losses from other peril losses will be reviewed.

Pre-Visit Letter

42. A-2.B, page 117: Provide a copy of the documented procedure for distinguishing wind-related hurricane losses from other peril losses.

Verified: YES

Professional Team Comments:

Reviewed documentation for Florida Claims Processing and Handling.

Discussed the criteria for identifying bypassing hurricanes. Reviewed examples of bypassing storm tracks.

Discussed that the model only computes wind losses.

A-3 Hurricane Coverages*

*(*Significant Revision)*

A. The methods used in the calculation of building hurricane loss costs, including the effect of law and ordinance coverage, shall be actuarially sound.

B. The methods used in the calculation of appurtenant structure hurricane loss costs shall be actuarially sound.

C. The methods used in the calculation of contents hurricane loss costs shall be actuarially sound.

D. The methods used in the calculation of time element hurricane loss costs shall be actuarially sound.

Audit

1. The methods used to produce building, appurtenant structure, contents and time element hurricane loss costs will be reviewed.

2. The treatment of law and ordinance coverage will be reviewed, including the statutory required 25% and 50% coverage options for personal residential policies.

Pre-Visit Letter

43. A-3.1-4, pages 118-119: Show a calculation of loss costs and probable maximum loss levels for the minimum Frame Owners loss costs in Form A-1, ZIP Code 32255 in Duval County.

44. A-3.5, page 119: Explain how the model handles the statutory 25% and 50% law and ordinance coverages. Explain how the three sets of damage functions were developed.

Verified: YES

Professional Team Comments:

Reviewed a calculation of frame-owners loss costs in Form A-1 for ZIP Code 32255 in Duval County.

Discussed that there are three sets of building damage functions to represent 0%, 25%, or 50% law and ordinance coverage.

Discussed the methodology for producing building, appurtenant structure, contents, and time-element loss costs.

Discussed with the Actuarial Standards signatory how she attested the model results to be actuarially sound.

A-4 Modeled Hurricane Loss Cost and Hurricane Probable Maximum Loss Level Considerations*

*(*Significant Revision)*

A. Hurricane loss cost projections and hurricane probable maximum loss levels shall not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margin.

B. Hurricane loss cost projections and hurricane probable maximum loss levels shall not make a prospective provision for economic inflation.

C. Hurricane loss cost projections and hurricane probable maximum loss levels shall not include any explicit provision for direct flood losses (including those from hurricane storm surge).

D. Hurricane loss cost projections and hurricane probable maximum loss levels shall be capable of being calculated from exposures at a geocode (latitude-longitude) level of resolution.

E. Demand surge shall be included in the hurricane model's calculation of hurricane loss costs and hurricane probable maximum loss levels using relevant data and actuarially sound methods and assumptions.

Audit

1. How the hurricane model handles expenses, risk load, investment income, premium reserves, taxes, assessments, profit margin, economic inflation, and any criteria other than direct property insurance claim payments will be reviewed.

2. The method of determining hurricane probable maximum loss levels will be reviewed.

3. The uncertainty in the estimated annual hurricane loss costs and hurricane probable maximum loss levels will be reviewed.

4. The data and methods used to incorporate individual aspects of demand surge on personal and commercial residential hurricane losses, inclusive of the effects from building material costs, labor costs, contents costs, and repair time will be reviewed.

5. How the hurricane model accounts for economic inflation associated with past insurance experience will be reviewed.

6. The treatment of flood losses (including hurricane storm surge) in the determination of modeled hurricane losses will be reviewed.

7. All referenced scientific and technical literature will be reviewed, in hard copy or electronic form, to determine applicability.

Pre-Visit Letter

45. A-4.1, pages 120-121: Provide, in Excel, tables of 1,000 years descending from the Top Event corresponding to Form A-8. For each year, show the value of each hurricane separately.

46. A-4, Audit items 1 and 5: Explain how economic inflation with regards to the claims environment, the legal environment, and litigation effects are modeled.

