Florida Commission on Hurricane Loss Projection Methodology

Professional Team Report

2021 Hurricane Standards

Hurricane Florence

Karen Clark & Company

On-Site Review: January 30–February 2, 2023

Additional Verification Review: May 2, 2023

On January 30 – February 2, 2023, the Professional Team conducted an on-site review of the Karen Clark & Company (KCC), KCC US Hurricane Reference Model Version 4.0. The following individuals participated in the review.

KCC

Vivek Basrur, Co-founder, Executive Vice President and Director of Software Development
Girma Bitsuamlak, Ph.D., P.E., Consultant
Karen Clark, CEO and President
Adrian Corman, Senior Software Developer
Glen Daraskevich, Senior Vice President
Emanuel Eagle, Risk Analyst
Grant Elgin, Director, Software Development
Kelly Flanigan, Technical Writer
Tanner Hanwright, Senior Data Analyst
Adam Jaeger, Ph.D., Statistician
Arjun Jayaprakash, Ph.D., Principal Engineer
Shaoning Li, Ph.D., Wind Engineer
Marshall Pagano, Director, Client Services
Arthur Phung, Software Developer
Jianxiong Sheng, Ph.D., Senior Scientist
Melinda Vasecka, ACAS, Actuarial Consultant
Daniel Ward, Ph.D., Director, Model Development
Nick Weed, Senior Software Developer

Professional Team

Jimmy Booth, Ph.D., Meteorology
Jenni Evans, Ph.D., Meteorology, observer
Paul Fishwick, Ph.D., Computer/Information
Mark Johnson, Ph.D., Statistics, Team Leader
Stu Mathewson, FCAS, MAAA, Actuarial
Masoud Zadeh, Ph.D., P.E., Vulnerability
Ben Addleton, Staff, observer
Donna Sirmons, Staff

The Professional Team began the review with an opening briefing and introductions were made. KCC provided a general overview of the model and then provided a detailed explanation of extensive updates to the model.

- Impact of climate change on hurricane intensity distributions at landfall
- Reintensification introduced for Florida landfall events that traverse the Gulf of Mexico making a second landfall in Florida
- Updates to track directions and other hurricane characteristics resulting from HURDAT2 reanalysis and update for new years
- Historical catalog years 2019-2021 added
- Updated land cover dataset used to compute surface friction
- Updated site-built building vulnerability functions associated with Very-New year-built band

- Updated year-built bands for manufactured homes
- Updated vulnerability functions for commercial residential, renters, and condos occupancy types when building height is unknown
- Updated ZIP Code centroids
- Excess litigation factor introduced
- Updated demand surge factors to reflect increased property values in the 2022 KCC Industry Exposure Database

The audit continued with a review of each standards section.

KCC reported an error in Form V-2 of the current accepted model. This error was discovered in September, 2022, but was not reported per the requirements in the Report of Activities, Section VIII, Discovery of Editorial Errors or Discrepancies in a Submission (page 67). KCC will be sending a written letter of notification to the Commission including an errata detailing the nature of the editorial error and the corresponding revisions to the submission.

In the course of the audit, KCC reported an error discovered in the current submission Form A-4. KCC provided further details on the problem detected in generating Form A-4. All standards associated with the impacted forms could not be verified pending review of those forms.

During the Commission meeting to review the model for acceptability under the 2021 Hurricane Standards, KCC 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.

*****Additional Verification Review – May 2, 2023*****

KCC submitted a revised submission on March 9, 2023. A subset of the Professional Team completed an additional verification review on May 2, 2023.

The following individuals participated in the additional verification review.

KCC
Adrian Corman, Senior Software Developer
Glen Daraskevich, Senior Vice President
Grant Elgin, Director, Software Development
Kelly Flanigan, Technical Writer
Tanner Hanwright, Senior Data Analyst
Marshall Pagano, Director, Client Services

Professional Team

Paul Fishwick, Ph.D., Computer/Information, Team Leader
Stu Mathewson, FCAS, MAAA, Actuarial
Donna Sirmons, Staff

Revised Form A-2, Base Hurricane Storm Set Statewide Hurricane Losses, revised Form A-4, Output Ranges, and open items from the initial on-site review were reviewed.

All standards are now verified by the Professional Team.

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. Non-responsive. The submission document pdf file is not bookmarked (see Report of Activities, page 56).

