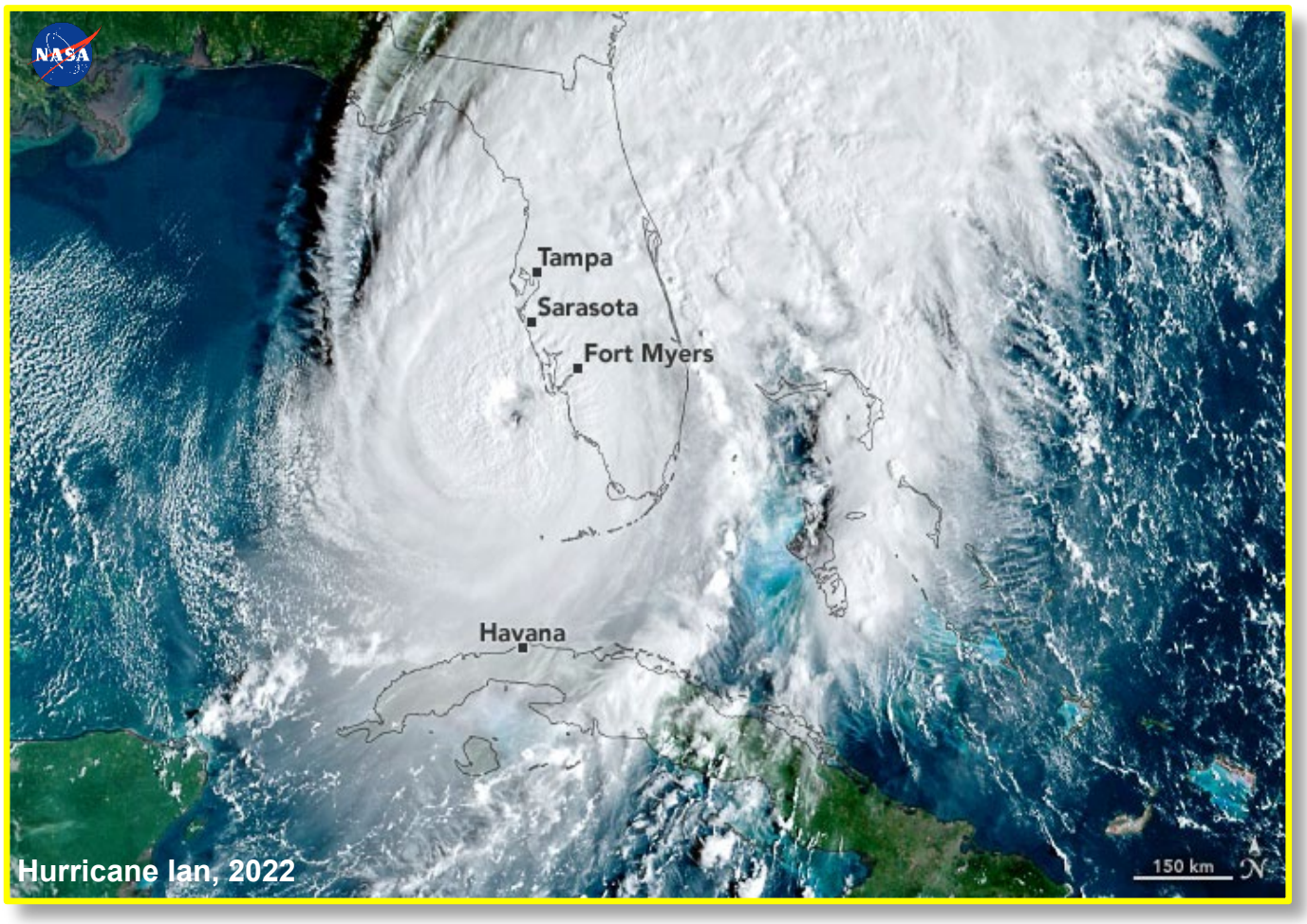
Florida Commission on Hurricane Loss Projection Methodology

Professional Team Report

2023 Hurricane Standards



CoreLogic/Cotality™, Inc.

On-Site Review: April 7-10, 2025

On April 7-10, 2025, the Professional Team conducted an on-site review of the CoreLogic/ Cotality™ Florida Hurricane Model 2025. The following individuals participated in the review.

CoreLogic/Cotality™
Branimir Betov, M.S., Director, Model Development
Justin Brolley, Ph.D., Principal Research Scientist
Mahmoud Khater, Ph.D., P.E., Chief Science and Engineering Officer
Howard Kunst, FCAS, MAAA, Actuary
Ilyes Meftah, Research Scientist
David Smith, Senior Director, Model Development
Amanuel Tecle, Ph.D., Research Scientist

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

Commission
Kathy Hurta, FCAS, Florida Hurricane Catastrophe Fund Advisory Council Actuary

The Professional Team began the review with an opening briefing and introductions were made. CoreLogic/Cotality™ provided an overview of the model updates to the current accepted model.

- Probabilistic hurricane database updated for 2022-2023 events
- Rmax, forward speed, profile factor, and filling rate storm parameters updated based on the additional historical data from 2022-2023 and the HURDAT2 reanalysis project
- Offshore hurricane intensity changes based on intensity changes given in HURDAT2
- Defaults for roof age and condition have been updated
- New post-2023 age band added
- Vintage of the underlying demand surge data updated to be consistent with 2023 data
- ZIP Code database updated to March 2024

CoreLogic/Cotality™ explained the impacts on loss costs for each of the model updates. The combined model changes resulted in a 3.75% increase in the average annual zero deductible statewide hurricane loss costs.

The audit continued with a review of each standards section.

Report on Deficiencies

The Professional Team reviewed the following deficiencies cited by the Commission at the January 3, 2025, meeting. The deficiencies were eliminated by the established time frame, and the modifications have been verified.

1. G-1.1, page 14: Incomplete. Identification of the primary platform and the distinguishing aspects of each platform not provided.

2. G-1.5, page 25: Forms S-5, A-1, A-4, and A-8 not provided for the Navigate v25 platform.

3. Form S-4.B, page 207: Incomplete. Provide a definition of the model relevant commercial residential classifications used.

Professional Team Pre-Visit Letter

The Professional Team's pre-visit letter items 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 CoreLogic's model submission under the 2023 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 on-site review that is not given below or discussed during an upcoming conference call to be held if requested by CoreLogic. The goal of a 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.

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. CoreLogic should then proceed with an explanation of new or updated material related to the model. Afterwards, a review of the standards in the *Hurricane Standards Report of Activities as of November 1, 2023,* will commence. Each standard should be addressed beginning with responses to the pre-visit letter questions for that specific standard followed by responses to each of the audit items for that standard. CoreLogic should discuss the Artificial Intelligence (AI) issue identified by the Commission at the January 3, 2025, meeting during the Computer Information Standards. The Professional Team will discuss with CoreLogic the two Commission Inquiries regarding roof covering type and attachment, and building and roof vulnerability after the Professional Team exit briefing.

If changes have been made in any part of the model or the modeling process from the descriptions provided in the initial November 5, 2024, 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, 2023*, for details on materials to be presented and provided to the Professional Team (pages 94-96).

While the Report of Activities specifies 4 printed copies, a Commission member and different Professional Team members will be in attendance. Please have available 6 printed copies of the presentations (printed two slides per page and duplexed), 1 additional printed copy of the actuarial standards presentation (printed two slides per page and duplexed), and 7 printed copies of the Form A-6 graphical summaries, the color-coded contour map of the hurricane loss costs for strong owners frame buildings, and the scatter plot of the hurricane loss costs against distance to closest coast for strong owners frame buildings.

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

GENERAL HURRICANE STANDARDS
Chris Nachtsheim, 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 literature, 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.

D. All meteorological forms, statistical Forms S-1, S-2, and S-6, and all actuarial forms with the exception of Form A-2 shall be produced through an automated procedure or procedures as indicated in the form instructions.

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

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

1. G-1.2, page 19: Discuss the Software/Hardware requirements for the Navigate platform.

   Discussed that there are no software/hardware requirements for the Navigate platform since it is a fully hosted platform that can be run on any major web browser.

2. G-1.7.A.1, page 30: Discuss the update to the database containing default year of construction.

   Discussed that the default year of construction for each ZIP Code is based on the 2020 U.S. Census housing data, and that the Census data provides the number of housing units built in each decade for each ZIP Code.

   Discussed that no Florida ZIP Codes were added or removed after the ZIP Code updates in the model under review.

   Discussed that the default year of construction has not been updated since the current accepted model.