Verified: YES

Professional Team Comments:

Discussed that all the Actuarial forms were completed with demand surge.

Reviewed the top 1,000 years of hurricane activity sorted by aggregate loss and occurrence loss corresponding to Form A-8.

Discussed that economic inflation with regard to the claims environment, the legal environment, and litigation effects is not modeled.

Reviewed the methodology for determining probable maximum loss levels.

Reviewed the demand surge methodology.

Reviewed the IF Financial Model Hurricane Wind Demand Surge documentation.

A-5 Hurricane Policy Conditions*

*(*Significant Revision)*

A. The methods used in the development of mathematical distributions to reflect the effects of deductibles and policy limits shall be actuarially sound.

B. The relationship among the modeled deductible hurricane loss costs shall be reasonable.

C. Deductible hurricane loss costs shall be calculated in accordance with s. 627.701(5)(a), F.S.

Audit

1. The extent that insurance company hurricane claims data are used to develop mathematical depictions of deductibles, policy limits, policy exclusions, and loss settlement provisions will be reviewed.

2. The extent that insurance company hurricane claims data are used to validate the hurricane model results will be reviewed.

3. Treatment of annual deductibles will be reviewed.

4. Justification for the changes from the currently accepted hurricane model in the relativities among corresponding deductible amounts for the same coverage will be reviewed.

Pre-Visit Letter

47. A-5.3, page 125: Explain in detail how the hurricane model treatment of annual hurricane deductibles complies with s. 627.701(5)-(9), Florida Statutes. Provide numerical evidence.

Verified: YES

Professional Team Comments:

Reviewed the methodology and implementation of the annual hurricane deductible.

Reviewed a numerical example of the annual hurricane deductible.

Reviewed a claims study to transform data in gross losses to ground-up losses used in the model.

Reviewed comparison of the changes in relativities among deductible amounts from the current accepted model for different vulnerability categories.

A-6 Hurricane Loss Outputs and Logical Relationships to Risk*

*(*Significant Revision)*

A. The methods, data, and assumptions used in the estimation of hurricane loss costs and hurricane probable maximum loss levels shall be actuarially sound.

B. Hurricane loss costs shall not exhibit an illogical relation to risk, nor shall hurricane loss costs exhibit a significant change when the underlying risk does not change significantly.

C. Hurricane loss costs produced by the hurricane model shall be positive and non-zero for all valid Florida ZIP Codes.

D. Hurricane loss costs cannot increase as the quality of construction type, materials, and workmanship increases, all other factors held constant.

E. Hurricane loss costs cannot increase as the presence of fixtures or construction techniques designed for hazard mitigation increases, all other factors held constant.

F. Hurricane loss costs cannot increase as the wind resistant design provisions increase, all other factors held constant.

G. Hurricane loss costs cannot increase as building code enforcement increases, all other factors held constant.

H. Hurricane loss costs shall decrease as deductibles increase, all other factors held constant.

I. The relationship of hurricane loss costs for individual coverages (e.g., building, appurtenant structure, contents, and time element) shall be consistent with the coverages provided.

J. Hurricane output ranges shall be logical for the type of risk being modeled and apparent deviations shall be justified.

K. All other factors held constant, hurricane output ranges produced by the hurricane model shall in general reflect lower hurricane loss costs for:

1. ***masonry construction versus frame construction,***
2. ***personal residential risk exposure versus manufactured home risk exposure,***
3. ***inland counties versus coastal counties,***
4. ***northern counties versus southern counties, and***
5. ***newer construction versus older construction.***

A-6 Hurricane Loss Outputs and Logical Relationships to Risk* (Continued) *(*Significant Revision)*

L. For hurricane loss cost and hurricane probable maximum loss level estimates derived from and validated with historical insured hurricane losses, the assumptions in the derivations concerning (1) construction characteristics, (2) policy provisions, (3) coinsurance, and (4) contractual provisions shall be appropriate based on the type of risk being modeled.