2. Form G-4, pages 172-173: Incomplete and unclear. Credentials (State, Expiration Date, and Professional License Type) are not provided. Explain the presence of two G-4 forms.

3. S-1.1, page 81: Incomplete. Annual landfall frequency goodness-of-fit statistic and the associated *p*-value are missing.

4. Form S-3, pages 191-192: Incomplete. Year Range Used column is to be split into two sub-columns, For Fitting and For Validation. Table 3 on pages 67-68 also needs column splitting.

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 KCC'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 KCC. 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. KCC 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 4, 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, additional Professional Team and Commission members will be in attendance. Please have available 9 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.

1. All instances of HURDAT have been corrected to HURDAT2 throughout the document.
2. Several acronyms defined upon first use throughout the document.
3. Flowchart figures updated for consistency.
4. G-1.2: Reference year added to the Kaplan and DeMaria citation.
5. G-1.3: Figure 2 revised for consistency with ISO 5807 standard and the updated KCC appendix to the standard.
6. G-1.6: Updated citations to reflect the correct references of ESDU and Vickery et al. references. Additional Meteorological references added. HURDAT2 reference updated to 2022. Clarified the three difference Vickery et al. 2009 references. Added KCC appendix to ISO 5807 in Computer Information Standard references.
7. G-1.7: ZIP Code centroid changes now appear as a separate category to better align with Table 1 and Figure 6. Clarified Vulnerability Module rationale.
8. G-2.2: Figure 9 revised for consistency.
9. G-2.8: Hyperlink to Form G-5 corrected.
10. G-3.4: Reference to Disclosure 7 corrected.
11. M-1: Standard lettering A removed.
12. V-1.8: Revised for clarification.
13. V-1.10: Revised for clarification.
14. V-2.2: Figure 37 revised for consistency.
15. V-2.4: Content at end of the first sentence edited to be plural.
16. V-3.2: Figure 38 revised for consistency.
17. A-1.4: Updated Table 17 to include the model name and version on the input form.
18. A-1.4: Figure 41 revised for consistency.
19. CI-3.B: Added KCC appendix to ISO 5807 reference.
20. CI-4.G: Corrected Audit 6 in Standard wording.
21. A-6: Figure 43 revised for consistency.
22. Form M-3: Reference for converting central pressure to windspeed in completing the form table added.
23. Form S-4: Corrected total values for Exposure and Actual Loss in Table 26.
24. Form A-2: Corrected filename.
25. Form A-4: Corrected Table 33.
26. Form A-5: Corrected Figure 69 map.
27. Appendix F: Bracketed text was an internal comment and has been removed.
28. Appendix G: Added acronyms omitted from the list.

GENERAL HURRICANE STANDARDS – Mark Johnson, Leader
Paul Fishwick, Leader, May Additional Verification Review

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 13: Explain the coordination across personnel.

2. G-1.7, page 35: Provide a detailed explanation of updates to the Event Catalog Module, the Intensity Footprint Module, the Vulnerability Module, and other changes impacting loss costs.

3. G-1.7, Figure 4, page 37 and Figure 6, page 38: Explain the changes in loss costs in Nassau County compared to Duval County.

4. G-1.7, Figure 4, page 37: Explain the change in hazard that is driving the changes in loss costs, especially for Broward and Holmes Counties.

5. G-1.7, pages 35-39: Explain how interim software updates, if performed, over the past two years mesh with Standard G-1.7.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of revised Forms A-4 and A-5.

Discussed the workflow of KCC professionals involved in development of the model.

Discussed the process by which KCC professionals develop the submission forms.

Discussed the model changes from the current accepted model, and the rationale for each change.

Discussed the reasons for the change in loss costs in Nassau and Duval Counties as shown in Figures 4 and 6.

Discussed that the general increase in loss costs across the state of Florida is due to the climate change driven shift toward higher hurricane intensities.

Discussed the changes in loss costs due to the updated land cover dataset.

Discussed the increases in loss costs in locations along the Florida Panhandle with the introduction of hurricane reintensification over the Gulf of Mexico.

Discussed no interim updates were made for the software used for residential rate filings in Florida since the current accepted model was released.

Discussed the source and vintage of the underlying model component data, the RiskInsight code base, and various technical literature. Discussed the justification for the model component data sources and their vintages.

*****Additional Verification Review Comments*****

Verified after review of revised Forms A-2 and A-4.

Discussed that no changes were made to Form A-5 in the revised submission as the correct Form A-4 values were used to complete Form A-5 in the initial submission.

