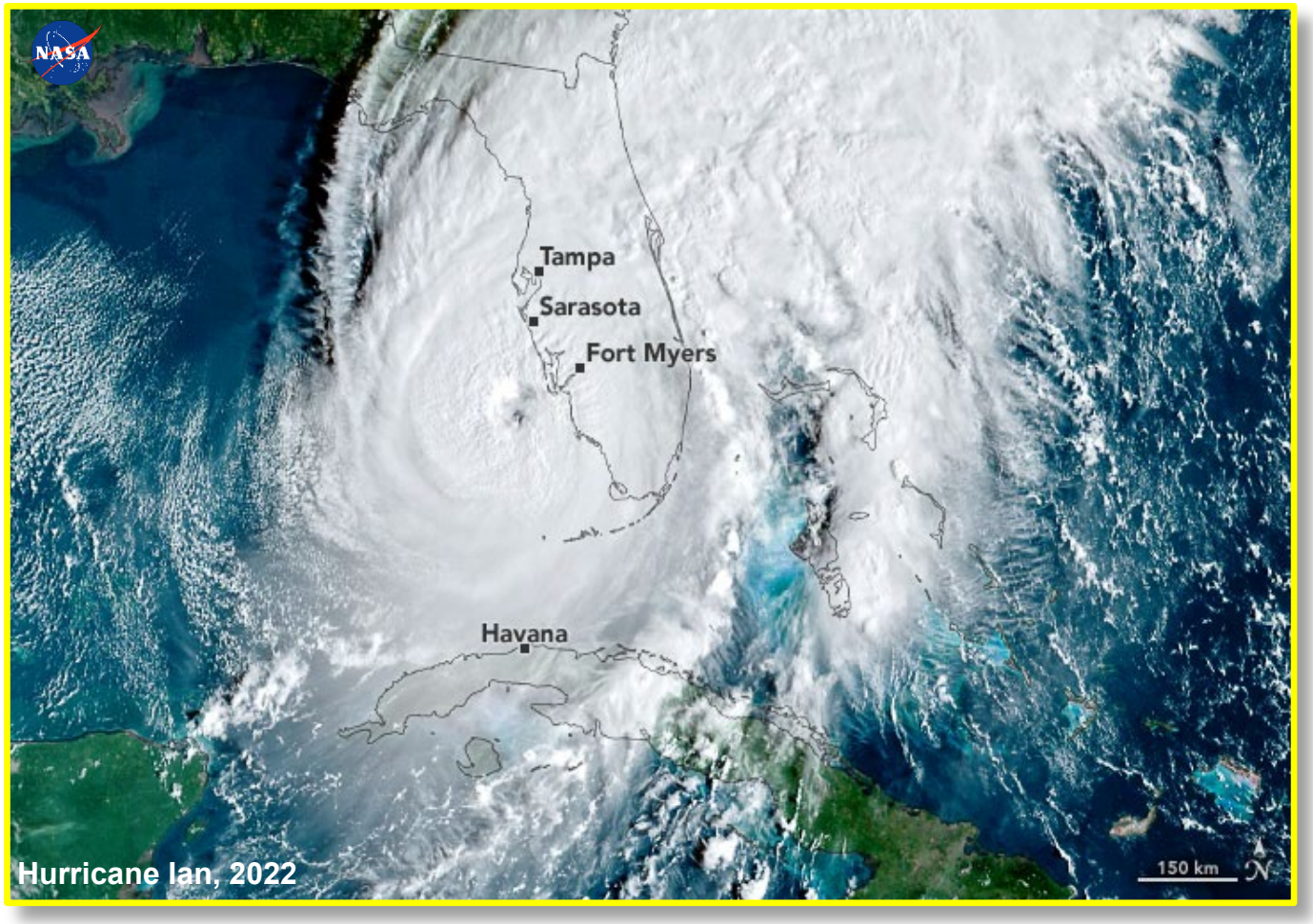
Florida Commission on Hurricane Loss Projection Methodology

Professional Team Report

2023 Hurricane Standards



Impact Forecasting

On-Site Review: April 22-25, 2025

On April 22-25, 2025, the Professional Team conducted an on-site review of the Impact Forecasting (IF) Florida Hurricane (FCHLPM) Model Version 3.0. The following individuals participated in the review.

IF

Ted Amdur, Ph.D., Senior Scientist, US Hurricane Model Development
Sushma Bhat, Director, Software Development
David Colbus, Director, Program Management
William Dong, Ph.D., Associate Director and Tech Lead, Software Development
Radovan Drinka, Global Head of Tropical Cyclone Model Development
Yujin Liang, Ph.D., P.E., Director, Catastrophe Model Development
Alex Kowaleski, Ph.D., Senior Associate Director of Hurricane Risk
Maria Lomelo, Managing Director, Global Program Director
Minchong Mao, FCAS, CCRMP, MAAA, Senior Managing Director, Actuary, Aon Reinsurance Solutions
Brian Penserini, Ph.D., Senior Scientist, Research and Development
Sri Harshitha Polamuri, Ph.D., Senior Scientist
Venkatesh Ramaiah, Associate Director, Software Development
Radek Solnicky, Senior Scientist
Corbin Tucker, Reinsurance Analytics Senior Analyst, Research and Development
Vipin Unnikrishnan, Ph.D., Principal Research Consultant
Zhuoxuan Wei, Ph.D., Senior Scientist
Chad Xu, Catastrophe Actuarial Analyst, Aon Reinsurance Solutions
Kun Yang, Ph.D., Associate Director
Karthik Yarasuri, Senior Scientist – Wind Vulnerability