Audit

1. The data and methods used for hurricane probable maximum loss levels for Form A-8, Hurricane Probable Maximum Loss for Florida, will be reviewed. The hurricane associated with the Top Events will be reviewed.

2. The frequency distribution and the individual event severity distribution, or information about the formulation of events, underlying Form A-8, Hurricane Probable Maximum Loss for Florida, will be reviewed.

3. All referenced scientific and technical literature will be reviewed, in hard copy or electronic form, to determine applicability.

4. Graphical representations of hurricane loss costs by ZIP Code and county will be reviewed.

5. Color-coded maps depicting the effects of land friction on hurricane loss costs by ZIP Code will be reviewed.

6. The procedures used by the modeling organization to verify the individual hurricane loss cost relationships will be reviewed. Methods (including any software) used in verifying Hurricane Standard A-6, Hurricane Loss Outputs and Logical Relationships to Risk, will be reviewed. Forms A-1, Zero Deductible Personal Residential Hurricane Loss Costs by ZIP Code; A-2, Base Hurricane Storm Set Statewide Hurricane Losses; A-3, Hurricane Losses; A-6, Logical Relationships to Hurricane Risk (Trade Secret Item); and A-7, Percentage Change in Logical Relationships to Hurricane Risk, will be reviewed to assess coverage relationships.

7. The hurricane loss cost relationships among deductible, policy form, construction type, coverage, year of construction, building strength, number of stories, territory, and region will be reviewed.

8. Forms A-4, Hurricane Output Ranges, and A-5, Percentage Change in Hurricane Output Ranges, will be reviewed, including geographical representations of the data where applicable.

9. Justification for all changes in hurricane loss costs from the currently accepted hurricane model will be reviewed.

10. Form A-4, Hurricane Output Ranges, will be reviewed to ensure appropriate relativities among deductibles, coverages, and construction types.

11. Apparent reversals in the hurricane output ranges and their justification will be reviewed.

12. The details on the calculation of uncertainty intervals and their justification will be reviewed.

Pre-Visit Letter

48. A-6.10, page 128: Discuss the calculation of uncertainty intervals.

49. A-6.16, page 129: Explain how the differences in hazard from the current accepted model resulted in changes in loss costs.

50. Form A-1, pages 202-204: Explain the low values given on Figures 62, 63, and 64 differing from the low values in Form A-1.

51. Form A-1: Explain the variation of loss costs between ZIP Codes 34139 and 34109 in Collier County.

52. Form A-1: Explain the variation of loss costs for ZIP Codes 33871 and 33857 in Highlands County.

53. Form A-2, pages 206-208: Explain the differences in losses from the current accepted model for the NoName06-1926 hurricane, as well as the hurricanes before that one.

54. Form A-4, 0% Deductible, pages 256-263: Explain the reversal in loss costs where Frame is less than Masonry:
    Owners: Gulf Average, Monroe Average
    Renters: Calhoun Low, Monroe Average, Wakulla Average
    Condo Unit: Monroe Average, Wakulla Average.

55. Form A-5, Figures 69-73, pages 274-276: Explain the regional changes (e.g., North Central versus Southeast Florida) in the loss costs in Form A-4, compared to the current accepted model.

56. Form A-5, Figures 74 and 75, pages 276-277: Explain the differences between Levy and Columbia Counties (Figure 74) and between Levy and Pasco Counties (Figure 75).

57. Form A-8, Figure 77, page 290: Explain the decreases in losses compared to the current accepted model.

58. Form A-8.B, Table 46, page 293: Explain the non-zero differences between Form A-8 and Form S-2 for the common return periods.

Verified: YES

Professional Team Comments:

Reviewed a corrected Form A-2 to address a change in region classification.

Reviewed Form A-1 loss costs by coverage for ZIP Code 33921.

Discussed the calculation of uncertainty intervals in Form A-8.

Discussed the missing ZIP Codes in Form A-1, and the QA procedures implemented to prevent a recurrence of the error.

