Florida Commission on Hurricane Loss Projection Methodology

Professional Team Report

2021 Hurricane Standards

Hurricane Florence

Risk Management Solutions, Inc.

On-Site Review

April 24-27, 2023

On April 24-27, 2023, the Professional Team conducted an on-site review of the Risk Management Solutions, Inc. (RMS) North Atlantic Hurricane Models Version 23.0 (Build 2250) on platforms RiskLink® 23.0 (Build 2250) and Risk Modeler™ 2.27.0 on RMS Intelligent Risk Platform™. The following individuals participated in the review.

RMS

Florian Arfeuille, Ph.D., Lead Modeler, Model Development
Karen Argonza, Senior Science Writer and Editor
Ed Bannister, Ph.D., Senior Modeler, Model Development
Enrica Bellone, Ph.D., Senior Director, Model Development
Peter Datin, Ph.D., Senior Director, Model Development
Alison Dobbin, Ph.D., Senior Principal Modeler, Model Development
Michael Drayton, Ph.D., Consultant
Greg Fanoe, FCAS, MAAA, Actuarial Consultant, Merlinos and Associates, Inc.
Phil Feiner, Manager, Model Success
Kian Greene, Senior Analyst, Regulatory Analytics
Jo Kaczmarska, Ph.D., FIA, Senior Principal Modeler, Model Development
Michael Kozar, Manager, HWind
Anilesh Lakhtakia, Director, Software Development
Rohit Mehta, Director, Model Development
Akwasi Mensah, Ph.D., Principal Modeler, Model Development
Christos Mitas, Vice President, Model Development
Matthew Nielsen, Senior Director, Government and Regulatory Affairs
Niloufar Nouri, Ph.D., Modeler, Model Development
Morolake Omoya, Ph.D., Modeler, Model Development
Matt Pinkowski, Regulatory Documentation Manager
Mohsen Rahnama, Ph.D., Chief Risk Modeling Officer and Executive Vice President
Emilie Scherer, Ph.D., CCRA, Consultant, Model Development
Tyler Sherrod, Tropical Cyclone Modeler, HWind
Mohan Smith, Ph.D., Senior Modeler, Model Development
Derek Stedman, Principal Modeler, Model Development
Lindsay Stone, Model Specialist, Regulatory Analytics
Shahram Taghavi, Ph.D., Model Development
Avinash Takale, Manager, Software Development
Vahid Valamanesh, Ph.D., Principal Modeler, Model Development
Rajkiran Vojjala, Vice President, Model Development
Jeff Waters, Staff Product Manager, Model Product Management
Hugo Winter, Ph.D., Senior Modeler, Model Development
Xiaoning Wu, Ph.D., CCRA, Senior Modeler, Model Development
Michael Young, M.E.Sc., P.E., Vice President, Model Product Management

Professional Team

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

Donna Sirmons, Staff
Toma Wilkerson, Staff, observer

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

- Updated geocoding data to March 2022
- Points of interest added to geocoding capabilities
- Stochastic set updated to be consistent with June 2021 HURDAT2
- Recreated several historical footprints
- Updated surface roughness data to be consistent with NLCD 2016 or later
- Reaggregation of ZIP and County-level wind hazard for all events against updated postal code vintage data and boundaries
- Added a new year-built band
- Recalibration of year-built and building height relativities for low-rise buildings
- Updated occupancy relativities
- Recalibration of construction class relativities
- Introduced new unique vulnerability curves for steel with concrete roof and steel with panel roof
- Updated regional vulnerability relativities for multi-family dwellings and concrete/steel buildings
- Updated vulnerability region assignments for some point postcodes
- Updated building inventory region assignments and inventory distributions
- Renamed secondary modifier options for the Construction Quality modifier
- Updated credits and penalties associated with Roof Age modifier
- Updated post-event loss amplification factors for all stochastic events

The audit continued with a review of each standards section.

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

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

Report on Deficiencies

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

1. Non-responsive. The submission does not include a general description of any trade secret information to be presented to the Professional Team, beyond the trade secret Forms V-3, V-5, and A-6 (see Report of Activities, page 55).