Professional Team

Paul Fishwick, Ph.D., Computer/Information
Mark Johnson, Ph.D., Statistics, Team Leader
Stu Mathewson, FCAS, MAAA, Actuarial
Greg McLellan, P.E., Vulnerability
Blake Tullis, Ph.D., Hydrology and Hydraulics, observer
Colin Zarzycki, Ph.D., Meteorology
Donna Sirmons, Staff

Commission

Kayne Smith, Ph.D., FCAS, Citizens Property Insurance Corporation

The Professional Team began the review with an opening briefing and introductions were made. IF provided a general overview of the hurricane model followed by explanations on the model changes and updates.

- Stochastic event set updated using HURDAT2 data through 2022
- Stochastic event set sea surface temperature updated through 2022
- Regression parameters recalculated for occurrence, track, intensity, Rmax, and Vmax
- Terrain model factors updated for consistency with National Land Cover Database (NLCD) 2021 released in 2023

- Asymmetry parameterization in North Atlantic tropical cyclones updated
- Hurricane Ian (2022) historical parameters updated
- Interpolation of event properties at landfall for historical events improved
- Change to explicitly incorporate damage uncertainty, including Chance of Loss
- Building vulnerability functions recalibrated based on additional insurance claims data
- Historical events used for claims analysis recalculated using terrain factors as of the time of event occurrence
- Improved statistical framework developed to improve calibration and validation of vulnerability functions using empirical loss data
- Vulnerability curve calibration for personal and commercial occupancies using hurricane footprints improved using station observations
- Vulnerability claims recalibrated using additional claims data from Hurricanes Matthew (2016), Hermine (2016), Irma (2017), Michael (2018), and Ian (2022)
- ZIP Codes updated to August 2023 vintage
- Method for assigning vulnerability tiers to ZIP Codes crossing two tiers enhanced
- New Chance of Loss that includes the addition of Chance of Loss probabilities that correspond with each individual damage function
- Occurrence (aggregate) probable maximum loss (PML) calculation process changed
- Estimation of Florida market loss from U.S. wide market loss performed to apply a demand surge factor to each event

IF explained the impacts on loss costs for each of the model updates. The combined model updates resulted in a 20.1% increase in the average annual zero deductible statewide hurricane loss costs, with the largest increases resulting from changes in the hazard component at 12.7% and from changes in the vulnerability component at 6.3%.

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. Form M-1, pages 299-301: Incomplete. Values not provided for all cells in the table.

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 IF'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 IF. 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. IF 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. IF 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 IF 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 4, 2024, submission, or the revised December 12, 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, an additional Professional Team member and a Commission member will be in attendance. Please have available 5 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 6 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.

The following pre-visit questions are arranged by standard groups. The page number references are from the December 12, 2024, revised submission.

GENERAL HURRICANE STANDARDS
Mark Johnson, 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-1.7.C, Figure 6, page 64:
   a. Provide details for the reason for changes in annual zero deductible hurricane loss costs due to change in hazard.
   b. Identify the specific updates in HURDAT2 that had an impact.
   c. Explain how the changes in the hazard component result in changes in loss costs of up to 30% across multiple counties.

Reviewed the hazard changes in the event set, ZIP Code centroids, terrain factor, and asymmetry that resulted in loss cost changes.

Discussed the increase in losses in the Panhandle and the decrease in Northeast Florida due to the new event set.

Audit

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

   Discussed that source control software and error tracking systems are used to maintain quality control.

   Reviewed the process documentation detailing the tools used for maintaining data and code correspondence, model versioning, testing, quality assurance, data checks, and training.

   Discussed that SharePoint is the primary repository for documentation versioning.

   Discussed that code development is stored using Microsoft Azure DevOps.

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.

   Discussed that model and software code, including R&D software code, source code for the ELEMENTS platform which includes the financial component, and code used to generate submission forms, is versioned using DevOps and Git.

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 evaluation of, and justification for, the vintage of model component data, code, and technical literature.

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

   Reviewed in detail the supporting material for the model updates and changes.

   Reviewed a schematic explaining how the percentage differences in average annual loss (AAL) were calculated for the changes made to the software, geocoding, hazard, vulnerability, and financial components of the model.

Reviewed validation comparisons between modeled and historical claims losses.

Reviewed map comparisons of the spatial distribution of the overall change in AAL.

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.

   Discussed that there have been no changes to the hurricane model since the submissions on November 4, 2024 and December 12, 2024.

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.

   Discussed that there have been no changes to Form A-4 since the December 12, 2024 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 December 12, 2024 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

2. G-2.2.B, pages 74-75: Provide resumes of the new personnel.

Reviewed resumes of new personnel:

- Ted Amdur, Ph.D. in Earth and Planetary Sciences, Harvard University, Cambridge, MA; M.Ed. in Secondary Science and Mathematics, Marquette University, Milwaukee, WI; B.A. in Physics, Williams College, Williamstown, MA

- Brian Penserini, Ph.D. in Earth Science, University of California, Santa Barbara, CA; M.S. in Geological Sciences, University of Oregon, Eugene, OR; B.S. in Geology, California Institute of Technology, Pasadena, CA

- Zhuoxuan Wei, Ph.D. in Civil Engineering, Florida Institute of Technology, Melbourne, FL; M.S. in Civil Engineering, Florida Institute of Technology, Melbourne, FL; B.S. in Construction Management, Sichuan University, Chengdu, Sichuan, China

- Kun Yang, Ph.D. in Civil Engineering, University of Delaware, Newark, DE; B.E. in Automation, Huazhong University of Science & Technology, Wuhan, China

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 #2 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.