3. G-1.7.C, Figure 5, page 32:
   a. Provide details for the reason for changes in annual zero deductible hurricane loss costs due to the frequency update.
   b. Identify the specific updates in HURDAT2 that had an impact.
   c. Explain how the changes from the frequency update resulted in changes in loss costs of up to 22% across multiple counties.

   Discussed that the Model Base Hurricane Set was updated to include the 2022 and 2023 hurricane seasons. The update included Hurricane Ian (2022) and Hurricane Idalia (2023) landfalls in the Big Bend and southwest Florida regions. Discussed the sensitivity of frequency updates in those regions.

   Discussed that the frequency of Category 3 hurricanes increased by 25% in the Big Bend region, and the frequency of Category 4 hurricanes increased by 33% in southwest Florida.

4. G-1.7.C, Figure 9, page 34: Explain the changes in Gulf, Franklin, Liberty, and Putnam Counties due to ZIP Code Update.

   Discussed and reviewed images of the changes in ZIP Code centroids in Gulf, Franklin, Liberty, and Putnam Counties, and the impact of those changes on loss costs.

Audit

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

   Reviewed several examples throughout the audit.

2. Maps, databases, and data files relevant to the submission will be reviewed in the course of the on-site review.

   All maps, databases, and data files were available for review. Reviewed samples throughout the audit.

3. Justification for the vintage of data, code, scientific literature, and technical literature used will be reviewed in the course of the on-site review.

   Discussed the vintage of data and code throughout the audit.

4. Supporting material for the hurricane model changes in Disclosure 7 will be reviewed.

   Reviewed the supporting material for the model updates under each corresponding standards group.

5. For any changes made in the hurricane model since the initial submission, color-coded maps by county reflecting the percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 FHCF exposure data for each hurricane model component change, between the initial submission and the revised submission, and between any intermediate revisions and the revised submission, will be reviewed.

   Confirmed that there have been no changes to the hurricane model since the initial submission.

6. For any modifications to Form A-4 using the 2017 FHCF exposure data resulting from changes in the hurricane model since the initial submission, a newly completed Form A-5 with the initial submission as the baseline for computing the percentage changes, and with any intermediate revisions as the baseline for computing the percentage changes, will be reviewed.

   Confirmed there have been no changes to Form A-4 since the initial submission.

7. If the output ranges in Form A-4 using the 2023 FHCF exposure data are regenerated since the initial submission, a Form A-5 based on the output range percentage changes using the 2023 FHCF exposure data with the initial submission as the baseline for computing the percentage changes, and with any intermediate revisions as the baseline for computing the percentage changes, will be reviewed.

   Not applicable as the output ranges have not changed since the initial submission.

G-2 Qualifications of Modeling Organization Personnel and Consultants Engaged in Development and Implementation 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 (current 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.

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

5. G-2.2.B, page 41: Provide resumes of the new personnel.

Reviewed resumes of new personnel:

- Matthew Casper, A.S. in Computer Support, Waukesha County Technical College, Pewaukee, WI
- Camille Daum-Lobko, M. in Environmental Sciences, Université du Québec à Montréal, Montreal, Canada; M.S. in Computer Science, Université Paris, Paris, France
- Barun Kumar Das, B.S. in Commerce, Calcutta University, Kolkata, India
- Anupama Nigam, M.S. in Insurance and Sustainable Risk Management, Glasgow Caledonian University, Glasgow, Scotland
- Tal Pascal, B.S. in Business Administration, University of North Carolina, Greensboro, NC

- Shanu Shivan, B.Tech. in Mechanical Engineering, GLA University, Bharthia, India
- Karen Stephens, B.S. in Business Management, Texas State University, San Marcos, TX

Audit

1. The professional vitae of new employees and consultants (since the previous submission) engaged in the development or implementation of the hurricane model under review and responsible for the submission will be reviewed.

   See PVL #5 for resumes reviewed.

2. 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.

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

G-3 Insured Exposure Location*

*(*Significant Revision)*

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.

Verified: YES

Professional Team comments are provided in black font below.

Audit

1. Geographic displays for all ZIP Codes will be reviewed.

   Reviewed geographic representation of ZIP Code boundaries and centroids.

2. Geographic comparisons of previous to current locations of ZIP Code centroids will be reviewed.

   Reviewed map comparisons of the centroid changes from the current accepted model.

   Reviewed the top 10 ZIP Code centroid movements.

3. Third party vendor information, if applicable, and a complete description of the process used to validate ZIP Code information will be reviewed.

   Reviewed the information provided in Disclosures 1 and 2.

4. The treatment of ZIP Code centroids over water or other uninhabitable terrain will be reviewed.

   Discussed that no ZIP Code centroids exist over water.

   Discussed the process to ensure ZIP Code centroids do not fall over water.

   Reviewed maps of Florida ZIP Code centroid locations.

5. Examples of geocoding for complete and incomplete street addresses will be reviewed.

   Discussed the processes for geocoding user-provided invalid and valid address data or geocodes.

   Reviewed examples of geocoding incomplete and incorrect addresses.

6. Examples of latitude and longitude to ZIP Code conversions will be reviewed.

   Discussed that ZIP Code assignments by latitude and longitude are based on ZIP Code polygons.

   Reviewed an example of a latitude-longitude conversion to a ZIP Code.

7. Hurricane model ZIP Code-based databases will be reviewed.

   Discussed the databases that are ZIP Code based.

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.

Verified: YES

Professional Team comments are provided in black font below.

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) in the course of the on-site review. 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.

   Reviewed the theoretical soundness, integration of components, and consistency across components throughout the audit.

   No evidence was seen to suggest that one component of the model was deliberately adjusted to compensate for another component.

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

   Reviewed all changes in the hurricane model since the current accepted model and determined none of the model updates impacted the independence of each model 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 that the submission has been personally reviewed and is editorially correct.

Verified: **YES**

Professional Team comments are provided in black font below.

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, 2023,* will be made.

   Discussed the experience of the editorial signatory.

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.

   CoreLogic/Cotality™ confirmed that the hurricane model submission was reviewed throughout the development process for grammatical correctness, typographical accuracy, completeness, and no inclusion of extraneous data or materials.

   Discussed the process for making editorial changes to the submission document.

3. Confirmation that the submission has been reviewed by the signatories on the Expert Certification Forms G-1 through G-6 for editorial compliance will be assessed.

   CoreLogic/Cotality™ confirmed that subject matter experts reviewed all submitted materials for completeness and accuracy.

4. The modification history for submission documentation will be reviewed.

   Reviewed the submission documentation modification history.

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

   Reviewed a flowchart of the process for submission form creation.

Editorial items noted in the pre-visit letter and during the on-site review by the Professional Team were satisfactorily addressed during the audit. The Professional Team has reviewed the submission, but cannot guarantee that all editorial difficulties have been identified. The modeler is responsible for eliminating such errors.

METEOROLOGICAL HURRICANE STANDARDS
Jimmy Booth, Leader

M-1 Model Base Hurricane Set*
*(*Significant Revision)*

A. The Model Base Hurricane Set shall be one of the following: (1) Reference Hurricane Set, (2) Model Adjusted Hurricane Set, or (3) Model Climate-Adjusted Hurricane Set, and shall be justifiable.

B. A climate-adjusted hurricane model shall use one of the hurricane sets listed in A as its Model Base Hurricane Set and shall be justifiable.

C. Annual frequencies used in the hurricane model validation shall be based upon the Model Base Hurricane Set.

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

6. M-1.4, page 53: Explain the differences in Form M-1 for the Model Base Hurricane Set as compared to the updated table numbers provided in April 2024 to account for updates to the years 1966-1970 in HURDAT2.

   Discussed that the Model Base Hurricane Set accounts for the reanalysis of 1966-1970 hurricanes and is consistent with Form A-2.

   Reviewed comparison of annual landfall and bypass frequency by region and neighboring states for the Reference Hurricane Set, the Model Base Hurricane Set, and the modeled stochastic set.

   Discussed the process for checking consistency among Forms M-1, S-1, and A-2.

Audit

1. The Model Base Hurricane Set and its justification will be reviewed.

   Discussed that Hurricane Elsa (2021), Hurricane Ian (2022), Hurricane Nicole (2022), and Hurricane Idalia (2023) have been added to the Model Base Hurricane Set.

   Reviewed Florida landfalling and bypassing storm frequency by category and milepost.

2. A flowchart or other illustration of how changes in the Reference Hurricane Set are used in the calculation of the Model Base Hurricane Set landfall distribution will be reviewed.