2. G-1.5, page 22: Incomplete. Additional calculations showing no differences for Forms S-5, V-2, A-1, A-4, and A-8 across platforms are not provided.

3. Form G-4, page 181: Incomplete. Credentials (State, Expiration Date, and Professional License Type) are not provided.

4. G-3.1, page 56 and G-3.4, page 58: Incomplete. List of databases, including names, is not provided.

5. V-1.3, pages 113-115: Incomplete. Number of policies is not provided.

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 RMS'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 RMS. 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. RMS 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 8, 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, a Commission member will be in attendance. Please have available 7 printed copies of all materials.

The pre-visit questions are grouped by hurricane standards sections.

Editorial Items

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

The Professional Team reviewed the following corrections to be included in the revised submission to be provided to the Commission no later than 10 days prior to the meeting to review the model for acceptability. Page numbers below correspond to the initial November 8, 2022 submission document.

1. References to Risk Modeler 2.25.0 updated to 2.27.0 throughout the document.
2. Hurricane Model Identification, page 4: Primary hurricane model platform designated.
3. Table of Contents, page 6: Titles and page numbers corrected for consistency.
4. G-1.2, pages 18-19: References to disclosures corrected.
5. G-1.7, page 36: Corrected the number of Geocoding Module Changes and added the update to annual deductible factors.
6. G-2.2B, page 52: Viraj Patil added to Appendix B.

7. M-3.A, page 68: Hyperlink to Form M-3 corrected.
8. M-4.7, page 75: Landsea and Franklin reference date corrected.
9. M-5.2, page 84: Stations SET and SPG identified in Figure 29.
10. V-1.A, page 111: Reference and hyperlink corrected.
11. V-1.D, page 111: Disclosure reference corrected.
12. V-1.2, page 113: Disclosure reference corrected.
13. A-1.5, page 139: Revised note in Table 17 for calculating losses from wind for clarification.
14. V-1.10, page 119: Revised for clarification.
15. V-4.3, page 129: Reference and hyperlink to Form V-1 corrected.
16. A-1.5, page 139: Reference corrected.
17. A-6.8, page 156: Disclosure reference corrected.
18. CI-5, page 168: Numbering corrected for subsections under Data Testing.
19. Form A-7, page 303: Disclosure reference corrected.
20. Appendix B, page 319: Hurricane project responsibilities for Karen Argonza updated.
21. Appendix G, pages 381-383: Added acronyms omitted from the list.

GENERAL HURRICANE STANDARDS – Paul Fishwick, Leader

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

*(*Significant Revision)*

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

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

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

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

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

Audit

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

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

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

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

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

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

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

Pre-Visit Letter

1. G-1.B, page 13: Explain the coordination across personnel.

2. G-1.3, Figure 3, page 20: Describe how by-passing hurricanes fit into the flowchart. Describe how hurricane tracks from genesis fit into the flowchart.

3. G-1.7, Figure 8, page 41: Explain why the only county with any increase is Flagler County. Explain why Miami-Dade County has less decrease relative to Broward and Monroe Counties.

4. G-1.7, Figure 10, page 43: Explain the overall change in Baker County as it relates to the changes due to individual components.

5. G-1.7, Figure 10, page 43: Explain the decrease in Franklin County versus increases in Gulf and neighboring counties.

6. G-1.7, pages 35-43: Explain how interim software updates, if performed, over the past two years mesh with Standard G-1.7.

Verified: YES

Professional Team Comments:

Reviewed the model updates and the impact of the changes on loss costs.

Discussed the underlying reasons for the increase in loss costs in Monroe and Collier Counties in Figure 6.

Discussed the flowchart, process, and tools used for coordinating personnel across multiple areas.

Discussed where bypassing hurricanes and hurricane tracks are considered in the Figure 3 flowchart.

Discussed the reasons for the change in loss costs in Flagler, Miami-Dade, Broward, and Monroe Counties in Figure 8, Percentage Change in AAL by County due to Vulnerability Module Changes.

Discussed the reasons for the change in loss costs in Baker County due to each individual model component change.

Discussed the reasons for the change in loss costs in Franklin, Gulf, Liberty, and Wakulla Counties in Figure 10.

Reviewed scripts for generating actuarial Forms A-1 and A-6.