   No such incidents were reported.

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.

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

   Reviewed comparisons of centroid and ZIP Code boundary changes from the current accepted model.

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

   Discussed the process for reviewing and validating the area-based ZIP Code centroids and point ZIP Code locations processed by Zip-Codes.com.

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

   Discussed that ZIP Code centroids are only used for point ZIP Codes in the model, and that there is no consideration of centroids over water or uninhabitable terrain which is handled by hazard assignment measures.

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

   Reviewed examples of the geocoder process when different levels of information are provided to determine locations. Discussed that geocoding locations that fail to import are not modeled.

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

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

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

   Discussed that the ZIP Code-based databases include ZIP Code Boundaries, ZIP Code Events, and Vulnerability Tiers.

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.

   Discussed that the historical storm footprints that are used for calibration of the vulnerability functions using Bayesian maximum likelihood estimation, further supports the independence of the hurricane model components.

   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 from the current accepted hurricane model, and determined that 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 David Colbus, the editorial compliance signatory, who reviewed the submission document. Discussed the process followed for reviewing and ensuring accuracy of the submission.

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.

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

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.

   IF confirmed that subject matter experts reviewed all submitted materials for completeness and accuracy.

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

   Discussed the process for preparing, reviewing, revising, and tracking revisions to the submission documentation. Reviewed the submission documentation modification history.

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

   Reviewed the flowchart of the process for submission forms 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
Colin Zarzycki, 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.

Audit

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

   Discussed that the Model Base Hurricane Set is based on HURDAT2 as of October 2023 and incorporates all storms that occurred within the period 1900-2022.

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 a flowchart of the process for updating the Model Base Hurricane Set landfall distribution.

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

   Discussed that the changes to the Model Base Hurricane Set included the addition of Hurricanes Elsa (2021), Ian (2022), and Nicole (2022), and that Hurricanes Ethel (1960), Camille (1969), and Sally (2020) were modified to consider them bypassing events.

   Discussed that Hurricane Inez (1966) and Hurricane Gladys (1968) were changed from Category 1 in the current accepted model to Category 2.

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 the goodness-of-fit of modeled to historical statewide and regional hurricane frequencies provided in Form M-1. Reviewed examples of distributions comparisons using two-sample Pearson's chi-squared tests.

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

   Discussed that the model under review does not account for climate variability or climate change.

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

3. M-2.1, page 90: Provide details on the new method for model cells with insufficient data. Explain the bi-square approach.

   Discussed the methodology for calculating regression coefficients for cells with insufficient data using a weighted regression approach. Reviewed the calculation using the bi-square approach for assigning weights, and discussed how it differs from the current accepted model.

4. M-2.3, pages 93-94: Provide the mathematical dependence of modeled windfield as a function of distance and direction from the center position.

   Reviewed the equation for calculating the modeled windfield. Discussed the use of Uhlhorn et al. (2014) to generate the asymmetric adjustment to the calculated Willoughby et at. (2006) windfield.

Audit

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

   Discussed the process for updating the temporal interpolation of event parameters for historical storms at landfall.

   Discussed the change in the conversion of HURDAT2 Vmax to an open-terrain equivalent.

   Discussed that the changes were applied to all historical events in the Model Hurricane Base Set and resulted in improved consistency between historical and stochastic modeling approaches.

Discussed the rapid fluctuations observed in Hurricane Ian (2022) intensity at landfall and the adjustment to the track parameters. Reviewed goodness-of-fit tests comparing the modified and previous Vmax. Discussed that modifications relative to HURDAT2 were applied independently to Hurricane Ian (2022).

Discussed the changes made to the stratified random sampling, event stop criteria, and procedure for track and intensity in regions with insufficient data.

Reviewed the distribution of lifetimes in the Model Base Hurricane Set. Reviewed a map of hurricane tracks lasting longer than 25 days. Reviewed basic statistics of storms lasting more than 25 days that affected Florida.

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

Discussed that the hurricane parameters used in the model are described in M-2.4 and are not adjusted for climate change.

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,
   b. The modeled dependencies among correlated parameters in the windfield component and how they are represented, and
   c. The parameters affecting asymmetric structure of hurricanes.

Reviewed graphical depiction of translational/forward speed, heading angle/direction, central pressure, and inflow angle.

Reviewed representation of the Vmax, Rmax, and radial wind profile parameters.

Reviewed representation of the inland decay rate.

Reviewed the empirical regression coefficients and graphical representation of angle and magnitude of windfield asymmetry.

Reviewed the referenced literature justification for hurricane parameters translational/ forward speed, heading angle/direction, central pressure, Vmax, Rmax, inland decay rate, wind profile parameters, and inflow angle.

Reviewed the equations for modeling Vmax and Rmax dependency on central pressure deficit and storm eye latitude.

Reviewed the equations for shape parameters and open terrain windspeed dependencies.