Discussed the changes in Form A-1 from the current accepted model in Collier, Duval, Highlands, and Hillsborough Counties.

Discussed the change in Form A-2 losses from the current accepted model for NoName06-1926 hurricane.

Discussed the loss costs in Form A-4 where frame loss costs are less than masonry loss costs and the underlying reasons for the results.

Discussed the regional changes in Form A-4 compared to the current accepted model.

Discussed the change in Form A-8 losses compared to the current accepted model.

Discussed the reasons for the differences between Form A-8 and Form S-2 for common return periods.

Reviewed the storm parameters and track for the top event in Form A-8.

Reviewed Form A-6 and the reasonableness checks performed to verify the individual loss cost relationships.

Reviewed maps depicting the effects of land friction on loss costs by ZIP Code.

Reviewed maps of loss costs by County for frame owners, renters, and condo unit, for masonry owners, renters, and condo unit, for manufactured homes, and for commercial residential.

COMPUTER/INFORMATION HURRICANE STANDARDS – Paul Fishwick, Leader

CI-1 Hurricane Model Documentation

A. Hurricane model functionality and technical descriptions shall be documented formally in an archival format separate from the use of correspondence including emails, presentation materials, and unformatted text files.

B. A primary document repository shall be maintained, containing or referencing a complete set of documentation specifying the hurricane model structure, detailed software description, and functionality. Documentation shall be indicative of current model development and software engineering practices.

C. All computer software (i.e., user interface, scientific, engineering, actuarial, data preparation, and validation) relevant to the hurricane model shall be consistently documented and dated.

D. The following shall be maintained: (1) a table of all changes in the hurricane model from the currently accepted hurricane model to the initial submission this year, and (2) a table of all substantive changes since this year's initial submission.

E. Documentation shall be created separately from the source code.

F. A list of all externally acquired, currently used, hurricane model-specific software and data assets shall be maintained. The list shall include (1) asset name, (2) asset version number, (3) asset acquisition date, (4) asset acquisition source, (5) asset acquisition mode (e.g., lease, purchase, open source), and (6) length of time asset has been in use by the modeling organization.

Audit

1. The primary document repository, containing or referencing full documentation of the software in either electronic or physical form, and its maintenance process will be reviewed.

2. All documentation should be easily accessible from a central location in order to be reviewed.

3. Complete user documentation, including all recent updates, will be reviewed.

4. Modeling organization personnel, or their designated proxies, responsible for each aspect of the software (i.e., user interface, quality assurance, engineering, actuarial, verification) should be present when the Computer/Information Hurricane Standards are being reviewed. Internal users of the software will be interviewed.

5. Verification that documentation is created separately from, and is maintained consistently with, the source code will be reviewed.

6. The list of all externally acquired hurricane model-specific software and data assets will be reviewed.

7. The tables specified in Hurricane Standard CI-1.D that contain the items listed in Hurricane Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 7 will be reviewed. The tables should contain the item number in the first column. The remaining five columns should contain specific document or file references for affected components or data relating to the following Computer/Information Hurricane Standards: CI-2, Hurricane Model Requirements; CI-3, Hurricane Model Organization and Component Design; CI-4, Hurricane Model Implementation; CI-5, Hurricane Model Verification; and CI-7, Hurricane Model Maintenance and Revision.

8. Tracing of the hurricane model changes specified in Hurricane Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 7 and Audit 7 through all Computer/Information Hurricane Standards will be reviewed.

Pre-Visit Letter

59. CI-1, page 131: From the Professional Team Report dated June 7, 2021, explain how the formal model development process, including interaction between R&D and software teams, and training for new and existing model developers, has been enhanced.

60. CI-1.B, page 131: Relate the primary binder table of contents with the response to Standard G-1.7 (pages 29-33) by demonstrating individual table item compliance with Computer/Information Standards CI-1 through CI-8.

61. CI-1.D, page 131: Provide the table required by Standard CI-1, Audit item 7.

62. CI-1.F, page 131: Provide the list of externally acquired software and data assets as described and required by Standard CI-1, Audit item 6.