Discussed the tools for maintaining source code, data files, and bug tracking.

Reviewed internal documentation standards.

Reviewed the delta spreadsheets for Forms V-2, A-1, A-4, A-8, and S-5 for the interim model and platform updates for the North Atlantic Hurricane Models 21.0.2 (Build 2050) on Risk Link® 21.0.2 (Build 2050) and Risk Modeler™ 2.14.0 found functionally equivalent and acceptable on February 2, 2022, and the North Atlantic Hurricane Models 21.0.2 (Build 2050) on Risk Modeler™ 2.19.0 and North Atlantic Hurricane Models 22.0 (Build 2150) on Risk Link® 22.0 (Build 2150) and Risk Modeler™ 2.19.0 found functionally equivalent and acceptable on September 20, 2022.

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

7. G-2.2B, page 52: Provide resumes of the new personnel.

Verified: YES

Professional Team Comments:

Reviewed resumes of new personnel and consultants:

- Ed Bannister, Ph.D. in Meteorology and Atmospheric Sciences, University of Birmingham, Birmingham, UK; M.S. in Meteorology and Climatology, University of Birmingham, Birmingham, UK; LLB Graduate conversion to Law, Nottingham Law School, Nottingham, UK; B.S. in Chemistry, University College of London, London, UK

- Abhieet Chhatry, M.Tech in Remote Sensing, National Institute of Technology Karnataka, Surathkal, India; B.E. in Civil Engineering, Yeshwantrao Chavan College of Engineering, Nagpur, India

- Alison Dobbin, Ph.D. in Atmospheric Physics, University College London, London, UK; M.S. in Geophysics, University of Leeds, Leeds, UK; B.S. in Physics and Astrophysics, University of Leicester, Leicester, UK

- Kian Greene, B.A. in Environmental Studies and Biological Anthropology, University of California Santa Barbara, Santa Barbara, CA

- Anfisa Kashkenova, B.S. in Earth Science and Policy, Pennsylvania State University, State College, PA

- Shree Khare, Ph.D. in Atmospheric and Oceanic Sciences, Princeton University, Princeton, NY; M.S. in Mathematical Finance, University of York, York, UK; B.S. in Physics, University of British Columbia, Vancouver, BC, Canada

- Nicolas Joss Matthewman, Ph.D. in Applied Mathematics, University College London, London, UK; M.S. in Mathematics, University College London, London, UK

- Viraj Patil, M.S. in Computer Science, California State University, Long Beach, CA; B.S. in Computer Engineering, Mumbai University, Maharashtra, India

- Tyler Sherrod, M.S. in Meteorology, Florida State University, Tallahassee, FL; B.S. in Meteorology, Florida State University, Tallahassee, FL

- Mohan Smith, Ph.D. in Atmospheric Physics, Imperial College London, Royal College of Science, London, UK; M.S. in Geophysics, Imperial College London, Royal School of Mines, London, UK

- Lindsay Stone, M.S. in Hydrology, University of Waterloo, Wilfrid Laurier University Joint Graduate Program, Wilfrid Laurier University, Waterloo, Ontario, Canada; B.S. in Physical Geography, McGill University, Montreal, Quebec, Canada

- Anudeep Sure, Ph.D. in Geoinformatics, Indian Institute of Technology Kanpur, Kanpur, India; M.Tech in Remote Sensing and GIS with Specialization in Water Resources, Indian Institute of Remote Sensing, Dehradun, India; B.Tech in Electronics and Communication, Jawaharlal Nehru Technological University, Hyderabad, India

- Hugo Winter, Ph.D. in Statistics and Operational Research, Lancaster University, Lancaster, UK; M.Res. in Statistics and Operational Research, Lancaster University, Lancaster, UK; M.Math in Mathematics, University of Exeter, Exeter, UK

- Xiaoning Wu, Ph.D. in Marine and Atmospheric Science, State University of New York at Stony Brook, Stony Brook, NY; M.S. in Geography (Natural Disasters), Beijing Normal University, Beijing, China; B.S. in Atmospheric Science, Sun Yat-Sen University, Guangzhou, China

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

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

Discussed the process for reviewing and validating ZIP Code data.

Reviewed examples of geocoding for complete and incomplete street addresses.