Discussed that the model under review uses an empirical model for storm-motion induced asymmetry derived from radiosonde data (Uhlhorn et al., 2014). Reviewed a snapshot of a hurricane windfield including the asymmetry factor.

Reviewed comparisons to the current accepted model of the asymmetric component of the windfield at the 25^{th} and 75^{th} percentiles for translational speed and its superposition on the axisymmetric wind.

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 goodness-of-fit tests on the distributions of hurricane parameters on cells closest to the coastal segments of Alabama/Mississippi and Georgia.

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

   Discussed that the model uses a Markov Chain approach to model the full track of both landfalling and bypassing storms from the point of initial genesis through final dissipation (Vickery et al., 2000).

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 the model does not require selection of storm track strike intervals and that landfall statistics are derived from full trajectories.

   Reviewed comparisons between modeled and historical landfall rates in M-2.8.

   Reviewed the distribution of landfall parameters and goodness-of-fit for landfalling gates near selected Florida major cities.

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 no modeling-organization-specific research was performed for simulating hurricane model variables in the stochastic model, and that all functional forms are adopted from published literature.

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.

Pre-Visit Letter

5. M-4.7, pages 110-111: Provide details on the Engineering Sciences Data Unit (ESDU) methodology.

   Reviewed the ESDU methodology for terrain factor and the equation defining the multiplicative conversion factor. Discussed that there was no change in the methodology from the current accepted model.

   Reviewed the ESDU documentation.

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 no modeling-organization-specific research was performed to derive the roughness distribution.

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

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

   Reviewed geographical representation of the spatial distribution of the terrain factor.

   Reviewed examples of terrain factor validation in an urbanization area along the East coast and of the land use change in northern Florida.

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

   Reviewed the flowchart to calculate the final surface windfield from base hurricane parameters, including the generation of the axisymmetric and asymmetric components of the windfield. Reviewed mathematical formulations associated with calculating hurricane surface windfields.

   Reviewed flowchart to obtain the terrain factor applied to the open-terrain surface gust that yields the final gust value.

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 maps 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 the spatial distributions of the above windfields provided in M-4.9.

   Reviewed the Hurricane Irma (2017) observational station data in the 95-110 mph range around Miami given in Figure 18.

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

   Discussed that the vertical variation of 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 the far-field pressure used in the model is a constant equal to 1013 mb.

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 inherent uncertainties of the conversion factor are not modeled, and that uncertainties in windspeed and Rmax are carried over to the conversion factor calculation.

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

    Reviewed the external data sources used in the Rmax model, the central pressure model, and the terrain model.

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.

   Discussed that inland decay rates are modeled differently for 7 regions in Eastern North America.

   Reviewed the regressions developed for each region using historical data to model inland decay rates as a function of central pressure deficit, forward speed, and Rmax at landfall.

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

   Reviewed the calculations for modeling the relative intensity after transitioning from land to 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 Florida Peninsula Coast and Gulf Coast for specific historical storms and the stochastic dataset.

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 maps of Hurricane Charley (2004), Hurricane Michael (2018), and Hurricane Ian (2022) winds and surface roughness 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.

Reviewed the script to calculate the radii of the different winds in Form M-3. Discussed the reasons for the differences from the current accepted model in the maximum radii for the given windspeed thresholds.

Pre-Visit Letter

6. M-6.4, pages 131-132: 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."

   Reviewed the revised disclosure text provided with the responses to deficiencies.

Audit

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

   Reviewed the equation for surface roughness on sustained winds.

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

   Reviewed the change in methodology for asymmetry modeling of the hurricane windfield.

   Discussed that the new asymmetry parameterization reduced the root mean square error and decreased bias relative to observed winds. Reviewed windfield and scatter plot comparisons between the old and new asymmetry.

   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 formulation of the model windfield.

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

   Reviewed the change in methodology for asymmetry modeling.

   Reviewed snapshots of hurricane winds over land with original translation speed and a reduced translation speed illustrating asymmetry decreases when translation speed is reduced.

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

   Discussed that hurricane translation speeds and terrain factors were varied and the effects on windspeeds were investigated to verify the logical relationships.

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

   Reviewed contour animation of a windfield distribution evolving from pre-landfall through landfall. Reviewed the same storm with reduced translation speed and increased surface roughness.

STATISTICAL HURRICANE STANDARDS
Mark Johnson, Leader

S-1 Modeled Results and Goodness-of-Fit*
*(*Significant Revision)*

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

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.

   Discussed that the uncertainty in damage estimates is captured in the vulnerability functions, including Chance of Loss.

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 the equation to model storm relative intensity.

   Reviewed the regression analyses for central pressure.

   Reviewed histograms of the residuals obtained from regression analysis.

   Reviewed comparisons of the standard and robust least-square fits for two cells in the 5x5 degree grid.

Reviewed the Bayesian inference approach for estimating hazard footprints and the maximum likelihood algorithm. Reviewed wind footprint map for Hurricane Irma (2017) showing agreement of input parameters with observations.

Discussed the reasons for changing from the previous Kolmogorov-Smirnov tests to Chi-squared tests for comparing modeled to observed Rmax.

Discussed with Radek Solnicky, Statistical Standards signatory, his review of the statistical portion of the submission document, including the results of the various goodness-of-fit tests completed.

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.

No new sensitivity analyses were performed.

Discussed current relevance of Form S-6.

Reviewed sensitivity analysis for gust factor scaling.