Reviewed the revised scripts for creating Forms A-2 and A-4.

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

6. G-2.2B, page 51: Provide resumes of the new personnel.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending updated expert certifications.

Reviewed resumes of new personnel and consultants:

- Girma Bitsuamlak, Ph.D. in Building Engineering, Concordia University, Montreal, Quebec, Canada; MTech in Civil Engineering, Indian Institute of Technology, Roorkee, India; B.S. in Civil Engineering, Addis Ababa University, Addis Ababa, Ethiopia
- Emanuel Eagle, B.A. in Environmental Science with a minor in Computer Science, Connecticut College, New London, CT
- Kelly Flanigan, M.S. in Climate and Society, University of Miami, Coral Gables, FL; B.S. in Atmospheric Sciences, University of Miami, Coral Gables, FL
- Tanner Hanwright, M.S. in Analytics, Georgia Institute of Technology, Atlanta, GA; B.S. in Business Administration, Babson College, Wellesley, MA
- Adam Jaeger, Ph.D. in Statistics, University of Georgia, Athens, GA
- Arjun Jayaprakash, Ph.D. in Civil Engineering, North Carolina State University, Raleigh, NC; M.S. in Civil Engineering, North Carolina State University, Raleigh, NC; B.Tech in Civil Engineering, National Institute of Technology, Calicut, India
- Shaoning Li, Ph.D. in Civil (Wind) Engineering, Northeastern University, Boston, MA; M.S. in Civil (Structural) Engineering, Northeastern University, Boston, MA; B.S. in Civil Engineering, China Agricultural University, Beijing, China
- Arthur Phung, B.S. in Mechanical Engineering, Boston University, Boston, MA
- Melinda Vasecka, B.A. in Mathematics, University of Minnesota, Minneapolis, MN
- Nick Weed, B.A. in Computer Science and Chinese, Williams College, Williamstown, MA

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

Discussed process for training new employees.

Reviewed the supporting documents provided to the independent external reviewer of the vulnerability module.

*****Additional Verification Review Comments*****

Verified after review of expert certifications in updated Forms G-1 through G-7.

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 geographic representation of the population-weighted centroids and ZIP Code boundaries.

Reviewed geographic comparison of the updated ZIP Code centroid locations from the current accepted model.

Reviewed the largest five ZIP Code centroid movements.

Discussed the process for reviewing and validating ZIP Code centroid data. Reviewed validation examples.

Reviewed examples of the quality assessment process to ensure ZIP Code centroids do not occur over water or other uninhabitable terrain.

Reviewed examples of the geocoding process and the process for geocoding incomplete or incorrect street addresses.

Discussed that latitude-longitude conversion to ZIP Codes are not made by the model. ZIP Codes are required as part of the input exposure data file.

Reviewed geographic display of the Florida vulnerability regions classified by ZIP Code and year of construction.

Discussed land cover changes at the ZIP Code level affecting results in Gilchrist County.

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: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

*****Additional Verification Review Comments*****

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

Verified after resolution of outstanding issues from other standards.

Reviewed the revised flowchart in Figure 2 illustrating the interaction between model components.

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: ~~NO~~ YES

Professional Team Comments:

Not verified pending updated expert certification and revised Forms A-4 and A-5.

Discussed 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.

*****Additional Verification Review Comments*****

Verified after review of updated expert certification in Form G-7 and revised Forms A-2 and A-4.

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.

Pre-Visit Letter

7. M-1.3, page 59: Provide the quantitative adjustments made to Vmax due to the effects of climate change.

8. Form M-1, pages 179-180: Explain the rationale for the Modified Base Storm Set numbers.

Verified: YES

Professional Team Comments:

Discussed the methodology for calculating the impact of climate change on hurricane intensity and the determination of the magnitude of the climate change adjustment.

Reviewed examples for incorporating the climate change trend into the Base Hurricane Storm Set.

Discussed the reintensification over the Gulf of Mexico of hurricanes with multiple landfalls.

Discussed how Vmax is determined during reintensification over the Gulf.

Reviewed an example of calculating reintensification.

Reviewed flowchart for processing changes in HURDAT2 in calculating landfall distributions.

Reviewed the hurricanes added to the Base Hurricane Storm Set and the hurricanes modified based on their updates in HURDAT2.

Discussed the storms leading to the modified Base Storm Set numbers for landfalling and by-passing storms in Form M-1.