Reviewed examples of latitude-longitude to ZIP Code conversions.

Discussed the model ZIP Code-based databases and their usage.

G-4 Independence of Hurricane Model Components

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

Audit

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

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

Verified: YES

Professional Team Comments:

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

G-5 Editorial Compliance

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

Audit

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

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

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

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

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

Verified: YES

Professional Team Comments:

Discussed the process for working with submission development and the editorial review process.

Reviewed an example of the modification and version history for submission documentation.

Reviewed the control flow diagram for creating Forms A-4 and A-5.

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

METEOROLOGICAL HURRICANE STANDARDS – Jimmy Booth, Leader

M-1 Base Hurricane Storm Set*

*(*Significant Revision)*

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

Audit

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

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

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

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

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

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

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

Verified: YES

Professional Team Comments:

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

Reviewed the methodology for historical storm reconstruction.

Reviewed comparisons of the modeled variable-resolution grid windspeeds to station observations for the storms added and modified.

Reviewed comparisons to the current accepted model of the modeled losses for the modified storms.

Reviewed comparisons of the modeled wind footprints for the regenerated storms.

Reviewed the methodology for updating landfall rates by gate and category.

Discussed the rationale for not accounting for climate change in the model submitted for review as options are in other versions of the model available to clients.

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

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 that RMS HWind is used for hurricane positions and parameters not included in HURDAT2.

Discussed the modeled dependencies among intensity and Rmax.

Discussed the use of the Deaves and Harris (1978), Harris and Deaves (1980), and Deaves (1981) methodology for gust coefficients as a function of roughness lengths.

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

Reviewed the methodology for selecting stochastic tracks.

Reviewed the process for calculating stochastic landfall frequencies and their comparison with historical landfall frequencies.

Reviewed an example of a stalling stochastic storm.

Reviewed the goodness-of-fit tests for central pressure, Vmax, translation speed, and Rmax for tracks over Florida and neighboring states.

Discussed modeling of storms that move back over water after making landfall.

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.

Pre-Visit Letter

8. M-4.7, page 79: Explain the change in observation data points in Figure 25, right panel relative to Figure 24, right panel in the current accepted model.

Verified: YES

Professional Team Comments:

Reviewed the process for assigning roughness lengths to the RMS variable-resolution grid (VRG).

Reviewed graphical representation of the updated VRG site coefficients.

Reviewed examples of new and expanded urban development and vegetation class changes. Discussed the process for validating the land use land cover updates.

Reviewed the modeling of Rmax.

Discussed the updated land cover data taken from the National Land Cover Database (NLCD) 2016.

Reviewed comparisons of observed to modeled windfields for Hurricane Charley (2004) and Hurricane Wilma (2005).

Discussed that the change in observation data points for the Hurricane Irma (2017) windfield footprint in Figure 25 is due to using a different observation station compared to the current accepted model.

Discussed that vertical variation of winds are accounted for in the vulnerability model.

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

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

*(*Significant Revision)*

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

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

Audit

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

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

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

Verified: YES

Professional Team Comments:

Reviewed comparison of the model over-land decay rates of historical storms represented in Figure 28.

Reviewed landfall windfield map and roughness length map for Hurricane Irma (2017).

Discussed the use of the Cook (1985, 1997) model for transitioning winds from over water to over land.

M-6 Logical Relationships of Hurricane Characteristics*

*(*Significant Revision)*

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

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

Audit

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

Pre-Visit Letter

9. Form M-3, page 197: Explain the change in outer radii >40mph values from the current accepted model.

Verified: YES

Professional Team Comments:

Discussed the revised calculation methodology for calculating the radii in the revised central pressure bins in the 2021 Hurricane Standards Report of Activities Form M-3.

Reviewed time-based contour animation for Hurricane Michael (2018).

STATISTICAL HURRICANE STANDARDS – Chris Nachtsheim, Leader

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

*(*Significant Revision)*

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

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

Audit

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

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

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

Verified: YES

Professional Team Comments:

Reviewed comparisons of the historical and modeled distributions for central pressure, inland filling rate, translational speed, and Rmax.

Reviewed goodness-of-fit tests for X1.