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.

Discussed current relevance of Form S-6.

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 a map of the contribution errors at all Florida counties with special attention to Nassau County.

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,

   Reviewed county level maps comparing claims and modeled gross losses for Hurricane Irma (2017), Hurricane Michael (2018), and Hurricane Ian (2022).

   b. The version of the hurricane model used to calculate modeled hurricane losses for each hurricane provided,

   Discussed that the version of the model that produced all losses in the submission is the Florida Hurricane Model Version 3.0 as implemented with ELEMENTS Version 18.1 software.

   c. A general description of the data and its source,

   Discussed the claims data provided at the location coverage level along with its concurrent exposures for numerous insurance companies and hurricanes.

   d. A disclosure of any material mismatch of exposure and hurricane loss data problems, or other material consideration,

   Reviewed examples of claims data received without matching exposure data.

e. The date of the exposures used for modeling and the date of the hurricane,

Reviewed example exposures and claims data joined together and separated by storm from an insurance company.

f. An explanation of differences in the actual and modeled hurricane parameters,

Discussed that there are no 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,

Reviewed the list of events where the hurricane windfield was revised through Bayesian maximum likelihood estimation using station observations.

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,

Reviewed comparisons of the modeled to observed loss by coverages and structure types.

i. The treatment of demand surge or loss adjustment expenses in the actual hurricane losses or the modeled hurricane losses, and

Discussed that demand surge is considered in modeled losses and that loss adjustment expenses are not included in modeled losses.

j. The treatment of flood losses (including hurricane storm surge losses) in the actual hurricane losses or the modeled hurricane losses.

Discussed that flood and storm surge losses are not included in 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),

Reviewed the procedure used to ensure the quality and relevancy of claims data used for validation.

b. An analysis that identifies and explains anomalies observed in the validation data, and

Discussed the procedure for processing and analyzing claims data to identify and address anomalies.

c. User input data for each insurer and hurricane detailing specific assumptions made with regard to exposed property.

Reviewed the documentation for mapping claims exposure.

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

Reviewed the 95% confidence interval on the statewide 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.

Discussed that Form S-4 provided in the submission contains actual (non-disguised, non-scaled) values.

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 comparisons of modeled to actual losses from multiple companies for one hurricane event.

Reviewed comparisons of modeled to actual losses from one company for multiple hurricane events.

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.

Audit

1. Justification for the following will be reviewed:

   a. Meteorological parameters,

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

   b. The effect of by-passing hurricanes,

   Discussed the effects of bypassing hurricanes on modeled losses.

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

   Discussed the effects of multiple landfalling hurricanes on modeled losses.

   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 there are no departures.

   e. Exposure assumptions.

   Discussed that the same exposure is used to estimate historical and modeled loss costs.

VULNERABILITY HURRICANE STANDARDS
Greg McLellan, 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

7. V-1.1, pages 176-177:
   a. Explain *Chance of Loss* and how the vulnerability component assesses *ground-up damage ratios*.

Reviewed the development of the Chance of Loss parameter to estimate exposures with no loss.

Reviewed the beta distribution that associates exposures with losses.

Reviewed comparison of observed damage ratios to expected damage ratios conditioned on loss occurring.

Reviewed comparison to the current accepted model of the mean damage ratio and standard deviation using the new Chance of Loss parameter.

Discussed that Chance of Loss is derived from historical claims analysis and engineering analysis.

Reviewed implementation of Chance of Loss.

   b. Explain *social dynamics* of claims reporting and how it is implemented in the vulnerability component.

Discussed that the social dynamics of claims reporting are not explicitly modeled and are instead implicitly included using observed claims for informing the Chance of Loss vulnerability curve calibration.

Discussed the different factors that are considered as social dynamics in claims reporting.

   c. Explain *peer-reviewed statistical estimator,* how it is implemented in the vulnerability component, and who provided the peer review.

Discussed the analogous maximum likelihood estimator and the process for filtering and processing claims data.

   d. Explain how *Bayesian maximum likelihood estimation* is implemented in the vulnerability component.

Discussed the Bayesian maximum likelihood estimation used to improve the accuracy of hazard data used in claims analysis.

e. Describe how *engineering principles are applied to constrain Chance of Loss at regions of low and high hazard where date quality or availability are lacking.*

Discussed the application of engineering principles before and after fitting the statistical vulnerability model.

f. Explain how *bootstrap resampling* is implemented in the vulnerability component.

Reviewed the bootstrap resampling process performed in the calibration of the vulnerability functions to address the variability and uncertainty in claims data.

8. V-1.5, pages 182-183: Explain how final vulnerability functions are determined by synthesizing the component-based and empirical damage functions.

Discussed the logistic regression model for vulnerability functions calibration.

Reviewed the process for using claims data for calibration of the vulnerability functions.

Reviewed the relationship between Chance of Loss and hazard where data are scarce.

Audit

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

Reviewed the vulnerability parameters Chance of Loss, expected damage ratio for a loss, and the standard deviation of losses.

Reviewed comparison of the beta distribution model with and without Chance of Loss.

Reviewed the logistic regression model for vulnerability curve calibration.

Reviewed the methodology for assigning vulnerability tiers to ZIP Codes. Reviewed map delineating the 3 vulnerability tiers in Florida. Reviewed the impacts on ZIP Codes along the tier boundaries.