   Reviewed flowchart for processing changes in HURDAT2 (Reference Hurricane Set) in calculating landfall distributions.

3. Changes to the Model Base Hurricane Set from the current accepted hurricane model used will be reviewed.

   Reviewed the 2021, 2022, and 2023 hurricanes added to the Model Base Hurricane Set.

4. Modeled probabilities will be compared with observed hurricane frequency using methods documented in current scientific literature and current technical literature. The goodness-of-fit of modeled to the Reference Hurricane Set statewide and regional hurricane frequencies as provided in Form M-1 will be reviewed.

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

   Reviewed the chi-square test function used in the Monte-Carlo simulation to estimate the *p*-values for the Form M-1 regions.

5. If the model is a climate-adjusted model, changes in hurricane intensity, frequency, and track, if applicable, will be reviewed.

   Discussed the rationale for not accounting for climate variability or climate change in the model submitted for review.

M-2 Hurricane Parameters (Inputs)*

*(*Significant Revision)*

Methods for depicting all modeled hurricane parameters shall be based on information documented in current scientific literature and current technical literature.

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

7. M-2.2, page 56: Clarify statement "among other variables" (your bullet point #9) to make clear that all input parameters are listed and explained.

   Discussed that the "other variables" include wind direction, directional friction factor, and the gust factor. Reviewed a revised response to bullet point 9 in M-2.2 to include these variables.

Audit

1. Supporting material for the meteorological component changes in Disclosure 1 will be reviewed.

   Reviewed the methodology for calculating Rmax, forward speed, and profile factor.

   Reviewed comparisons of modeled and historical Rmax, profile factor, and forward speed and their associated goodness-of-fit tests.

   Reviewed the updated filling-rate distribution and the associated goodness-of-fit test.

   Reviewed the new methodology for calculating the intensity of offshore storms in the stochastic model.

   Reviewed a comparison between a historical storm intensity change and a stochastic storm with a similar track and intensity, with focus on re-intensification.

   Discussed the external data sources for the hazard component updates.

2. All hurricane parameters used in the hurricane model, including any adjusted for climate change, will be reviewed.

   Discussed the hurricane parameters landfall location, track direction, maximum one-minute sustained winds, Rmax, translational speed, filling rate, and profile factor, and their associated distributions.

   Reviewed the gust factor equation. Discussed the gust factor dependency on the friction factor.

3. 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,

   Reviewed the datasets for landfall location, maximum sustained winds, Rmax, translational speed, filling rate, and profile factor.

   b. The modeled dependencies among correlated parameters in the windfield component and how they are represented, and

   Reviewed the relationship between modeled profile factor and Rmax for all historical storms including non-Florida landfalling storms.

   Reviewed the methodology for computing the profile factor.

   Reviewed the relationship between Rmax and central pressure.

   c. The parameters affecting asymmetric structure of hurricanes.

   Reviewed an example of the asymmetric windfield for a stochastic storm.

M-3 Hurricane Probability Distributions*

*(*Significant Revision)*

A. Modeled probability distributions of hurricane parameters shall be consistent with the Model Base Hurricane Set. Any differences shall be justifiable.

B. Modeled hurricane landfall frequency distributions shall reflect the Model Base Hurricane 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). Any differences shall be justifiable.

C. The hurricane model shall use maximum one-minute sustained 10-meter windspeed when defining hurricane landfall intensity. This applies both to the Model Base Hurricane 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.

Verified: **YES**

Professional Team comments are provided in black font below.

Audit

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

   Reviewed the goodness-of-fit results for landfall frequency for Alabama, Mississippi, Georgia, northwest Florida, and northeast Florida.

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

   Reviewed the methodology for selecting stochastic storm tracks from the existing track catalog. Discussed that stochastic storm landfall points are distributed continuously.

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

   Discussed that stochastic landfall points are based on smoothed historical data on a continuous distribution. Reviewed maps illustrating the smoothing along the Florida coastline.

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

   Discussed that modeled variables are statistically derived from historical data.

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.

Verified: YES

Professional Team comments are provided in black font below.

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.

   Discussed that no modeling-organization-specific research was performed to develop the windfield functions.

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

   Discussed that the National Land Cover Database (NLCD) 2016 published in April 2019 is used as the source for the land use land cover data. Discussed that there was no change from the current accepted model.

   Discussed the methodology for modifying the roughness distributions.

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

   Reviewed geographical representation of the modeled surface roughness distribution for Florida.

4. A flowchart or other illustration depicting the process for calculating hurricane surface winds will be reviewed.

   Reviewed the flowchart of the windfield structure.

   Reviewed the equations for calculating hurricane surface winds.

5. 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.

   Reviewed map comparisons to the current accepted model of the spatial distribution of winds for the LaborDay03 (1935) and NoName09 (1945) storms.

6. 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.

   Reviewed maps of the modeled windfields for Hurricane Charley (2004), Hurricane Wilma (2005), Hurricane Irma (2017), and Hurricane Michael (2018).

   Reviewed goodness-of-fit tests for each storm.

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

   Discussed that the vertical variation in winds is accounted for in the vulnerability functions.

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

   Discussed that far-field pressure in the model is always 1013mb, and that intensity for each event is specified in terms of 1-minute sustained winds and not central pressure.

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

   Discussed that the maximum 1-minute sustained 10-meter windspeed is used as input into the windfield model, not central pressure or gradient windspeed.

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

    Reviewed the external data sources that affect the model windfields.

M-5 Hurricane Intensity Change Methodologies*

*(*Significant Revision)*

A. The hurricane intensity change methodology used by the hurricane model shall be consistent 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.

C. Intensity change of hurricanes that pass from over land to over water shall be consistent with current state-of-the-science.

Verified: YES

Professional Team comments are provided in black font below.

Audit

1. The variation in overland decay rates used in the hurricane model will be reviewed.

   Reviewed goodness-of-fit tests for filling rate distributions in the Gulf and Florida.

2. The transition of storm intensity from over land to over water will be reviewed.

   Reviewed the new methodology for changes in hurricane intensity while over water. Discussed reintensification of multiple landfalling storms. Reviewed a comparison of intensity changes along the track while over water.

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

   Reviewed comparisons of modeled-to-observed filling rates in the Gulf and in Florida.

   Reviewed comparison to the current accepted model filling rate coefficients.

4. 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 Charley (2004), Hurricane Michael (2018), and Hurricane Ian (2022) at the closest time after landfall will be reviewed.

   Reviewed Hurricane Ian (2022) and Hurricane Michael (2018) wind animations.

   Reviewed the windspeed adjustment from ocean to open terrain.

Reviewed images of Hurricane Ian (2022) and Hurricane Michael (2018) maximum gust winds at landfall.

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.

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

8. M-6.4, page 74: Provide a response to the revised disclosure provided in the 2023 Hurricane Standards Report of Activities Q&As on September 12, 2024, i.e., "Describe the dependencies among characteristics (i.e., model output) in the windfield component and how they are represented by the hurricane model."

   Discussed that the vulnerability component explicitly uses peak gust. Reviewed the revision to the text that will be provided in the final submission document.

   Discussed the procedure for calculating peak gust winds.

Audit

1. The logical relationship between windspeed and surface roughness will be reviewed.

   See M-5, Audit 4.

2. Justification for the relationship between intensity and radius of maximum winds will be reviewed.

   Reviewed the relationship between mean Rmax and central pressure.

3. The mathematical dependence of the modeled windfield as a function of distance and direction from the center position will be reviewed.

   Reviewed the relationship between asymmetry and different forward speeds.

4. Justification for the variation of the asymmetry with the translation speed will be reviewed.

   Reviewed the equations for the asymmetry term based on NWS-23 and Knaff 2007.

5. Methods (including any software) used in verifying logical relationships of hurricane characteristics will be reviewed.

   Discussed the methods for verifying that the modeled relationship between mean values for central pressure and Rmax were consistent with observations.

6. Contour animations of windfield distributions demonstrating scientifically reasonable windfield characteristics and logical relationships will be reviewed.

   Reviewed animation of Hurricane Charley (2004) windfield.

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 literature and current technical literature.

B. Modeled results shall reflect statistical agreement with historical data or the Model Base Hurricane Set using current scientific and statistical methods for the academic disciplines appropriate for the various hurricane model components. Any differences shall be justifiable.

Verified: YES

Professional Team comments are provided in black font below.

Reviewed a revised response to S-1.2 removing Hurricane Idalia (2023) as a source of claims data used for validation.

Discussed that the *p*-value for translational speed in disclosure 8 remained at 0.98 due to coincidence.