Reviewed the calculation of portfolio standard deviation.

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 that the contribution attributable to the sampling process is negligible for the 100,000+ years of simulation.

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

10. S-5.1, Table 11, page 107: Explain why the RMS Model estimates for Hurricanes Wilma, Irma, and Michael are low relative to the Reported Estimate and are substantially so compared to the current accepted model.

11. S-5.1, Figure 44 and Table 11, page 107: Explain the increase in Reported Estimate for Hurricane Andrew and Hurricanes Jeanne+Frances, and the increase in FL-OIR Estimate for Hurricanes Wilma and Irma relative to the current accepted model.

12. S-5.1, Table 12, page 108: Provide Table 12 with the actual values rather than normalized values along with a scatterplot of these non-normalized values.

Verified: YES

Professional Team Comments:

Discussed the modeled loss estimate comparisons in Table 11, Comparison of Actual and Estimated Industry Loss, and Figure 44.

Reviewed comparison of the reported and Florida OIR estimates untrended and trended for the current accepted model and the model under review for Hurricanes Andrew (1992), Jeanne+Frances (2004), Wilma (2005), and Irma (2017).

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

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 hurricane loss costs.

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

13. V-1.1, page 112: Provide a detailed explanation of the bullet items listed under V-1.1.

14. V-1.6, page 117: Describe how uncertainties associated with building vulnerability functions are derived for wood frame and manufactured home constructions.

15. V-1.10, page 119: Provide justification and supporting data for "appurtenant structures are modeled separately using the same vulnerability functions as buildings," given appurtenant structure coverage may include garages, pool screens, and sheds.

16. V-1.10, page 120: Provide the hurricane names and dates and the building construction types for the data in Figure 47.

17. Form V-1, pages 214-216: Explain why the losses for some windspeeds have decreased, some remain unchanged, and some have increased relative to Form V-1 as given in the current accepted model. Explain why, in Part B, Wood Frame losses have decreased, Concrete have increased, and Manufactured Home remains the same. Provide the underlying building vulnerability functions for the 3 construction types compared to the same building vulnerability functions for the current accepted model.

Verified: YES

Professional Team Comments:

Reviewed the procedure for processing claims and exposure data used for validation. Discussed the uncertainties in claims analyses.

Reviewed new claims data received for Hurricanes Irma (2017) and Michael (2018).

Reviewed the key observations from claims analyses and damage reports from Hurricanes Irma (2017) and Michael (2018).

Reviewed example claims adjustor reports with modeled windspeeds from Hurricane Irma (2017) and Hurricane Michael (2018).

Reviewed comparisons between the updated vulnerability curves and the current accepted model vulnerability curves by vulnerability region.

Reviewed the new year band 2021+ which was added to account for changes in the 2020 Florida Building Code for all construction types except manufactured homes.

Reviewed the research and analysis of claims data that resulted in the single-family and multi-family vulnerability updates.

Reviewed comparisons of year-built vulnerability curves across windspeed bands for single-family masonry construction.

Reviewed the component vulnerability modeling (CVM) used to create vulnerability functions.

Reviewed comparisons to the current accepted model of the CVM updated parameters.

Reviewed the year-built relativities update to vary by construction class, number of stories, and occupancy.

Reviewed comparisons to the current accepted model of the year-built relativities by construction class and height.

Reviewed comparisons of year-built vulnerability curves across windspeed bands for multi-family wood frame construction.

Reviewed comparison to the current accepted model of the building height relativity for 15+ stories.

Reviewed the new vulnerability curves for steel with concrete roof, steel with panel roof, concrete with concrete roof, and concrete with panel roof constructions.

Reviewed comparison to the current accepted model of the regional differentiation in the vulnerability curves.

Reviewed the update to the Homeowner Association (HOA) relativities. Discussed that the Condo-Unit Owner relativities did not change.

Reviewed comparison to the current accepted model of the HOA and Condo-Unit Owner relativities.

Reviewed the Florida inventory regions and their data sources. Reviewed the update to the inventory regions.

Reviewed the building inventory use when primary characteristics are unknown.

Reviewed geographical representation of the inventory region assignments in Florida.

Reviewed examples of ZIP Code inventory region assignments in Palm Beach and Orange Counties.