Verified: YES

Professional Team Comments:

Reviewed documentation on the automated and human processes used to ensure continued agreement between model related data and associated materials.

Discussed the use of Microsoft SharePoint for shared documentation and Microsoft Team Foundation Server (TFS) as the source and version control system.

Reviewed documentation for the relative intensity model.

Reviewed the table of model changes.

Reviewed the Hurricane Wind Demand Surge documentation.

Discussed the communication and documentation enhancements implemented between R&D and the software teams.

Discussed training procedures for model developers on software processes and tools. Reviewed an example training video.

Reviewed the Model Development Process and Guide documentation.

Reviewed examples of meeting notes from technical meetings to discuss model development and software implementation.

Reviewed the list of externally acquired software and data sources.

CI-2 Hurricane Model Requirements

A complete set of requirements for each software component, as well as for each database or data file accessed by a component, shall be maintained. Requirements shall be updated whenever changes are made to the hurricane model.

Audit

1. Maintenance and documentation of a complete set of requirements for each software component, database, and data file accessed by a component will be reviewed.

Pre-Visit Letter

63. CI-2, page 132: Provide requirements documentation that specifically relates to each model change identified in Standard G-1.7 (pages 29-30).

Verified: YES

Professional Team Comments:

Reviewed software requirements documentation for model updates.

CI-3 Hurricane Model Organization and Component Design

A. The following shall be maintained and documented: (1) detailed control and data flowcharts and interface specifications for each software component, (2) schema definitions for each database and data file, (3) flowcharts illustrating hurricane model-related flow of information and its processing by modeling organization personnel or consultants, (4) network organization, and (5) system model representations associated with (1)-(4) above. Documentation shall be to the level of components that make significant contributions to the hurricane model output.

B. All flowcharts (e.g., software, data, and system models) in the submission or in other relevant documentation shall be based on (1) a referenced industry standard (e.g., UML, BPMN, SysML), or (2) a comparable internally-developed standard which is separately documented.

Audit

1. The following will be reviewed:
   a. Detailed control and data flowcharts, completely and sufficiently labeled for each component,
   b. Interface specifications for all components in the hurricane model,
   c. Documentation for schemas for all data files, along with field type definitions,
   d. Each network flowchart including components, sub-component flowcharts, arcs, and labels,
   e. Flowcharts illustrating hurricane model-related information flow among modeling organization personnel or consultants (e.g., BPMN, UML, SysML, or equivalent technique including a modeling organization internal standard), and
   f. If the hurricane model is implemented on more than one platform, the detailed control and data flowcharts, component interface specifications, schema documentation for all data files, and detailed network flowcharts for each platform.

2. A hurricane model component custodian, or designated proxy, should be available for the review of each component.

3. The flowchart reference guide or industry standard reference will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed the Impact Forecasting Flowchart Standards.

Reviewed revised flowchart defining the process for submission forms creation.

Reviewed flowchart for processing changes in HURDAT2 in calculating storm frequencies.

Reviewed flowchart for stochastic event simulation.

Reviewed the relative intensity model flowchart.

Reviewed flowcharts defining the discretization procedure for landfalling and bypassing events.

Reviewed an example of database schemata.

Reviewed flowchart for model data quality check and validation testing within the ELEMENTS platform.

CI-4 Hurricane Model Implementation*

*(*Significant Revision)*

A. A complete procedure of coding guidelines consistent with accepted software engineering practices shall be maintained.

B. Network organization documentation shall be maintained.

C. A complete procedure used in creating, deriving, or procuring and verifying databases or data files accessed by components shall be maintained.

D. All components shall be traceable, through explicit component identification in the hurricane model representations (e.g., flowcharts) down to the code level.

E. A table of all software components affecting hurricane loss costs and hurricane probable maximum loss levels shall be maintained with the following table columns: (1) component name, (2) number of lines of code, minus blank and comment lines, and (3) number of explanatory comment lines.