Pre-Visit Letter

9. S-1.5, Figure 23, page 81: Justify the positioning of the mean claims (orange circles) relative to the distributions of claims (blue dots), and the ratio of residual variance to total variance (0.01).

   Discussed that the damage ratios of zero were not included in the blue dots and that the variances are computed using the mean claims data.

   Reviewed an improved Figure 23 revised to use a normal scale (to include the zeros), to add lines showing the slicing, and to provide the R^2.

10. Form S-1, Table 13, page 198: Provide goodness-of-fit testing results for modeled versus observed frequencies.

    Discussed that Figure 21 in the submission used values from the current accepted model for the Model Base Hurricane Set Probability. Reviewed a corrected Figure 21 with an updated chi-square *p*-value of 56%.

Audit

1. 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 in the course of the on-site review.

   Reviewed goodness-of-fit tests for landfall frequency.

2. Regression analyses performed will be reviewed, including 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.

   Reviewed statistical tests for the model updates.

   Reviewed vulnerability functions and uncertainties comparison to claims data under the Vulnerability Standards.

S-2 Sensitivity Analysis for Hurricane Model Output*

*(*Significant Revision)*

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.

Verified: YES

Professional Team comments are provided in black font below.

The sensitivity analyses performed on track spacing, the number of attack angles given landfall, the number of windspeed intervals given landfall and attack angle, and the number of other storm parameter samples used in the stochastic storm set are discussed in S-2, Disclosures 1-5.

S-3 Uncertainty Analysis for Hurricane Model Output*

*(*Significant Revision)*

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.

Verified: YES

Professional Team comments are provided in black font below.

The uncertainty analysis on the temporal and spatial outputs is discussed in S-3, Disclosures 1-4.

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.

Verified: YES

Professional Team comments are provided in black font below.

Audit

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

   Reviewed the standard error in Nassau County as a percentage of expected annual loss costs over a number of events.

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), Hurricane Michael (2018), and Hurricane Ian (2022) to the extent data from Hurricane Ian are available.

Verified: YES

Professional Team comments are provided in black font below.

Audit

1. The following information for each insurance company 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 list 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 review,
   h. The type of coverage 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.

Discussed that the date of exposures is based on insurance portfolios at the time of each storm landfall.

Discussed that the CoreLogic/Cotality™ Florida Hurricane Model 2025 was used to generate all modeled losses.

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

Reviewed scatter plot validations in Form S-4.

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

Reviewed the new methodology for determining confidence intervals based on average annual loss.

4. An additional version of Form S-4 with actual (i.e., non-disguised and non-scaled) values with associated scatter plots (modeled hurricane loss versus company actual hurricane loss) will be reviewed.

Reviewed scatter plot validations of loss estimates as given in Form S-4.

Discussed the process for completing Form S-4. Reviewed a revised Table 16 correcting the percentage differences between Actual/TIV and modeled TIV for Company D.

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.

Reviewed the results provided in Form S-4.

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.

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

11. Form S-5.C, pages 208-209: Explain the formula employed for the standard error of A.

Reviewed the new methodology for calculating the standard error of A.

Reviewed a revised Form S-5.C providing the confidence interval.

12. Form S-5.C, pages 208-209: Justify the value of the *t* quantile employed in the calculation of the confidence limits.

Reviewed revised values of A1 and A2 based on the new methodology computing the differences.

Audit

1. Justification for the following will be reviewed:

Discussed that there were no changes from the current accepted model.

a. Meteorological parameters,

Discussed during review of meteorological audit items.

b. The effect of by-passing hurricanes,

Discussed that by-passing storms are included in calculations as long as windspeeds are at least 40 mph.

c. The effect of actual hurricanes that had two landfalls impacting Florida,

Discussed that the model handles secondary landfalls the same as primary landfalls.

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 review, and

Discussed that the model assumes uniform environmental conditions outside of hurricanes.

e. Exposure assumptions.

Discussed that exposure is limited to the input data provided by insurance companies.

VULNERABILITY HURRICANE STANDARDS
Masoud Zadeh, Leader

V-1 Development of Building Hurricane Vulnerability Functions*
*(*Significant Revision)*

A. Development of the building hurricane vulnerability functions shall be based on a combination of available insurance company hurricane claims data and rational engineering analysis supported by laboratory testing, field testing, or post-event site investigations.

B. The development 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 development and application of building hurricane vulnerability functions.

E. Hurricane vulnerability functions shall be developed 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).

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

13. V-1.A, page 92: Explain the lack of post-hurricane field surveys for hurricanes impacting Florida and the U.S. from 2009 through 2023, and hurricane claims data since 2008. Explain the validity of the hurricane vulnerability functions last updated in 2008 for the latest hurricanes, and particularly for buildings constructed post 2011.

    Discussed that post-hurricane field surveys have been conducted for several major events, including Hurricane Sandy (2012), Hurricane Charley (2004), Hurricane Florence (2018), Hurricane Ian (2022), Hurricane Helene (2024), and Hurricane Milton (2024). Reviewed revisions to the submission in V-1, V-2, and V-3 that includes more recent storms post-hurricane field surveys.

    Discussed that post-hurricane surveys can impact the vulnerability functions and secondary modifiers in the model.

    Discussed that secondary structural modifiers are customized for each building type, considering building codes, enforcement practices, and other factors that affect construction quality.

    Discussed the challenges in claims data acquisition due to proprietary restrictions and data privacy regulations.

    Discussed the collaborative efforts with insurance companies to facilitate data sharing agreements.

14. V-1.1, page 94: Provide further details on the changes.

    Discussed that the roof condition and roof age secondary modifiers are updated regularly to reflect the roof's performance within each designated age-band.

    Discussed that the new default post 2023 age-band secondary structural modifier was added to capture the performance characteristics of buildings constructed under the Florida Building Code implemented on December 31, 2023.

    Reviewed a damage analysis showing the percentage increase in damage for each roof age category compared to the baseline of roofs less than 6 years old.

    Reviewed a damage analysis showing the percentage increase in damage for each roof condition compared to a roof in very good condition.

15. V-1.6, pages 97-98: Provide an example of multi-year claims data, engineering analyses, and post-hurricane surveys used to arrive at uncertainty for a building hurricane vulnerability function.

    Discussed that claims data and post-hurricane surveys could be used to validate the vulnerability functions.

    Reviewed examples of masonry and wood frame coefficients of variation from the claims data.

16. V-1.7, page 98: Provide a summary of the post-event site inspections for Hurricane Florence (2018), Hurricane Ian (2022), and Hurricane Milton (2024).

    Reviewed post-hurricane surveys for Hurricane Ian (2022) and Hurricane Milton (2024). Discussed the results and conclusions drawn from the post-hurricane surveys.

17. V-1.8, pages 99-100: Explain how the primary characteristics given in V-1.11.d (page 102) define/correlate to the model 96 basic construction classes.

    Discussed that the model assigns the primary characteristics Year Built, Height, Structure Type, and Occupancy to the appropriate construction class.

    Reviewed map of Florida counties by U.S. Department of Housing and Urban Development (HUD) wind zones. Discussed how the HUD zones are addressed in the model.

    Reviewed the model assignment of vulnerability regions for HUD Zones II and III.

    Reviewed the process for implementing manufactured homes vulnerability in HUD Zone III.

18. V-1.9, page 100: Justify the year-built bands relative to changes in the Florida Building Code.

    Discussed that building code development by year built is represented as a year band in the development of the default secondary structural modifiers.

    Discussed the process for evaluating updates to the Florida Building Code (FBC) and implementation of FBC amendments and new building characteristics into the model.

19. V-1.10, page 101: Discuss the consistency of the building and appurtenant structure hurricane vulnerability functions with insurance company hurricane claims data.

    Discussed the claims data used for development of the building and appurtenant structure vulnerability functions.

    Discussed that the building and appurtenant structure vulnerability functions align with empirical observations from claims data.

Reviewed a comparison of masonry building versus appurtenant structure vulnerability functions.

20. V-1.11, pages 101-102:
    a. Explain how the new weights are derived. Provide comparisons of the weights with the current accepted model.

    Discussed the methodology for creating a weighted average composition of structures by line of business and by region.

    Reviewed a comparison to the current accepted model of the default structure types for personal and commercial residential.

    b. Provide the default building characteristics as a function of the year of construction.

    Reviewed the default building characteristics as a function of the year of construction.

    Reviewed the "North Atlantic Hurricane Model RQE v25 Principles and Methodology" technical documentation.

    c. Describe the treatment of construction located in the FBC High Velocity Hurricane Zone (HVHZ).