Reviewed example inventory distributions comparisons to the current accepted model.

Discussed the implications for modeled vulnerability on historical loss comparisons.

Reviewed scatter plot of the relationship between ground-up and claims damage ratios.

Reviewed scatter plots of the relationship between building and appurtenant structure mean damage ratios from the model, old claims data, and recent claims data.

Reviewed relationship between the mean damage ratio coefficient of variation curves and the uncertainty in building vulnerability functions.

Reviewed Form V-1 losses. Reviewed comparisons of the building vulnerability curves for the different Form V-1 construction types to the current accepted model.

Reviewed the flowchart for generation of Form V-1.

Discussed that there was no change to the manufactured homes vulnerability curves from the current accepted model.

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

18. V-2.1, page 122: Describe how contents damage functions have been updated due to updates to building vulnerability functions. Provide a comparison of contents vulnerability functions for wood frame, concrete, and manufactured homes with the same vulnerability functions from the current accepted model.

19. V-2.4, page 124: 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 scatter plots of the relationship between contents and building mean damage ratios. Discussed that there was no change in the relationships from the current accepted model.

Discussed that the updates to building vulnerability are also applied to contents and consequently that the corresponding contents vulnerability functions have been updated.

Reviewed comparisons of contents vulnerability curves to the current accepted model.

Reviewed comparison of contents vulnerability curves between 1980 and 2020 construction eras.

Discussed the treatment of uncertainties in contents vulnerability functions.

V-3 Derivation of Time Element Hurricane Vulnerability Functions*

*(*Significant Revision)*

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

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

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

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

Audit

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

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

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

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

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

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

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

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

Pre-Visit Letter

20. V-3.1, page 125: Describe 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, concrete, and manufactured homes to the same vulnerability functions from the current accepted model.

Verified: YES

Professional Team Comments:

Reviewed the relationship between time element and building damage ratios.

Discussed that the time-element methodology has not changed from the current accepted model.

Discussed that time-element vulnerability is updated based on updates to building vulnerability.

Reviewed comparisons of time-element vulnerability curves to the current accepted model.

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

21. V-4.1, page 129: Provide a detailed explanation of the renamed secondary modifier options for the Construction Quality modifier, and the updated credits and penalties associated with the Roof Age secondary modifier.

22. Form V-2, Part A, page 217: Demonstrate how the vulnerability functions for the reference structures have been developed, per the final sentence in the response.

23. Form V-2, Part B, pages 219-220: Explain why the values for 160mph for Roof-Wall Strength changed from the current accepted model for Wood Frame but not for Masonry construction.

24. Form V-4, page 223: Explain the values for Roof Covering for ASTM D7158 Class H Shingles.

Verified: YES

Professional Team Comments:

Discussed the basis for renaming construction quality options.

Reviewed the update to roof age credits and penalties that vary by windspeed.

Reviewed the methodology for combining secondary structural modifiers and their implementation.

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

Reviewed Form A-1 losses for ZIP Code 33921 by construction type and coverages.

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.

Pre-Visit Letter

25. A-1.6, Table 18, pages 139-143: Discuss the model options for Florida rate filings.

Verified: YES

Professional Team Comments:

Reviewed the available analysis options and settings in the model for a Florida rate filing.

Reviewed the FHCF EDM development documentation for processing the 2017 FHCF aggregated exposure data.

Reviewed example model input and output forms.

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

26. A-2.B, page 145: Provide a copy of the documented procedure for distinguishing wind-related hurricane losses from other peril losses.

Verified: YES

Professional Team Comments:

Discussed the procedure to remove storm surge losses from claims data.

Reviewed the Windstorm Claims & Exposure Data Requirements provided to clients when requesting claims data.

Reviewed the criteria for including landfalling and bypassing hurricanes in the stochastic event set.

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

27. A-3.1-4, pages 146-147: 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 32331 in Madison County).

28. A-3.5, page 148: Explain how law and ordinance coverage is implicitly accounted for and handled in the model. Explain how the model handles the statutory 25% and 50% coverages.

Verified: YES

Professional Team Comments:

Discussed with Greg Fanoe, consultant and Actuarial Standards signatory, his process and review of the model changes and the modeled results in the actuarial forms, and his attestation of actuarial soundness.