F. Each component shall be sufficiently and consistently commented so that a software engineer unfamiliar with the code shall be able to comprehend the component logic at a reasonable level of abstraction.

G. The following documentation shall be maintained for all components or data modified by items identified in Hurricane Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 7 and Audit 7:

1. A list of all equations and formulas used in documentation of the hurricane model with definitions of all terms and variables, and

2. A cross-referenced list of implementation source code terms and variable names corresponding to items within G.1 above.

H. Hurricane model code and data shall be accompanied by documented maintenance, testing, and update plans with their schedules. The vintage of the code and data shall be justified.

Audit

1. Sample code and data implementations will be selected and reviewed, for at least the meteorology, vulnerability, and actuarial components.

2. The documented coding guidelines, including procedures for ensuring readable identifiers for variables, constants, and components, and confirmation that these guidelines are uniformly implemented will be reviewed.

3. The procedure used in creating, deriving, or procuring and verifying databases or data files accessed by components will be reviewed.

4. The traceability among components at all levels of representation will be reviewed.

5. The following information will be reviewed for each component, either in a header comment block, source control database, or the documentation:
   a. Component name,
   b. Date created,
   c. Dates modified, modification rationale, and by whom,
   d. Purpose or function of the component, and
   e. Input and output parameter definitions.

6. The table of all software components as specified in Hurricane Standard CI-4.E will be reviewed.

7. Hurricane model components and the method of mapping to elements in the computer program will be reviewed.

8. Comments within components will be reviewed for sufficiency, consistency, and explanatory quality.

9. Unique aspects within various platforms with regard to the use of hardware, operating system, and essential software will be reviewed.

10. Network organization implementation will be reviewed.

11. Code and data maintenance plans, testing plans, update plans, and schedules will be reviewed. Justification for the vintage of code and data will be reviewed.

Verified: YES

Professional Team Comments:

Discussed errors corrected in the script for producing the loss and claims values in Standard S-5 tables.

Reviewed the variable mapping and implementation for the relative intensity model.

Reviewed the Impact Forecasting Coding Guidelines and Best Practices.

Reviewed an update to the coding guidelines for additional spell checking.

Reviewed implementation for secondary modifier application to primary vulnerability functions.

Reviewed the variable mapping and implementation of the annual hurricane deductible.

Reviewed an example of a code analyzer report with the number of lines of code and number of comment lines.

Reviewed the network organization diagram for ELEMENTS.

Discussed the test plans and vintage of code.

CI-5 Hurricane Model Verification*

*(*Significant Revision)*

A. General

For each component, procedures shall be maintained for verification, such as code inspections, reviews, calculation crosschecks, and walkthroughs, sufficient to demonstrate code correctness. Verification procedures shall include tests performed by modeling organization personnel other than the original component developers.

B. Component Testing

1. ***Testing software shall be used to assist in documenting and analyzing all components.***

2. ***Unit tests shall be performed and documented for each updated component.***

3. ***Regression tests shall be performed and documented on incremental builds.***

4. ***Integration tests shall be performed and documented to ensure the correctness of all hurricane model components. Sufficient testing shall be performed to ensure that all components have been executed at least once.***

C. Data Testing

1. ***Testing software shall be used to assist in documenting and analyzing all databases and data files accessed by components.***

2. ***Integrity, consistency, and correctness checks shall be performed and documented on all databases and data files accessed by the components.***

Audit

1. Procedures for unit conversion verification will be reviewed.

2. The components will be reviewed for containment of sufficient logical assertions, exception-handling mechanisms, and flag-triggered output statements to test the correct values for key variables that might be subject to modification.

3. The testing software used by the modeling organization will be reviewed.

4. The component (unit, regression, integration) and data test processes and documentation will be reviewed including compliance with independence of the verification procedures.

5. Fully time-stamped, documented cross-checking procedures and results for verifying equations, including tester identification, will be reviewed. Examples include mathematical calculations versus source code implementation or the use of multiple implementations using different languages.