Discussed that there have been no systematic variations in the climatological hurricane landfall frequencies.

Reviewed landfall frequency goodness-of-fit Chi-square tests by region for Florida and neighboring states.

Reviewed the annual occurrence rates of Florida landfalling hurricanes in Form M-1 compared to Form S-1 and Form A-2.

Reviewed Vmax probability distributions of historical and modeled fits for different regions of Florida.

Reviewed plot of track directions by landfall location.

Reviewed comparison of modeled and historical Rmax and forward speed.

Discussed the weighting of the ternary tree branches in determining event rates.

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:

Discussed no change in the methodology for calculating landfalling storm frequencies.

Reviewed the relationship between modeled Rmax to historical Vmax.

Reviewed comparison of modeled and historical Rmax.

Reviewed comparison of modeled and historical forward speed.

Reviewed the asymmetry factor calculation for different forward speeds.

Reviewed a windfield snapshot of Hurricane Wilma (2005) with the asymmetry factor applied based on the forward speed.

Discussed that the model simulates surface windspeeds directly, therefore no conversion is performed in the model.

Reviewed geographic representation of the NLCD 2019 land use land cover.

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.

Verified: YES

Professional Team Comments:

Reviewed goodness-of-fit tests for Vmax, track direction, Rmax, forward speed, and over-land decay for tracks over Florida and neighboring states.

Discussed that landfall locations are on a discrete set of coastal points.

Reviewed plots of Vmax, Rmax, forward speed, annual landfall frequency, and event day of year distributions and the statistical comparisons between modeled and historical observations.

Reviewed climate change trends by hurricane category.

Reviewed comparison of modeled to historical hurricane landfalls in Florida.

Discussed how the year loss table is created from the events per year empirical distribution.

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 land cover data taken from the National Land Cover Database (NLCD) 2019.

Reviewed an example of the spatial change in land cover classification caused by Hurricane Michael (2018).

Discussed the methodology for assigning appropriate roughness lengths.

Reviewed geographical representation of the model surface roughness distribution.

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

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

Reviewed the model treatment of Vmax over the ocean pre-landfall and after landfall.

Reviewed example of Hurricane Michael (2018) windfield footprint validation.

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 the over-land decay function and its calculation.

Reviewed plots comparing model over-land weakening rates to historical Florida hurricane weakening rates.

Reviewed landfall windfield maps, land-use data maps, and roughness length maps for Hurricane Andrew (1992), Hurricane Jeanne (2004), and Hurricane Irma (2017).

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.

Verified: YES

Professional Team Comments:

Reviewed the relationship between windspeed and surface roughness for Hurricane Jeanne (2004).

Reviewed box plots of Rmax for different maximum windspeeds.

Reviewed Rmax calculation for storms with Vmax less than 157 mph and for storms with Vmax greater than or equal to 157 mph.

Reviewed sample event footprints used to demonstrate and verify logical relationships among parameters.

Reviewed a time-based contour animation of the Hurricane Wilma (2005) windfield.

Discussed the conversion of Vmax to central pressure for completing Form M-3.

STATISTICAL HURRICANE STANDARDS – Mark Johnson, 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

9. S-1.1, page 79 and page 82: Explain how the Shapiro-Wilk test was applied for fitted distributions other than normal (Vmax with generalized Pareto and forward speed with Weibull).

10. S-1.6, Figure 25, page 86: Explain how the Chi-square test was applied here.

Verified: YES

Professional Team Comments:

Discussed the Shapiro-Wilk test used for assessing fitted distributions.

Discussed the Chi-square goodness-of-fit test used for building mean damage ratio curves.

Discussed the change in goodness-of-fit tests used for model parameters from the current accepted model.

Reviewed goodness-of-fit tests for Vmax, forward speed, landfalls per year, and Rmax distributions.

Reviewed comparisons of the historical and modeled distributions.

Reviewed annual probability of exceedance for the 2017 FHCF exposure data.

Discussed the choice of statistical model for relationship between year and global sea-surface temperature (SST). Reviewed plot of the fitted model for the regression of SST on year.

Reviewed the parameter estimates for the change in Vmax for historical storms in the Gulf of Mexico.

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:

Discussed that no changes were made in model methodology from the current accepted model, and that no new sensitivity analyses were performed.

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:

Discussed that no changes were made in model methodology from the current accepted model, and that no new uncertainty analyses were performed.

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.