Reviewed a calculation of frame-owners loss costs in Form A-1 for ZIP Code 32331 in Madison County.

Reviewed the development of probable maximum loss and generation of the occurrence exceedance probability curve.

Reviewed the RMS Exceedance Probability Methodology white paper.

Reviewed the occurrence exceedance probability calculation for ZIP Code 32331 in Madison County. Discussed that law and ordinance coverage is implied in the vulnerability functions for personal residential properties.

Reviewed the law and ordinance limit extension applicable to single-family dwellings.

Discussed that the impact of the statutory required 25% and 50% law and ordinance coverage options is factored into the post-event loss amplification.

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

29. A-4.1, pages 149-150: 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.

30. A-4.3, pages 150-151: Explain the post-event loss amplification (PLA) and how it factors into the demand surge in the model.

31. 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 the uncertainties in claims analysis, the treatment of social inflation factors, and impacts of litigation.

Reviewed the post-event loss amplification (PLA) and demand surge model methodology.

Reviewed the updated PLA factors and the updated shape of the economic demand surge curve.

Reviewed the updated methodology to account for localized super catastrophe effects based on Florida county-level losses.

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

Discussed that economic inflation and litigation costs are not considered in the model.

Discussed that flood losses are not included unless explicitly selected by the user and that selection will be shown in the model output report.

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: YES

Professional Team Comments:

Discussed the methodology for processing insurer claims data used for model validation.

Discussed that there was no change in the methodology for application of the annual hurricane deductible. Discussed that the annual deductible tables have been updated.

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

32. A-6.10, page 156: Discuss the calculation of uncertainty intervals.

33. Form A-1: Explain the changes in Frame Owners and Masonry Owners from the following ZIP Codes compared to other ZIP Codes in the county: 32782, 32783, 32941 (Brevard), 32449 (Calhoun), 32061 (Columbia), 32964 (Indian River), 33902, 33910 (Lee), 32081 (St. Johns), and 32437 (Washington).

34. Form A-2, pages 230-233: Explain the differences in the total losses for Hurricanes Cleo-1964, Dora-1964, Hilda-1964, Isbell-1964, and Betsy-1965 compared to the current accepted model.

35. Form A-4, page 281: Explain the high Frame Renters Average value relative to the Frame Owners Average value for Monroe County compared to all other counties.

36. Form A-4, page 281: Explain the high Masonry Renters Average value relative to the Masonry Owners Average value for Monroe County compared to all other counties.

37. Form A-4, 0% Deductible, pages 277-283: Explain the reversal in loss costs where Frame is less than Masonry:
    Owners: Alachua Average, Franklin Average, St. Johns Average, Wakulla Average
    Renters: Franklin Average, Miami-Dade Average, Wakulla Average
    Condo Unit: Leon Average, Wakulla Average.

38. Form A-5, pages 293-301: Explain the regional changes (e.g., Panhandle versus the rest of the State) in the loss costs in Form A-4 compared to the current accepted model.

39. Form A-5, Tables 39 and 40, page 293: Explain for the North region how Frame and Masonry Owners increased (slightly) whereas Frame and Masonry Renters decreased considerably.

40. Form A-5, Figure 85, page 299: For Frame Condo Unit Owners, explain the +29.8% change shown for Washington County compared to surrounding counties.

41. Form A-5, Figure 86, page 300: For Frame Condo Unit Owners, explain the +21.7% change shown for Gulf County compared to surrounding counties.

42. Form A-7, Table 41, pages 304-305: Explain the differences in the Statewide changes for Frame Owners, Frame Renters, Masonry Renters and Masonry Condo Unit compared to the Statewide changes in Form A-5.

Verified: YES

Professional Team Comments:

Reviewed Form A-1 losses for ZIP Code 33921 by construction type and coverages.

Discussed the error in Form A-6, why it occurred, why it was not found previously, the corrections made, and the new QA test plan to mitigate future errors.

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

Reviewed the methodology for calculating the uncertainty intervals in Form A-8.

Discussed the changes in Form A-1 from the current accepted model in Brevard, Calhoun, Columbia, Indian River, Lee, St. Johns, and Washington Counties.