6. Flowcharts defining the processes used for manual and automatic verification will be reviewed.

7. Verification approaches used for externally acquired data, software, and models will be reviewed.

Pre-Visit Letter

64. CI-5, pages 137-139: Provide complete and thorough verification procedures and output from the model changes identified in Standard G-1.7 (pages 29-30).

Verified: YES

Professional Team Comments:

Reviewed an example test comparing a manual calculation to a modeled run of adjusting damage vulnerability functions with secondary modifiers.

Discussed the data checks and testing for different model components.

Reviewed an example unit test for building, contents, and time-element damage percentages after application of secondary modifiers.

Discussed the testing tools used for unit testing.

Discussed that manual test cases are run in addition to unit tests and automation tests.

CI-6 Human-Computer Interaction*

*(*New Hurricane Standard)*

A. Interfaces shall be implemented as consistent with accepted principles and practices of Human-Computer Interaction (HCI), Interaction Design, and User Experience (UX) engineering.

B. Interface options used in the hurricane model shall be unique, explicit, and distinctly emphasized.

C. For a Florida rate filing, interface options shall be limited to those options found acceptable by the Commission.

Audit

1. External and internal user interfaces will be reviewed.
2. Documentation related to HCI, Interaction Design, and UX engineering will be reviewed.
3. The decision process specifying the logic of interface option selections, when an acceptable hurricane model is selected, will be reviewed.

Pre-Visit Letter

65. CI-6.C, page 140: Provide and explain the FCHLPM interface option.

Verified: YES

Professional Team Comments:

Reviewed the user interface for Florida ratemaking and the restrictions on analysis options.

Reviewed a live demonstration of selecting options for a model run.

CI-7 Hurricane Model Maintenance and Revision

A. A clearly written policy shall be implemented for review, maintenance, and revision of the hurricane model and network organization, including verification and validation of revised components, databases, and data files.

B. A revision to any portion of the hurricane model that results in a change in any Florida residential hurricane loss cost or hurricane probable maximum loss level shall result in a new hurricane model version identification.

C. Tracking software shall be used to identify and describe all errors, as well as modifications to code, data, and documentation.

D. A list of all hurricane model versions since the initial submission for this year shall be maintained. Each hurricane model description shall have a unique version identification and a list of additions, deletions, and changes that define that version.

Audit

1. All policies and procedures used to review and maintain the code, data, and documentation will be reviewed. For each component in the system decomposition, the installation date under configuration control, the current version identification, and the date of the most recent change(s) will be reviewed.

2. The policy for hurricane model revision and management will be reviewed.

3. Portions of the code, not necessarily related to recent changes in the hurricane model, will be reviewed.

4. The tracking software will be reviewed and checked for the ability to track date and time.

5. The list of all hurricane model revisions as specified in Hurricane Standard CI-7.D will be reviewed.

Pre-Visit Letter

66. CI-7.2, pages 142-143: Provide the model version history over the past 5 years, leading up to the version identified in the submission.

Verified: YES

Professional Team Comments:

Reviewed the model version history.

Discussed that there was no change to the policy for review, maintenance, and revision.

CI-8 Hurricane Model Security

Security procedures shall be implemented and fully documented for (1) secure access to individual computers where the software components or data can be created or modified, (2) secure operation of the hurricane model by clients, if relevant, to ensure that the correct software operation cannot be compromised, (3) anti-virus software installation for all machines where all components and data are being accessed, and (4) secure access to documentation, software, and data in the event of a catastrophe.

Audit

1. The written policy for all security procedures and methods used to ensure the security of code, data, and documentation will be reviewed.

2. Documented security procedures for access, client hurricane model use, anti-virus software installation, and off-site procedures in the event of a catastrophe will be reviewed.

3. Security aspects of each platform will be reviewed.

4. Network security documentation and network integrity assurance procedures will be reviewed.

Verified: YES

Professional Team Comments:

Discussed that there was no change in the security processes and procedures.

Discussed that there have been no known security breaches.