Reviewed comparison of observed to Bayesian maximum likelihood fit wind footprints.

Reviewed the simulated damage ratio distribution for a given hazard and exposure type.

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

Reviewed comparisons to the current accepted model of masonry, wood frame, and manufactured homes vulnerability functions for the three different vulnerability tiers.

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.

Reviewed comparison of observed damage ratio distributions from claims data to modeled damage ratios for Hurricane Charley (2004).

Reviewed the secondary uncertainty distributions around various mean damage ratios and the coefficient of variation for wood frame, masonry, and manufactured homes.

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.

   Discussed that the model does not explicitly consider uncertainties in windspeed at a particular location over the life of a hurricane.

   Discussed that building vulnerability functions were developed based on the maximum windspeed (3-second gust) at a location.

   Discussed that the calibration of building vulnerability functions uses claims data where the losses implicitly include uncertainties in windspeed.

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.

   Reviewed the summary of claims data. Discussed that claims which cannot be connected to exposures are not used.

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

   Discussed that claims data are resampled using block bootstrap. Reviewed two-tailed z-test based on the resampled claims dataset.

   Reviewed boxplot comparisons of mean claims loss ratios to mean modeled loss ratios.

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

   Reviewed loading conditions and damage states in the vulnerability simulator documentation.

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

    Discussed that the model uses component-based methodology to develop engineering-based building hurricane vulnerability functions.

    Reviewed flowchart of the component-based vulnerability function estimation of buildings subject to wind hazard.

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 the process using both claims data and engineering estimates in the calibration process.

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

    Discussed the use of post-event site investigations to validate the engineering assumptions and damage functions.

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

    Discussed the exposure study conducted to determine the primary construction classes and secondary modifiers.

    Reviewed the distribution of policies by occupancy type and construction type.

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 samples of building vulnerability functions for personal residential masonry, wood frame, and manufactured homes, and for a commercial residential building.

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

    Reviewed documentation summarizing the major changes in building codes, construction practices, and the effects on buildings.

    Reviewed the code enforcement and construction practices by year-built bands for site-built and manufactured homes.

    Reviewed the criteria for assigning vulnerability tiers.

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

    Reviewed the new claims and exposure data provided for personal residential, commercial residential, and manufactured homes from Hurricanes Hermine (2016), Matthew (2016), Irma (2017), Michael (2018), and Ian (2022).

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 claims practices are accounted for implicitly from the claims data received from insurance companies.

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

    Discussed that the model does not assume a total structure loss at or above a percentage of damage, and that the mean damage ratio of the structure increases with windspeed until it reaches 100% damage.

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

    Reviewed documentation summarizing the assumptions, development, and implementation of the law and ordinance coverage option.

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

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

    Reviewed comparison of building and appurtenant structure vulnerability functions for wood frame and masonry constructions.

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

    Reviewed scatter plots of actual versus modeled mean damage ratios for building and appurtenant structures.

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.

Pre-Visit Letter

9. V-2.1, page 192: Explain how the contents vulnerability curves are now a function of *conditional building damage*, and the introduction of *Chance of Loss*.

   Discussed that Monte Carlo simulations are used to assess building and contents damage.

   Reviewed the implementation of Chance of Loss to estimate contents losses.

Audit

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

   Reviewed the Chance of Loss incorporated into the contents loss estimation.

   Reviewed the portfolio level validation and comparisons of modeled to observed contents loss by client and by event.

   See PVL #7 and V-1, Audit 1.

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

   Reviewed comparisons of contents vulnerability functions for masonry, wood frame, and manufactured home constructions.

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.

   Discussed that implementation of building Chance of Loss improved the distribution of damage ratios around the mean.

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

   Reviewed samples of contents vulnerability functions.

   Reviewed the building damage ratio to contents damage ratio relationship.

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

   See V-1, Audit 8.

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

   Discussed the Monte Carlo method sampling to calculate the mean and standard deviation of a beta distribution for contents damage ratio.

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 conditional on building damage ratio, and that any dependency of contents vulnerability on construction and occupancy type is accounted for in the building vulnerability functions.

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 preliminary contents vulnerability functions were developed based on engineering analysis and judgment using the damage simulator.

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

   Reviewed the Monte Carlo simulation engine methodology for developing contents vulnerability functions.

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 contents vulnerability curves were developed using the Monte Carlo simulation engine and then calibrated and validated using historical claims data.

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

    Discussed that the wind vulnerability simulator does not explicitly model contents losses due to water infiltration.

    Discussed that the impacts of water infiltration are implicitly accounted for in the historical claims data used in the calibration and validation processes.

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.

Pre-Visit Letter

10. V-3.1, page 197: Explain how the time element vulnerability curves are now a function of *conditional building damage*, and the introduction of *Chance of Loss*.

    Discussed that Monte Carlo simulations are used to assess building and time element damage.

    Reviewed the implementation of Chance of Loss to estimate time element losses.

Audit

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

    Reviewed the Chance of Loss incorporated into the time element loss estimation.

    Discussed that time element losses are a function of building damage.

    See PVL #7 and V-1, Audit 1.

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

   Reviewed comparisons of time element vulnerability curves for masonry, wood frame, and manufactured home constructions.

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.

   Discussed that implementation of building Chance of Loss improved the distribution of damage ratios around the mean.

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

   Reviewed samples of time element vulnerability functions.

   Reviewed the building damage ratio to time element damage ratio relationship.