Discussed the changes in losses for Hurricanes Cleo-1964, Dora-1964, Hilda-1964, Isbell-1964, and Betsy-1965 in Form A-2 driven by changes in the historical footprints for these storms.

Discussed the Form A-4 high Frame Renters Average loss costs relative to Frame Owners Average for Monroe County and compared to other counties.

Discussed the Form A-4 Masonry Renters Average loss costs relative to Masonry Owners Average for Monroe County and compared to other counties.

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

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

Discussed the statewide changes for loss costs in Form A-7 compared to Form A-5.

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

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

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

43. CI-1.B, page 158: Relate the primary binder table of contents with the response to Standard G-1.7 (pages 35-43) by demonstrating individual table item compliance with Computer/Information Standards CI-1 through CI-8.

44. CI-1.D, page 158: Provide the table required by Standard CI-1, Audit item 7.

45. CI-1.F, page 159: Provide the list of externally acquired software and data assets as described and required by Standard CI-1, Audit item 6.

Verified: YES

Professional Team Comments:

Reviewed documentation standards.

Reviewed documentation for the post-event loss amplification (PLA) methodology update.

Reviewed the table of model changes.

Reviewed the list of externally acquired software and data assets.

Reviewed documentation for secondary modifiers.

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

46. CI-2, pages 160-161: Provide requirements documentation that specifically relates to each model change identified in Standard G-1.7 (pages 36-37).

Verified: YES

Professional Team Comments:

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

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.

Pre-Visit Letter

47. CI-3.B, page 162: Provide the flowchart standards document.

Verified: YES

Professional Team Comments:

Reviewed the revised flow diagram standards.

Reviewed the flowchart for quality and consistency checks on ZIP Code data.

Reviewed the revised flowchart for creating Form V-1.

Reviewed the revised control flow diagram for Forms A-4 and A-5 creation.

Reviewed the flowchart for the windfield footprint.

Reviewed the stochastic wind model basic structure flux diagram.

Reviewed the flowchart defining the PLA methodology.

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

48. CI-4.H, page 165: Provide the information as noted.

Verified: YES

Professional Team Comments:

Reviewed the corrected automation script for Form A-6.

Reviewed the script for generating Form A-1.

Reviewed the variable mapping and implementation for the wind profile, surface winds, and application of surface roughness site coefficients.

Reviewed the spreadsheet and equations for calculating the economic demand surge curves.

Reviewed the script to calculate the PLA factors.

Reviewed implementation of secondary modifiers.

Reviewed the coding guidelines for different languages.

Reviewed the hardware platforms, user access, operating systems, and software platforms for the Risk Modeler and RiskLink platforms.

Reviewed the network organization structure for the Risk Modeler and RiskLink platforms.

Reviewed the code and data maintenance, testing, and update plans.

Reviewed the line count table for the stochastic windfield code with the number of comment lines and the number of code lines.

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

49. CI-5, pages 167-169: Provide complete and thorough verification procedures and output from the model changes identified in Standard G-1.7 (pages 36-37).

Verified: YES

Professional Team Comments:

Reviewed the updated QA test plan for Actuarial forms output.

Discussed the QA script for checking consistency between Form A-2 and Form M-1.

Reviewed the QA test script for Form A-8.

Reviewed results of the QA tests on Form A-8 losses.

Reviewed the unit testing for updates to the vulnerability curves.

Reviewed the list of validation tests completed for the model updates.

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

50. CI-6.C, page 170: Provide and explain the Florida rate filing interface options.

Verified: YES

Professional Team Comments:

Reviewed a live demonstration of the user interface with pre-defined settings for a Florida rate filing.

Reviewed the design specification and principles documentation for the Risk Modeler user interface.

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

51. CI-7.D, page 172: 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 past 5 years model version history on the RiskLink primary platform.

Discussed the version number change for the functionally equivalent platform Risk Modeler to 2.27.0 and the changes between version 2.25.0 and version 2.27.0

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:

Reviewed the security aspects for the RiskLink and Risk Modeler platforms.

Reviewed the network security diagrams for RiskLink and Risk Modeler platforms.

Discussed that there have been no known security breaches.