Verified: YES

Professional Team Comments:

Discussed the approach to verify the standard.

Discussed the stability of loss costs for the event catalog created using the ternary tree methodology.

Reviewed comparison of average annual losses in Nassau County a set of catalogs with different number of years.

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

11. S-5.1, Table 6, pages 98-99: Provide Table 6 with the actual values rather than scaled values along with a scatterplot of the unscaled values.

12. S-5.1, Table 6, pages 98-99: Provide the basis and justification for "An excess litigation factor of 15 percent has been applied to Florida single family home modeled losses for Irma and Michael."

13. S-5.1, Table 6, pages 98-99: Explain the increase in Actual Loss from the current accepted model, e.g., Hurricanes Charley and Frances + Jeanne.

Verified: YES

Professional Team Comments:

Reviewed scatter plot of actual versus modeled losses with undisguised insurer data for Florida and non-Florida hurricanes.

Discussed the analysis of claims data with indicators for litigated claims. Reviewed the excess litigation factor applied to single-family residential buildings in Florida, excluding manufactured homes.

Discussed the updated methodology for generating Table 6.

Reviewed the list of historical hurricanes for which detailed claims data have been analyzed and used for model validation.

Reviewed table summarizing the historical event landfall date and date of in-force exposure data.

Discussed how demand surge and loss adjustment expenses are handled in the model.

Discussed the documented procedure for verifying losses for a single peril. Reviewed how flood and storm surge losses are not considered in the modeled hurricane losses.

Discussed that data used in validation are processed in accordance with documented claims processing procedures.

Discussed that insurer exposure data are imported in accordance with documented exposure data processing procedures.

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:

Reviewed Form S-5 comparing historical and modeled annual average statewide hurricane loss costs.

Reviewed the exposure mapping of input values for the 2017 FHCF exposure database.

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

14. V-1.A, page 102: Discuss the model effects of climate change on the validation of the vulnerability functions.

15. V-1.1, page 103: Provide a detailed explanation of the changes listed under V-1.1.

16. V-1.6, pages 106-107: Explain in detail how the empirical distributions are chosen and the "complex iterative process" to develop them.

17. V-1.6, pages 106-107: Describe how uncertainties associated with building vulnerability functions are derived for wood frame and manufactured home constructions.

18. V-1.8, Table 12, page 110: Given the statement in G-1.7 (page 36), "In addition, the vulnerability functions were updated to capture the modifications in Florida Building Code 2020 (effective since 2021)," explain the basis and justify the use of year-built band >2011.

19. V-1.10, page 111: Provide examples of vulnerability functions for sheds and gazebos, and compare them with wood frame and manufactured homes building vulnerability functions.

20. Form V-1, page 202: Explain the reduction of losses across windspeeds in Parts A and B for all three construction types compared to Form V-1 as given in the current accepted model.

Verified: YES

Professional Team Comments:

Discussed that the vulnerability component of the model consists of approximately 4,200 vulnerability functions for residential and commercial-residential buildings in Florida.

Reviewed comparison of the updated Very-New site-built home vulnerability function to the current accepted model. Reviewed comparison of loss by ZIP Code for Very-New year-built band to the current accepted model and the underlying claims data.

Reviewed comparison of the updated manufactured home vulnerability functions for different year bands to the current accepted model. Reviewed comparison of loss by ZIP Code for manufactured home to the current accepted model and the underlying claims data.

Discussed the methodology for updating the building vulnerability functions for unknown building height.

Reviewed comparison of commercial residential vulnerability functions across windspeed bands to the current accepted model.

Discussed that validation of the vulnerability functions uses windspeed data for hurricanes. Discussed that the amount of climate change contribution to the windspeed is not used in validation.

Discussed how empirical distributions are selected for modeling uncertainty in vulnerability functions. Reviewed examples of secondary uncertainty associated with damage ratios.

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

Discussed the development of year-built band >2011 accounts for revisions in the Florida Building Code 2020 (effective 2021). Discussed the revisions in Florida Building Code 2020 compared to Florida Building Code 2017.

Reviewed the relationship between building and appurtenant structure vulnerability functions.

Reviewed the different construction types for site-built and manufactured homes.

Discussed the variation of losses across windspeeds in Form V-1 compared to the current accepted model.

Discussed the updated hurricane claims data by policy type.

Reviewed scatter plots of modeled-to-claims mean damage ratios for single-family homes and manufactured homes. Reviewed scatter plots of modeled-to-claims mean damage ratios for wood frame and masonry structures.