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 the new Chance of Loss improves the ability to capture uncertainty around the mean damage ratio.

   Reviewed comparison of modeled time element loss versus claims distributions for wood frame, masonry, and manufactured homes.

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 the time element damage ratios are a function of building damage ratios.

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

   See V-1, Audit 8.

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

   Reviewed the methodology for developing time element vulnerability functions.

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 vulnerability curves were developed using the Monte Carlo simulation engine and then calibrated and validated using historical claims data.

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.

Pre-Visit Letter

11. V-4.1, page 203: Explain the application of secondary modifiers to *Chance of Loss, conditional mean damage ratio and standard deviation*.

Discussed that secondary modifiers vary by base vulnerability function and windspeed.

Reviewed the methodology for combining multiple mitigation measures.

Reviewed the equations for computing the conditional mean and conditional standard deviation of final damage ratios and Chance of Loss.

12. Form V-4, pages 357-361: Explain the changes from the current accepted model.

Discussed that the impact of secondary modifiers on primary vulnerability functions has not changed from the current accepted model.

Discussed the underlying reasons for the changes in Form V-4 related to windspeeds and vertical reinforcing.

Audit

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

Discussed that there are no changes in the impact of secondary modifiers from the current accepted model.

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

No changes were made from the current accepted model.

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

Reviewed implementation of combining individual secondary modifiers before adjusting the base vulnerability curves.

Discussed the methodology used when multiple secondary modifiers are present.

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.

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 set of secondary characteristics available for model users provided in V-4.4.

Reviewed implementation of individual and multiple secondary modifiers provided in the model documentation.

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 sample vulnerability curves with multiple secondary characteristics.

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.

   Discussed that secondary modifiers were developed based on engineering analysis and claims data.

   Reviewed comparison of modeled loss to claims for exposures that include Class D and Class H shingles.

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.

   Reviewed the assumptions made to complete Form V-2 related to roof age.

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 implementation of multiple secondary characteristics and mitigation measures, which vary across windspeeds.

   Reviewed documentation and implementation of roof type and external and internal pressure coefficients on walls.

   Reviewed the input variables identifying the characteristics of a building in the code.

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 complete set of hurricane mitigation measures and secondary characteristics.

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

13. A-1.B, page 212:
    a. Describe how the calculation of the average default factors are updated and kept current for missing user input values.

    Discussed the process for assigning values for missing input data.

    b. If different from the current accepted model, for one revised average default factor, provide the calculation for updating the default factor.

    Discussed that no changes have been made in the process for assigning values from the current accepted model.

    c. Include a sample of a hurricane model output report using this factor.

    Discussed that the model output reports do not denote where user input data was missing.

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.

   Reviewed the "Actuarial Forms Exposure Generation Plan" documentation that outlines the procedures and methods to assure accuracy of insurance and other input data for generating submission forms.

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 the general procedures for treatment of data during import into the model.

   Reviewed sample output reports disclosing assumptions, post-import summaries, and model settings.

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 example input forms for policy input and site input.

   Reviewed the hurricane model input forms documentation.

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 the Florida rate filing interface screen where only compliant-analysis options are permitted when "FCHLPM rate filing compliance" is selected.

   Reviewed an exported analysis output report for a Florida rate filing model run.

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

14. A-2.B, page 223: 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.

   Discussed that the calculation of loss costs and PML levels for Florida includes damage from landfalling and bypassing hurricanes, and that damage is included from the time the hurricane first reaches damaging windspeeds on land in Florida.

   Discussed that the model automatically excludes storm surge losses from model runs.

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.

   Discussed that a bypassing hurricane is a hurricane that does not make landfall in Florida but produces minimum damaging windspeeds or greater on land in Florida.

   Reviewed examples of bypassing hurricane events that made landfall in neighboring states or tracked close to, but offshore of, Florida.

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 model only computes wind and storm surge losses separately.

   Discussed that the model only provides users the option to model wind-only losses and that storm surge losses are excluded from any Florida hurricane analysis run by the model.

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

   See PVL #14.

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

15. A-3.1-4, pages 226-228: Show a calculation of loss costs and probable maximum loss levels for the minimum Frame Owners loss costs in Form A-1, ZIP Code 32247 in Duval County.

    Reviewed the methodology for calculating loss costs and probable maximum loss levels (PML).

    Reviewed the equations for calculating loss costs and PML for ZIP Code 32247 in Duval County.

16. A-3.5, page 228-229: Explain how the model handles the statutory 25% and 50% law and ordinance coverages. Explain how the three sets of damage functions were developed.

    Discussed that the model uses vulnerability functions to account for law and ordinance coverage, and that the model user has the option to choose between 0%, 25%, and 50% law and ordinance.

    Discussed the development of the three sets of building damage functions to represent 0%, 25%, and 50% law and ordinance.

Audit

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

   Reviewed the process for calculating loss costs for building, appurtenant structure, contents, and time element coverages.

   Reviewed the "IF Financial" documentation.

   Reviewed a diagram of the damage ratio uncertainty profile by intensity.

   Discussed with Minchong Mao, Actuarial Standards signatory, her review of the actuarial portion of the submission document. Discussed how she 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.

   See PVL #16.

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.

Pre-Visit Letter

17. A-4.1, pages 231-233: 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 agreement to Form A-8.

18. A-4.5, page 237: Explain how economic inflation with regard to the claims environment, the legal environment, and litigation effects are modeled.