    Discussed the approach for the HVHZ hurricane vulnerability framework.

21. V-1.14, page 103: Explain how the ability of a structure to resist water infiltration through various features is addressed in the model. Describe how water infiltration is addressed through options in the Roof Sheathing feature.

    Discussed that secondary structural modifiers that address various roofing system features are used to capture a building's water resistance performance.

    Reviewed examples of roof sheathing, water barrier installation, and nailing techniques.

    Reviewed the classification of roof shingles reflecting wind resistance capacity and ability to prevent water infiltration.

22. Form V-1, page 214: Given the modifications in the vulnerability component and updates to the ZIP Code-based databases, explain the lack of changes in Part A and Part B relative to the current accepted model.

    Discussed that the vulnerability updates for roof condition and roof age are outside the year of construction specified in Form V-1 (1980 and 1995).

Audit

1. Supporting material for the building vulnerability component changes in Disclosure 1 will be reviewed.

   See PVL #14.

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

   Discussed that no modifications have been made to the building vulnerability functions from the current accepted model.

3. The breakdown of insurance company exposure data used to develop the building hurricane vulnerability functions into number of insurers, number of policies, number of locations, and amount of dollar exposure by policy type will be reviewed.

Policy Type	Number of Insurers	Number of Policies	Number of Locations	Exposure Value ($)
Personal Residential				
Manufactured Homes				
Commercial Residential				

   Reviewed the requested breakdown of insurance company exposure data.

4. The breakdown of insurance company hurricane claims data used to develop the building hurricane vulnerability functions into events (year and storm name), number of insurers, number of policies, number of locations, number of claims, and amount of loss separated by policy type will be reviewed.

Year	Storm Name	Number of Insurers			Number of Policies			Number of Locations			Number of Claims			Loss Amount ($)		
		Personal Residential	Manufactured Homes	Commercial Residential	Personal Residential	Manufactured Homes	Commercial Residential	Personal Residential	Manufactured Homes	Commercial Residential	Personal Residential	Manufactured Homes	Commercial Residential	Personal Residential	Manufactured Homes	Commercial Residential

Reviewed the requested breakdown of insurance company hurricane claims data.

5. The modeling of uncertainty associated with building hurricane vulnerability functions for wood frame, masonry, and manufactured homes construction classes will be reviewed.

Discussed that uncertainties are developed from a combination of historical data, engineering analysis, statistical methods, and the tracking of building code updates.

6. How the uncertainties in windspeed for an individual hurricane at a given location are accounted for in the hurricane model damage estimates will be reviewed.

Reviewed the methodology to account for uncertainties in windspeed at a given location. See M-2.2 and M-4.1-13.

Reviewed the code for uncertainties in the friction and gust factors.

Discussed that Figure 26 shows a beta distribution of vulnerability uncertainties rather than a lognormal distribution.

7. Insurance company hurricane claims data in the original form will be reviewed with explanations for any changes made and descriptions of how missing or incorrect data were handled.

Discussed the insurance company hurricane claims data used. Discussed the treatment of missing or incorrect data.

8. The goodness-of-fit of the building hurricane vulnerability functions will be reviewed.

   Reviewed scatter plots of modeled to claims mean damage ratios for masonry and wood frame structures.

9. Complete reports detailing loading conditions and damage states for any laboratory or field-testing data used will be reviewed.

   Discussed that no laboratory or field-testing data were used in developing the hurricane vulnerability functions.

10. Rational engineering analysis used to develop building hurricane vulnerability functions will be reviewed for a variety of different building construction classes.

    See Audit 11.

11. The combination of available insurance company hurricane claims data and rational engineering analysis to develop the building hurricane vulnerability functions will be reviewed.

    Discussed that claims data (up to 2005), the MacDonald and Mehta report, and the "Secondary Structural Modifiers: Features and Model Description" documentation were used to develop the building hurricane vulnerability functions.

12. Laboratory or field tests and original post-event site investigation reports will be reviewed.

    See PVL #16.

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

    Discussed that construction types are defined in the claims data.

14. Multiple samples of building hurricane vulnerability functions for commercial residential building structures, personal residential building structures, manufactured homes, and appurtenant structures will be reviewed.

    Reviewed building vulnerability functions for untied manufactured homes, tied-down manufactured homes, wood frame, unreinforced masonry, and reinforced masonry.

15. Documentation and justification for the effects on the building hurricane vulnerability functions due to applicable building codes will be reviewed.

    Discussed that enhanced structural resilience through enforcement of the Florida Building Code is accounted for in the vulnerability functions.

Discussed that claims data, to the extent available, provides empirical validation of code-compliant buildings and validation of the building vulnerability functions.

16. The process for incorporating new insurance company hurricane claims data, if any, will be reviewed.

    Discussed the underlying reasons for not using claims data from Hurricane Irma (2017) and Hurricane Michael (2018) to evaluate or update the vulnerability functions.

17. How the claim practices of insurance companies are accounted for when insurance company hurricane claims data are used to develop building hurricane vulnerability functions will be reviewed. 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, and the impact of the legal environment in the claims data analyses will be reviewed.

    Discussed that no adjustments are made to the claims data when used for model validation.

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

    Discussed that there is no set percentage of loss above which the model assumes a total loss.

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

    Discussed that there is no explicit provision for law and ordinance coverage.

20. A plot comparing hurricane vulnerability functions for wood frame building structure, masonry building structure, and appurtenant structure will be reviewed.

    Reviewed comparisons of vulnerability functions for wood frame, masonry, and manufactured homes.

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

    Reviewed plots of actual versus modeled mean damage ratio by windspeed for masonry, wood frame, and manufactured homes appurtenant structures. Reviewed regression diagnostics including QQ plots of the residuals versus theoretical quantiles, plots of the residuals versus fitted values, and *p*-values for the significance of the regression.

V-2 Development of Contents Hurricane Vulnerability Functions*

*(*Significant Revision)*

A. Development of the contents hurricane vulnerability functions shall be based on a combination of available insurance company hurricane claims data and rational engineering analysis supported by laboratory testing, field testing, or post-event site investigations.

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

Verified: YES

Professional Team comments are provided in black font below.

Audit

1. Supporting material for the contents vulnerability component changes in Disclosure 1 will be reviewed.

   Discussed that the contents vulnerability functions have not been modified from the current accepted model.

2. Comparisons of the modified contents hurricane vulnerability functions, if any, with the current accepted hurricane model will be reviewed.

   Not applicable since no modifications were made to the contents vulnerability functions.

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

   Not applicable since no modifications were made to the contents vulnerability functions.

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

   Reviewed contents vulnerability functions for untied manufactured homes, tied-down manufactured homes, wood frame, unreinforced masonry, and reinforced masonry.

   Discussed total mean loss to manufactured homes where contents loss showed less than total loss. Discussed that the modeler might perform research on this subject and address it in the future.

5. The goodness-of-fit of the contents hurricane vulnerability functions will be reviewed.

   Reviewed scatter plots of modeled to claims mean damage ratios for masonry and wood frame contents.

6. The modeling of uncertainty associated with contents hurricane vulnerability functions for wood frame, masonry, and manufactured homes construction classes will be reviewed.

   See V-1 Audit 5.

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

   Discussed that contents vulnerability functions are derived from claims data as a function of structure type and occupancy.

8. Justification and documentation of the method of development, the underlying data, and assumptions related to contents hurricane vulnerability functions will be reviewed.

   Discussed that the contents vulnerability functions are derived from claims data.

9. Support for the rational engineering analysis used in developing the contents hurricane vulnerability functions will be reviewed.

   See Audit 8.

10. The combination of available insurance company hurricane claims data and rational engineering analysis to develop the contents hurricane vulnerability functions will be reviewed.

    Discussed that the contents vulnerability functions are based on historical observed damage from claims data and post-hurricane field surveys, and experimental research conducted by Professors Mehta and McDonald at Texas Tech University.

11. The modeling of water infiltration on contents vulnerability functions for a multi-story commercial residential building, if applicable, will be reviewed.

    See PVL #21.

V-3 Development of Time Element Hurricane Vulnerability Functions*

*(*Significant Revision)*

A. Development of the time element hurricane vulnerability functions shall be based on a combination of available insurance company hurricane claims data and rational engineering analysis supported by laboratory testing, field testing, or post-event site investigations.

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 insurance company hurricane claims data.

C. Time element hurricane vulnerability function development 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.

Verified: YES

Professional Team comments are provided in black font below.