Reviewed geographical representation of the pre-2012 and 2012 and newer Florida vulnerability regions for site-built homes.

Discussed the process for assigning ZIP Codes to one of the vulnerability regions.

Reviewed the assignment of Florida Building Code characteristics to the model primary and secondary building characteristics.

Discussed with Girma Bitsuamlak, independent external reviewer, his review of the vulnerability module, updates to the vulnerability component, and the vulnerability portion of the submission document.

Discussed the process for receiving client feedback on the model performance during and after a live event. Reviewed the insurer claims data request letter. Discussed the uniqueness of insurer claims data from different clients, and the procedures for processing and analyzing the client claims information.

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

21. V-2.1, page 113: Demonstrate how contents vulnerability functions have been updated due to updates to building vulnerability functions. Provide a comparison of contents vulnerability functions for wood frame and manufactured homes built in 1980 and 2010.

22. V-2.4, page 115: 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:

Reviewed comparison of contents vulnerability functions across windspeed bands for wood frame, masonry, and manufactured home constructions.

Reviewed the relationship between contents and building damage ratio by occupancy and construction type.

Discussed the claims data used for validating the building to contents vulnerability relationship.

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.

Pre-Visit Letter

23. V-3.1, page 116: Demonstrate how time element vulnerability functions have been updated due to updates to building vulnerability functions. Provide a comparison of time element vulnerability functions for wood frame and manufactured homes built in 1980 and 2010.

Verified: YES

Professional Team Comments:

Reviewed comparison of time element vulnerability functions across windspeed bands for wood frame, masonry, and manufactured home constructions.

Reviewed the M. Baradaranshoraka (2017) reference with average times of repair by building component.

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

24. Form V-4, page 208: Explain the non-zero entries for Masonry construction combined mitigation.

Verified: YES

Professional Team Comments:

Discussed the revised processes and flowchart for generating data for the vulnerability forms.

Discussed the editorial error in the input for Form V-4 and how the error was avoided in Form V-2 for the model under review.

Discussed that hurricane mitigation and secondary characteristics have not been modified since the current accepted model.

Discussed the process for determining the impact of secondary characteristics and mitigation measures.

Reviewed the Roof Cover Age options in the model.

Reviewed the process of combining the effects of multiple mitigation measures and secondary characteristics.

Reviewed Form V-3 which was revised during the review to include the effects of excess litigation in the loss costs.

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 exposure data processing and import user guides.

Reviewed example of an analysis output report.

Reviewed the input data format fields.

Reviewed the Florida Hurricane Rate Filing template with pre-defined values that are required for a Florida rate filing.

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

25. A-2.B, page 138: Provide a copy of the documented procedure for distinguishing wind-related hurricane losses from other peril losses.

Verified: YES

Professional Team Comments:

Reviewed the documented procedure and methodology for distinguishing wind losses from other peril losses.

Discussed the criteria for identifying by-passing hurricanes.

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

26. A-3.1-4, pages 139-140: Show a calculation of loss costs and probable maximum loss levels for the minimum Frame Owners loss costs in Form A-1 (i.e., ZIP Code 32096 in Hamilton County).

27. A-3.5, page 140: Explain how the model handles the statutory 25% and 50% law and ordinance coverages.

Verified: YES

Professional Team Comments:

Discussed with Melinda Vasecka, Actuarial Standards signatory, her review of the actuarial portion of the submission document. Discussed how she attested the model results to be actuarially sound.

Reviewed a calculation of frame-owners loss costs in Form A-1 for ZIP Code 32096 in Hamilton County.

Reviewed the probable maximum loss calculations for ZIP Code 32096 in Hamilton County.

Reviewed the process for collecting loss information for law and ordinance.

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

28. A-4.1, pages 141-142: 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.

29. A-4.3, page 142: Provide a copy of the documented procedure and its implementation in the code.

30. 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 KCC's analysis of the impact of excess litigation, the claims data analysis processes, and how the data are used for model validation.

Reviewed comparison of the severity of litigated and non-litigated claims by windspeed.

Discussed the litigation analyses of Hurricane Irma (2017) and Hurricane Michael (2018) claims data.

Reviewed the results of litigation factor testing and the selected factor applied to account for recent and possible future legislative changes associated with the home insurance market in Florida.

Discussed that modeled hurricane losses have been validated with claims data for 28 hurricanes since 2004.

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

Reviewed the demand surge methodology documentation.

Reviewed the relationship between ground-up industry losses and the demand surge function.

Discussed that no adjustments for economic inflation are made to insurer exposure or claims data.

Reviewed the inclusion of an excess litigation factor for Florida site-built single-family homes.

Reviewed the change in methodology for calculating the uncertainty intervals for estimated loss costs and probable maximum loss levels.

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.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of revised Forms A-4 and A-5.

Discussed no change in the methodology for the effects of deductibles and policy limits.

Reviewed an example of annual hurricane deductibles.

Reviewed comparison to the current accepted model of average loss cost relativities across different deductible values in Form A-6, for frame-owners.

*****Additional Verification Review Comments*****

Verified after review of revised Form A-4.

Discussed that no changes were made to Form A-5 in the revised submission as the correct Form A-4 values were used to complete Form A-5 in the initial submission.

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

31. A-6.10, page 148: Explain the details for calculating the uncertainty intervals.

32. A-6.16, page 149: Provide the details for changes in the output ranges (Form A-4) due to adjustments for climate change.

33. Form A-1: Explain the increases in ZIP Codes 33146, 33156, and 33158 (Miami-Dade County), as well as ZIP Codes 32449 (Calhoun County) and 33982 (Charlotte County).

34. Form A-1: Explain the differences for ZIP Codes with population centroids that cannot be mapped as they lack physical ZIP Code boundaries, e.g., 32142 (Flagler County), 33349 (Broward County), 33425 (Palm Beach County), and 34230 (Sarasota County).

35. Form A-2, pages 215-218: Explain the significant differences from the current accepted model for Hurricanes LaborDay03-1935, NoName05-1935, Donna-1960, Betsy-1965, Frederic-1979, Elena-1985, Andrew-1992, and Wilma-2005.

36. Form A-4, 0% Deductible, pages 223-230: Explain the reversal in loss costs where Frame is less than Masonry:
    Owners: Alachua Average, Gulf Average, Pasco Average, St. Johns Average
    Renters: Liberty Average, Pasco Average, Wakulla Average
    Condo Unit: Franklin Average, Okaloosa Low, Pasco Average, Wakulla Average.

37. Form A-5, pages 240-244: Explain the declines in values for Nassau County.

38. Form A-5, Figure 70, page 243: Explain the regional changes (e.g., Panhandle and Southwest Florida versus Southeast Florida and the Big Bend) in the manufactured housing loss costs in Form A-4, compared to the current accepted model.

39. Form A-5, Figure 71, page 244: Explain the decline for Dixie County.

40. Form A-8, page 259: Explain the changes in Parts B and C from those in the current accepted model for the 5 and 10-year return periods compared to the longer return periods.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of revised Forms A-4 and A-5.

Reviewed Form A-1. Discussed the ZIP Code changes from the previous Form A-1 due to reclassification of some ZIP Code centroids by the new 2022 ZIP Code dataset.

Discussed the changes in Form A-1 from the current accepted model in Miami-Dade, Calhoun, and Charlotte Counties.

Discussed changes in Form A-1 from the current accepted model for several ZIP Codes with population centroids that cannot be mapped.

Discussed the differences in Form A-2 losses from the current accepted model for hurricanes Frederick (1979), Betsy (1965), LaborDay03 (1935), and Donna (1960).

Discussed that the automated procedure for Form A-4 pulled an incorrect input file for completing the 0% deductible loss costs in the form.

Discussed steps taken to prevent a recurrence of the error including automated checks for additional submission forms.

Reviewed Form A-8. Discussed the methodology for calculating the uncertainty intervals and the frequency and severity distributions.

Reviewed the hurricanes associated with the Form A-8 top event at the occurrence level and at the aggregate level and for the 500-year return period aggregate level.

Reviewed maps of loss costs by ZIP Code and County for frame owners, masonry owners, and manufactured homes.

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

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

*****Additional Verification Review Comments*****

Verified after review of revised Forms A-2 and A-4.

Discussed the error in Form A-4, how it happened, the impact of the error, and the corrective actions taken.

Reviewed a corrected Form A-2. Discussed the error in Form A-2, how it happened, the impact of the error, and the corrective actions taken.

Discussed that no changes were made to Form A-5 in the revised submission as the correct Form A-4 values were used to complete Form A-5 in the initial submission.

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 decrease in loss costs for Nassau and Dixie Counties.