Audit

1. Supporting material for the time element vulnerability component changes in Disclosure 1 will be reviewed.

   Discussed that the time element vulnerability functions have not been modified from the current accepted model.

2. Comparisons of the modified time element hurricane vulnerability functions, if any, with the current accepted hurricane model will be reviewed.

   Not applicable since no modifications were made to the time element vulnerability functions.

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

   Not applicable since no modifications were made to the time element vulnerability functions.

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

   Reviewed comparison of time-element vulnerability functions with available claims data.

   Reviewed the relationship of time-element damage ratio to building and contents damage ratios.

5. The modeling of uncertainty associated with time element hurricane vulnerability functions for wood frame, masonry, and manufactured home construction classes will be reviewed.

   Discussed that there were no changes from the current accepted model.

6. Justification and documentation of the method of development, the underlying data, and assumptions related to time element hurricane vulnerability functions will be reviewed.

   Discussed that time-element vulnerability functions are based on occupancy from claims data.

   Reviewed the time-element methodology.

   Reviewed comparison of residential time element vulnerability function with claims data.

7. The goodness-of-fit of the time element vulnerability functions will be reviewed.

   Reviewed the building and contents to time-element vulnerability relationship with claims data.

8. Support for the rational engineering analysis used in developing the time element hurricane vulnerability functions will be reviewed.

   See Audit 6.

9. The combination of available insurance company hurricane claims data and rational engineering analysis to develop the time element hurricane vulnerability functions will be reviewed.

   Discussed that time element is a function of contents damage, building damage, and occupancy.

V-4 Hurricane Mitigation Measures and Secondary Characteristics*

*(*Significant Revision)*

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.

Verified: YES

Professional Team comments are provided in black font below.

Audit

1. Supporting material for the hurricane mitigation measures and secondary characteristics vulnerability component changes in Disclosure 1 will be reviewed.

   Discussed that no modifications have been made to the hurricane mitigation measures and secondary characteristics vulnerability component from the current accepted model, except for updates given in V-1.1.

2. Comparisons of the modified hurricane mitigation measures and secondary characteristics, if any, with the current accepted hurricane model will be reviewed.

   Not applicable since no modifications were made to the existing hurricane mitigation measures or secondary characteristics.

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

   Discussed the calculation for the loss cost values in Form V-5.

4. Form V-3 and Form V-5 will be reviewed.

   Reviewed Forms V-3 and V-5, and their correspondence to Forms V-2 and V-4.

   Discussed that no changes occurred in Forms V-2 and V-4 from the current accepted model.

   Discussed that in the model, metal and membrane roof covering performs worse than the reference structure shingles in Form V-2. Reviewed supporting evidence showing a typical metal roof deck failure on older construction.

   Discussed the underlying reasons for Form V-4 showing no changes in the wall-foundation-strength connection for larger anchors or closer spacing.

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.

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

6. Any variation in the change in hurricane damage over the range of windspeeds for individual hurricane mitigation measures and secondary characteristics will be reviewed.

   Reviewed examples of impacts of secondary characteristics by windspeed.

7. Insurance company hurricane claims data, rational engineering analysis, or engineering judgment used to support the assumptions and implementation of the hurricane mitigation measures and secondary characteristics will be reviewed.

   Reviewed the “Secondary Structural Modifiers: Features and Model Description” documentation.

8. For each roof covering type used to complete Form V-2, the following will be reviewed:
   a. Roof age definition as considered in the model, including assumptions,
   b. The association between roof age and year built, including assumptions,
   c. Variation in roof age assumptions (e.g., by region or ZIP Code), and
   d. The impact of roof age on loss costs.

   Discussed that roof age is based on the year of construction.

   Reviewed the "Secondary Structural Modifiers: Features and Model Description" documentation.

9. 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.

   Reviewed the "Secondary Structural Modifiers: Features and Model Description" documentation.

10. Hurricane mitigation measures and secondary characteristics used by the hurricane model, whether or not referenced in Form V-2 and Form V-3 will be reviewed for theoretical soundness and reasonability.

    Reviewed the "Secondary Structural Modifiers: Features and Model Description" documentation.

ACTUARIAL HURRICANE STANDARDS
Stu Mathewson, Leader

A-1 Hurricane Model Input Data and Output Reports

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.

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

23. A-1.B, page 130:
    a. Describe how the calculation of the average default factors are updated and kept current for missing user input values.
    b. If different from the current accepted model, for one average default factor that changed, provide the calculation for updating the default factor. If no default factors changed, explain why not.
    c. Include a sample of a hurricane model output report using the revised factor.

Discussed that year of construction and regions in the state of Florida impact the default secondary structural modifiers which are based on the Florida Building Code and construction practice.

Discussed that the default year of construction for each ZIP Code is based on the 2020 U.S. Census housing data which provides the number of housing units built in each decade for each ZIP Code.

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.

   Discussed the procedures and methods used to ensure accuracy of insurance and other input data.

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.

   Discussed that the model user can process a series of reports to verify the correctness of the input data.

   Discussed that the model output report provides a list of the factors used in the analysis.

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.

   Reviewed the input data format fields provided in Table 9 and the description of the input data fields in Table 11 of the submission document.

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

   Reviewed under CI-6.

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.

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

24. A-2.B, page 142: Provide a copy of the documented procedure for distinguishing wind-related hurricane losses from other peril losses.

    Reviewed the 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.

   Reviewed the storm classification types for inclusion in the modeled loss costs.

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.

   Reviewed under Audit 1.

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).

   Discussed that the wind-vulnerability functions only account for wind damage and do not include storm surge and flood damage. Discussed that the vulnerability functions are based on claims data that includes wind-induced damage only.

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

   Reviewed the documented procedure to exclude storm surge losses.

A-3 Hurricane Coverages

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.

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

25. A-3.1-4, pages 143-146: Show a calculation of loss costs and probable maximum loss levels (PMLs) for the minimum Masonry Owners loss costs in Form A-1 (i.e., ZIP Code 32009 in Nassau County).

    Reviewed the loss costs and PMLs for ZIP Code 32009 in Nassau County.

Audit

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

    Reviewed under the Vulnerability Standards.

    Reviewed the relationship between building and contents loss costs.

    Discussed with Howard Kunst, Actuarial Standards signatory, how he attested the model results to be actuarially sound.

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

   Discussed that there is no explicit provision for law and ordinance coverage.

   Discussed that the appropriate reconstruction cost value, provided as input, reflects whether the insured selected law and ordinance coverage.

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 and 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.

Verified: YES

Professional Team comments are provided in black font below.

Discussed that the vintage of the underlying demand surge was updated to 2023 data that includes an update to the supply of construction materials and wages. Discussed that since 2006, there has been an increase in available construction materials and labor, and that the demand surge update in the model reflects the supply increase resulting in a decrease in loss costs.

Reviewed comparisons of the changes from 2006 to 2023 in population, wages of the building material industries, and wages of construction labor.

Pre-Visit Letter

26. A-4.1, pages 148-149: 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.

    Reviewed the tables of 1,000 years descending from the top event which showed differences from Form A-8. Discussed the reasons for the differences.

Reviewed a revised Excel spreadsheet of the 1,000-year annual exceedance probability which showed agreement with Form A-8.

27. A-4.3, page 150: Provide additional details on the demand surge factor calculation, particularly the Cat Index and Cat Inflation Index.

    Reviewed the demand surge methodology and the demand surge factor calculation.

    Reviewed the update to the underlying demand surge data.

    Discussed that the Cat Index is determined by the ratio between demand and available supply. Reviewed the Cat Index calculation.

    Discussed that Cat Inflation represents the factor by which repair cost increases after an event. Reviewed the formula for calculating the Cat Inflation factor. Discussed the claims data used for calibration.

    Reviewed a stochastic storm example comparing the updated Cat Index to the Cat Index in the current accepted model.

    Reviewed implementation of demand surge.

28. A-4.5, page 150: Explain how economic inflation with regard to the claims environment, the legal environment, and litigation effects are modeled.

    Discussed that the model has no handling of economic inflation, nor the legal environment and litigation effects.

Audit

1. The hurricane model's handling of expenses, risk load, investment income, premium reserves, taxes, assessments, profit margin, economic inflation, and any criteria other than direct residential property insurance hurricane claim payments will be reviewed.

    Discussed that the modeled loss costs do not include expenses, risk load, investment income, premium reserves, taxes, assessments, profit margin, or economic inflation.

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

    Reviewed the methodology and flowchart for determining PMLs. Reviewed the per occurrence and annual occurrence PML calculations.