Discussed the regional changes in Forms A-4 and A-5 compared to the current accepted model.

Reviewed graphical summaries of the sensitivity tests in Form A-6.

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

41. CI-1.B, page 150: Relate the primary binder table of contents with the response to Standard G-1.7 (pages 35-39) by demonstrating individual table item compliance with Computer/Information Standards CI-1 through CI-8.

42. CI-1.D, page 150: Provide the table required by Standard CI-1, Audit item 7.

43. CI-1.F, page 150: Provide the list of all externally acquired software and data assets as described and required by Standard CI-1, Audit item 6.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Reviewed the revised Model Development Guide documentation for reintensification of storms over the Gulf of Mexico.

Discussed the process for model deployment.

Reviewed the RiskInsight Installation Guide.

Reviewed the table of model changes as required by CI-1.D.

Reviewed documentation defining the process, decisions, implementation, and validation of updates to the model.

Reviewed the list of externally-acquired hurricane model-specific software and data assets.

Discussed that documentation is created separately and is maintained consistently with the source code.

*****Additional Verification Review Comments*****

Verified after verification of other standards.

Reviewed an example of source code revision on Microsoft Team Foundation Server.

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

44. CI-2, page 151: Provide requirements documentation that specifically relates to each model change identified in Standard G-1.7 (page 35).

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Reviewed software requirements documentation for updates made in the model under review.

Reviewed Track File Generator, Loss Analytics, and Financial Loss Calculator requirements documents.

*****Additional Verification Review Comments*****

Verified after verification of other standards.

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: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Reviewed the flowchart defining the process for creating the submission forms.

Reviewed the flowchart for processing changes in HURDAT2 for calculating landfall distributions.

Discussed the changes in the procedure for testing software components prior to release illustrated in the submission Figure 45 flowchart.

Reviewed flowchart defining the process for preparing and submitting analysis requests.

Reviewed examples of interface specifications for the model.

Reviewed examples of schema documentation for data files.

*****Additional Verification Review Comments*****

Verified after review of open items and verification of other standards.

Reviewed the KCC appendix to the ISO 5807 standard.

Reviewed revised flowcharts for consistency with the ISO 5807 standard and the updated KCC appendix to the standard.

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.

Pre-Visit Letter

45. CI-4.H, page 153: Provide the documents as noted.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Reviewed the coding guidelines.

Reviewed the code and data update plans documentation.

Discussed the process for determining the schedule and scope for model and software updates.

Reviewed implementation of calculation of hurricane reintensification over the Gulf of Mexico with multiple landfalls.

Reviewed implementation for the excess litigation factor.

Reviewed an example of the procedure for procuring and verifying the land use land cover data to derive a roughness factor and create friction files.

Reviewed the traceability of model components.

Reviewed an example of the table containing the number of lines of code and number of comment lines.

Reviewed flowchart for the network organization implementation.

Reviewed implementation of the minimum windspeed at which damage starts in the model.

*****Additional Verification Review Comments*****

Verified after verification of other standards.

Reviewed the revised scripts for creating Forms A-2 and A-4.

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

46. CI-5, pages 156-160: Provide complete and thorough verification procedures and output from the model changes identified in Standard G-1.7 (page 35).

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Reviewed the procedure to ensure complete and accurate implementation of model updates.

Reviewed example of validation and reporting of useful error details to the model user.

Reviewed code examples for automated unit tests, regression tests, and aggregation tests.

Reviewed a manual test example.

Reviewed the unit tests for reintensification of hurricanes over the Gulf of Mexico, the excess litigation factor, and unknown building height updates.

*****Additional Verification Review Comments*****

Verified after verification of other standards.

Discussed the new and expanded automated checks for submission forms and consistency checks across various submission forms.

Reviewed the scripts with new logic checks for Form A-2 and Form A-4.

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

47. CI-6.C, page 161: Provide and explain the RiskInsight pre-defined loss analysis options template for rate filings in Florida.

Verified: YES

Professional Team Comments:

Reviewed the Florida Hurricane Rate Filing template with pre-defined values that are required for a Florida rate filing.

Discussed the system controls for ensuring user selections cannot be changed when using the Florida rate filing template.

Reviewed the flowchart defining the process for selecting the Florida rate filing template and exposures for loss analysis.

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

48. CI-7.D, page 162: 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.

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 updates to the security procedures.

Discussed examples of encrypted, proprietary, and non-encrypted files.