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

   Discussed that each event has a distribution around the mean damage/loss which is taken into consideration in generating loss costs and PMLs.

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. The vintage of the underlying demand surge data and references will be reviewed.

   See PVL #27.

5. The treatment of economic inflation and the claims and legal environments (social inflation) will be reviewed.

   Discussed that exposure and claims data from the time of an event is used to validate hurricane loss costs and PMLs from that event.

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

   Discussed that the model does not include flood and storm surge losses and that vulnerability functions are based on claims data of wind-only policies.

   Discussed that the model is capable of calculating flood and storm surge losses, and that a user may select the option to include flood and storm surge losses.

   Discussed that the modeled losses in all the submission forms do not include flood and storm surge, and that those perils cannot be included when the model is used for Florida residential property insurance rate filings.

A-5 Hurricane Policy Conditions

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.

Verified: YES

Professional Team comments are provided in black font below.

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.

   Discussed that there were no changes from the current accepted model.

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

   Discussed during the review of the Vulnerability Standards.

3. Treatment of annual hurricane deductibles will be reviewed.

   Reviewed the annual deductible calculation.

   Reviewed examples of annual deductibles and per occurrence deductibles.

   Discussed that there was no change in the treatment of deductibles from the current accepted model.

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

   Discussed that there were no changes from the current accepted model.

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,***

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

4. northern counties versus southern counties, and

5. newer construction versus older construction.

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.

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

29. A-6.10, page 158: Provide details for the calculation of uncertainty intervals.

Reviewed the methodology for calculating the uncertainty intervals for estimated loss costs.

30. Form A-1, pages 226-230: Explain the loss costs in ZIP Code 32228 compared to other ZIP Codes in Duval County.

Discussed that the ZIP Code centroid for 32228 is closer to the coast than all the other ZIP Code centroids in Duval County, and is also near the mouth of the St. John's River.

Reviewed a map of the ZIP Code centroid locations in Duval County.

31. Form A-4, 0% Deductible, 2017 FHCF Exposure Data, pages 250-254: Explain the reversal in loss costs where Frame is less than Masonry:

a. Owners: Indian River High

Discussed that the 2017 FHCF exposure data has no frame owners exposure in the ZIP Code where the masonry loss costs are higher, and that the ZIP Code is farther inland resulting in a lower wind hazard.

b. Renters: Taylor Low, Wakulla Average

Discussed that the reversal in Taylor County is due to the difference in year of construction between the frame renters and masonry renters.

Discussed that the higher masonry average losses than frame in Wakulla County is due to a larger percent of frame exposures constructed after 2003 than masonry structures, and that there is a larger percentage of masonry renters exposure closer to the coast than frame renters.

c. Condo Unit: Franklin Average, Okeechobee Average, Wakulla Average.

Discussed that in Franklin County there is a larger percentage of frame structures built after 1995 than masonry structures. Reviewed a comparison of the percentage of frame versus masonry structures by year built in Franklin County.

Discussed that in Okeechobee County, the majority of masonry exposure is close to Lake Okeechobee with a higher wind hazard than the majority of frame exposure further inland from the lake. Reviewed a map of the prominent exposure ZIP Code centroid locations and their proximity to Lake Okeechobee.

Discussed that in Wakulla County there is only one ZIP Code with masonry condos, and it is the ZIP Code closest to the coast whereas the ZIP Code with frame condos is inland.

32. Form A-5, pages 272-280: Explain the regional changes (e.g., Panhandle vs. West Florida) in the loss costs in Form A-4 compared to the current accepted model.

Discussed that loss costs have increased in West Florida due to Hurricane Ian (2022) and Hurricane Idalia (2023) being added with the frequency update.

33. Form A-5, pages 276-277: For Figures 67 and 68, explain the large changes in Dixie County.

Discussed that the large change in Dixie County loss costs is due to Hurricane Idalia (2023) added with the frequency update.

34. Form A-5, Figure 70, page 279: Explain the decrease in Volusia County and reconcile with the changes shown in Form A-4.

Discussed that a Volusia County ZIP Code centroid movement into rougher terrain caused the decrease in loss costs.

35. Form A-8.A, Table 31, page 285: Explain the changes in distribution of Number of Hurricanes by ranges, especially for the higher loss events.

Discussed that the changes in distribution of number of hurricanes by ranges are due to updates to storm parameters, offshore intensity changes, and updates to the demand surge supply data.

Discussed that for the top 30 storms, the increase in eastern Florida landfalling storms is due to the offshore intensity update, and that there was an increase in the average profile factor from the current accepted model for the top 30 storms.

Audit

1. Supporting material for the financial component changes in Disclosure 1 will be reviewed.

   Discussed that no changes were made to the financial component of the model from the current accepted model.

2. The data and methods used for hurricane probable maximum loss levels for Form A-8, will be reviewed. The hurricane associated with the Top Events will be reviewed.

   Discussed that the PML levels in Form A-8 are based on zero-deductible losses for each stochastic event and its associated frequency.

   Reviewed the landfall characteristics for the top event.

3. The frequency distribution and the individual event severity distribution, or information about the formulation of events, underlying Form A-8 will be reviewed.

   Reviewed storm frequency by milepost and category.

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

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

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

   Reviewed the roughness length distribution map.

   Reviewed map of an example of the effects of surface roughness on damage for a Category 4 storm.

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 will be reviewed.

   Discussed the assumptions used in completing Form A-6.

   Reviewed map with the Grid A locations plotted.

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.

   Reviewed Form A-6 graphical representations of the loss costs relationships and confirmed reasonability.

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

   Discussed during the review of the model updates.

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

   Discussed that statewide weighted average loss costs for masonry are higher than the corresponding statewide weighted average loss costs for frame for all coverage types, policy types, and deductibles in Form A-4 due to the masonry exposures generally being more heavily weighted than the frame exposures in areas having higher levels of hazard.

   Discussed that where the maximum/minimum loss costs for masonry owners are equal to or higher than the corresponding maximum/minimum loss costs for frame owners for certain coverage types and deductibles for a number of counties in Form A-4, it is due to variations in secondary structural modifiers and some ZIP Codes with no frame or masonry exposures.

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

    Discussed that each event has a distribution around the mean damage/loss which is taken into consideration in generating loss costs and PMLs.

COMPUTER/INFORMATION HURRICANE STANDARDS
Kevin Moran, Leader

CI-1 Hurricane Model Documentation*
*(*Significant Revision)*

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. All documentation, code, and scripts shall be located in central repositories controlled by repository software. Repository software shall support track changes, versioning, and collaborative editing.

C. All computer software 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 current 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.

Verified: YES

Professional Team comments are provided in black font below.

Audit

1. The central repositories will be reviewed.

   Discussed the use of SharePoint, Doxygen, and GitHub as repository software. Reviewed examples throughout the audit.

   Reviewed the primary document binder.

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

   Reviewed the "Master List of Reference Documents."

   Reviewed the "North Atlantic Hurricane Model RQE v25 Principles and Methodology" technical documentation.

   Reviewed the modeler's plan to create additional documentation.

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

   Subject matter experts and personnel involved in software implementation were available and participated throughout the audit.

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

   Reviewed examples illustrating that documentation is created separately from the source code and maintained within GitHub.

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

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

6. The tables specified in Hurricane Standard CI-1.D that contain the items listed in Hurricane Standard G-1, Disclosure 7 will be reviewed. The tables shall contain the item number in the first column. The remaining five columns shall contain specific document or file references for affected components or data relating to Computer/Information Hurricane Standards CI-2, CI-3, CI-4, CI-5, and CI-7.

   Reviewed the summary table of model updates from the current accepted model.

7. Tracing of the hurricane model changes specified in Hurricane Standard G-1, Disclosure 7 and Audit 4 through all Computer/Information Hurricane Standards will be reviewed.

   Traced the hurricane model updates given in G-1.7 through the Computer/Information Standards.

CI-2 Hurricane Model Requirements*

*(*Significant Revision)*

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.

Verified: YES

Professional Team comments are provided in black font below.

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.

   Discussed that documents describing the specifications and product requirements are maintained.

   Reviewed requirements documentation for calculating the hurricane windfield.

   Reviewed "Financial Model Requirements Specification" documentation.

2. Requirements documentation specifically relating to each model change identified in Hurricane Standard G-1, Disclosure 7 will be reviewed.

   Reviewed "Requirements USHurricane 2025" documentation for the model updates.

   Reviewed an example user story for the storm parameter updates.

CI-3 Hurricane Model Organization and Component Design

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

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

Verified: YES

Professional Team comments are provided in black font below.

Audit

1. The following will be reviewed:

   a. Detailed control and data flowcharts, completely and sufficiently labeled for each component,

   Reviewed the frequency generation flowchart.

   Reviewed the flowchart for calculating hurricane surface winds.

   Reviewed the flowchart for calculating per occurrence PML.

   Reviewed the flowchart for calculating the uncertainty intervals for estimated loss costs.

   b. Interface specifications for all components in the hurricane model,

   Reviewed the overall architecture description, RQE analysis flow, and confluence documentation.

c. Documentation for schemas for all data files, along with field type definitions,

Reviewed the user manual, reference guide, quality assurance (QA) test procedures, and high-level design documentation.

Reviewed the data dictionary and data schema documentation.

d. Each network flowchart including components, sub-component flowcharts, arcs, and labels,

Reviewed flowcharts, class diagrams, and tables in Figures 1-3 summarizing the model components, databases, and data files system.

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

Reviewed flowchart for the primary portfolios execution flow.

Reviewed the RQE technology and software development process flowchart.

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.

Discussed that the framework for implementing the CoreLogic/Cotality™ Florida Hurricane Model 2025 are the Risk Quantification and Engineering™ (RQE) v25 (primary) and Navigate™ v25 platforms.

Discussed that the Navigate platform uses the RQE platform to run analyses.

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

Reviewed the “Charting and Diagramming Standards – Science & Analytics Global Risk – Confluence” document.

CI-4 Hurricane Model Implementation*

*(*Significant Revision)*

A. A complete procedure of coding guidelines consistent with accepted practices shall be maintained. Coding guidelines shall be referenced for each programming language used in the hurricane model or submission document.

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., requirements, flowcharts) down to the implementation 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, Disclosure 7 and Audit 4:

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 review plans, testing plans, and if needed, update plans through regularly scheduled intervals. The vintage of the hurricane model code and data shall be justified.

Verified: YES

Professional Team comments are provided in black font below.

Pre-Visit Letter

36. CI-4: Discuss the plan and progress made on code refactoring as documented in the 2023 Professional Team On-Site Review Report.

Discussed the work and progress made in improving code quality.

Discussed changes in code infrastructure and code repositories.

Discussed changes in unit testing, regression, and system testing.

Discussed changes to improve tooling.

Discussed changes implemented to educate scientists on best practices using GitHub and various programming languages and tools.

Discussed next steps in the improvement process plan.

Audit

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

Reviewed the code for calculating hurricane surface winds.

Reviewed the code for manufactured homes vulnerability region assignment of HUD Zone III.

Reviewed the code for assigning wind-borne debris regions by year of construction.

Reviewed the code for default roof age, roof condition, and the new post-2023 age band.

Reviewed the friction factor and gust factor code. Reviewed the uncertainty for the friction and gust factors in the code.

Reviewed the code for demand surge.

Reviewed the pseudocode for calculating per occurrence and annual aggregate PMLs.

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.

   Reviewed the documented procedures for software development, including code style guides.

   Discussed the process for enforcing coding standards.

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

   Reviewed the procedures for data updates and checking GIS datasets.

   Reviewed the "Database/Data File Creation and Verification Procedure" documentation.

   Reviewed the data reference manual.

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

   Discussed the need to improve traceability at all levels, including requirements, design, implementation, verification, and testing.

   Reviewed the modeler's plan to improve traceability and organization of documentation.

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.

   Reviewed example pull requests and merging in GitHub.

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

   Reviewed the table of all software components as specified in CI-4.E.

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

   Reviewed the equations cross-refences documentation.

Reviewed the variable mapping for the equations to calculate the hurricane windfield.

Reviewed the variable mapping for the equations to calculate demand surge.

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

Reviewed comments in selected source code examined throughout the audit.

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

Reviewed the RQE user guide.

Discussed that the Navigate platform is primarily a user-facing web-interface that allows users to run the models implemented in the RQE platform.

10. Network organization implementation will be reviewed.

Reviewed the network organization documentation.

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

See PVL #36.

Discussed the Git workflow for implementation and branching. Discussed justification for the branching methodology.

Discussed the code review process and the tools used.

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

Discussed the process for creating submission forms.

Reviewed the script for generating Form M-1.

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.

Verified: YES

Professional Team comments are provided in black font below.

Audit

1. Procedures for physical unit conversion verification (e.g., knots to mph) will be reviewed.

   Discussed that unit conversion verification is handled manually by the code developer.

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.

   Discussed that verification procedures are in place to ensure that calculated results are consistent.

   Discussed the process used for algorithm verification performed by personnel other than the code developers.

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

   Discussed changes in unit testing, regression and system testing.

   Discussed the various testing software used for the different types of unit testing.

   Discussed that unit testing is performed for every build.

   Discussed the frequency of integration tests.

   Discussed the modeler's methods for dealing with test flakiness.

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

   Reviewed the QA test procedures.

   Reviewed the "Test Runs, Test Plan and Summary of Results" documentation.

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.

   Discussed the cross-checking procedures for verifying equations.

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

   Reviewed the product verification process.

   Reviewed the process to develop automated test scripts.

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

   Discussed the validation process for external source data.

8. Complete and thorough verification procedures and output from the model changes identified in Hurricane Standard G-1, Disclosure 7 will be reviewed.

   Reviewed the model update verification process.

   Reviewed the “Test Runs, QA Verification of Scenario Wind Speed” documentation.

   Reviewed examples of testing on the age band, year band, roof age, roof conditions, and HUD zones.

   Reviewed an example of a test failure.

   Reviewed the continuous integration/continuous delivery testing harness for running automated tests on the updated model code.

CI-6 Human-Computer Interaction

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 insurance rate filing, interface options shall be limited to those options found acceptable by the Commission.

Verified: YES

Professional Team comments are provided in black font below.

Audit

1. External and internal user interfaces will be reviewed.

   Discussed the user interface and application programming interface for the Navigate™ platform.

2. Documentation related to HCI, Interaction Design, and UX engineering will be reviewed.

   Reviewed the workflow for the Navigate™ platform.

3. The decision process specifying the logic of interface option selections, when an acceptable hurricane model is selected, will be reviewed.

   Discussed that the RQE user interface has a specific selection option for Florida rate filings with model options that cannot be changed by the user.

   Discussed that Navigate™ has not been used for hurricane rate filings.

   Reviewed the analysis options required for a Florida rate filing and confirmed that the analysis options cannot be changed.

   Reviewed a live demonstration of the Florida rate filing template.

CI-7 Hurricane Model Maintenance and Revision*

*(*Significant 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 personal and commercial residential hurricane loss cost or hurricane probable maximum loss level shall result in a new hurricane model version identification.

C. 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.

Verified: YES

Professional Team comments are provided in black font below.

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.

   Reviewed the model development procedures documentation.

   Reviewed the Git workflow documentation.

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

   Reviewed the model development procedures documentation.

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

   Code reviews were conducted as listed under CI-4.

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

   Discussed the use of GitHub for tracking software.

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

   Reviewed the relevant requirements documentation reflecting the model updates.

6. The model version history over the past 5 years, leading up to the version submitted will be reviewed.

   Reviewed the model version history.

CI-8 Hurricane Model Security*

*(*Significant Revision)*

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.

Verified: YES

Professional Team comments are provided in black font below.

Audit

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

   Reviewed the security policy for access to source code, data, and documentation.

   Discussed the process to detect vulnerabilities in the code.

   Discussed that procedures are in place to ensure that the use of external libraries in the hurricane model cannot compromise the correct operation of the software.

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.

   Reviewed the CoreLogic/Cotality™ security/IT policy.

   Discussed disaster contingency and maintenance of anti-virus software on machines where code and data are accessed.

3. Security aspects of each platform will be reviewed.

   Reviewed the CoreLogic/Cotality™ security/IT policy.

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

   Reviewed the CoreLogic/Cotality™ security/IT policy.

Commission Issue

Specify if and where Artificial Intelligence (AI) is used (e.g., development, implementation, testing, data analysis, documentation). If used, explain how AI is employed along with what AI models (in-house, proprietary, or open source) and inference are implemented. For any training performed by the modeling organization, specify whether fine-tuning is done or whether the AI model is trained from scratch. Specify the AI model types, learning algorithms, training data, testing data, and measures of effectiveness.

Discussed that AI was not used in the development of the CoreLogic/Cotality™ Florida Hurricane Model 2025.

Discussed AI use cases in the severe convective storms model that are potential AI use cases for future model submissions which will be discussed with the Commission during the trade secret session of the June 2025 meeting to review the model for acceptability.