    Discussed that the model does not include economic inflation, the legal environment, or litigation effects in model loss calculations.

    Discussed that the effects of the claims and legal environment, and litigation effects on Hurricane Irma (2017) claims impact the vulnerability functions.

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 losses and PML levels generated by the model do not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margins.

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

   Reviewed the change in methodology for calculating occurrence (aggregate) PMLs.

   Reviewed comparison to the current accepted model of the difference in ground-up and gross losses at key return periods.

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

   Reviewed the methodology for calculation of uncertainty intervals.

   See PVL #15.

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.

   Reviewed the demand surge methodology and the update to the demand surge function calculation.

   Reviewed the "IF Financial Model Hurricane Wind Demand Surge" documentation.

   Reviewed implementation of the demand surge function.

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

   See PVL #18.

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

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

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.

Pre-Visit Letter

19. A-5.3, page 240: Explain in detail how the hurricane model treatment of annual hurricane deductibles complies with s. 627.701(5)-(9), Florida Statutes. Provide numerical evidence.

Reviewed the process and calculation for applying annual hurricane deductibles.

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 historical claims data were not used to develop mathematical depictions of deductibles and policy limits. Discussed how policy deductibles and policy limits are developed, and how policy exclusions, loss settlement, and other exclusions are handled.

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

Discussed the claims data used for calibration and validation.

3. Treatment of annual hurricane deductibles will be reviewed.

Reviewed the process and calculation for applying annual hurricane deductibles.

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 the model changes have different effects on the strength of deductibles.

   Reviewed comparisons to the current accepted model of example ground up versus gross loss due to Chance of Loss.

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

20. A-6.10, page 247: Explain the calculation of uncertainty intervals.

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

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

Discussed that the variation in loss costs is due to variations in terrain roughness impacting modeled windspeeds.

Discussed that a similar variation is also seen for masonry owners and manufactured homes related to hazard differences between the two ZIP Codes.

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

Discussed that the variation in loss costs is due to variations in terrain roughness impacting modeled windspeeds.

Discussed that a similar variation for masonry owners and a difference for manufactured homes relates to hazard differences between the two ZIP Codes.

23. Form A-1: Explain the differences in Frame Owners losses from the current accepted model between ZIP Code 33052 in Monroe County (-48%) and ZIP Code 33631 in Hillsborough County (+123.7%).

    Discussed that the decrease in ZIP Code 33052 in Monroe County is primarily due to a decrease in hazard.

    Discussed that the increase in ZIP Code 33631 in Hillsborough County is due to both hazard and vulnerability changes in the model under review.

    Reviewed comparisons to the current accepted model of the frame owners building damage function curves in both ZIP Codes.

24. Form A-2, Table 36, pages 364-370: Explain the differences in losses from the current accepted model for most of the hurricanes shown (e.g., Andrew-1992, Charley-2004, and Michael-2018).

    Discussed that the recalibration of vulnerability functions, changes in hazard methodology with how the asymmetry is calculated, and the terrain factor impact for each event contributes to changes in the historical losses.

25. Form A-4, 0% Deductible, pages 376-391: Explain the reversal in loss costs where Frame is less than Masonry:
    a. Owners: Gulf Average, Monroe Average, St Johns Average
    b. Renters: Miami-Dade Average, Monroe Average, Wakulla Average
    c. Condo Unit: Monroe Average, Okeechobee Average, Wakulla Average.

    Discussed that the reversal in loss costs where frame is less than masonry is due to the buildings in the 2017 and 2023 FHCF exposure data being different, including the distribution of secondary modifiers (roof type and window protection), differences in year built, and differences in geographic distributions within the counties.

    Reviewed differences in year-built distributions with some counties having masonry exposures older than wood frame exposures.

    Reviewed differences in geographic distributions.

26. Form A-5, Figures 71-72, pages 443-444: Explain the regional changes (e.g., Panhandle versus Southeast Florida) in the loss costs in Form A-4, compared to the current accepted model.

    Discussed that the increase in the Panhandle and the decrease in Southeast Florida are driven by the change in hazard and the adjustment to ZIP Code centroid windspeed based on housing units rather than weighted by population.

27. Form A-5, Figure 73, page 445: Explain the regional changes (e.g., Panhandle versus Northeast Florida) in the loss costs in Form A-4, compared to the current accepted model.

    Discussed that the manufactured homes changes in Northeast Florida are due to decreases of vulnerability and only slight increases in hazard. Discussed that the increases in the Panhandle are due to small decreases in vulnerability and larger increases in hazard.

28. Form A-5, Figures 74 and 75, pages 446-447: Explain the differences between Jefferson and Sumter Counties loss costs in Form A-4, compared to the current accepted model.

    Discussed that the differences are due to model changes and different exposures in the counties.

    Discussed that the frame renters portfolio in Jefferson County has a greater percentage of pre-1995 buildings, while Sumter County has a greater percentage of newer buildings.

    Reviewed a comparison between Jefferson and Sumter Counties of the differences in unknown and hip roofs.

29. Form A-5, Figures 76 and 77, pages 448-449: Explain the differences between Wakulla and Franklin Counties loss costs in Form A-4, compared to the current accepted model.

    Discussed that the differences between Wakulla and Franklin Counties loss costs are attributed to the exposure in each county. Discussed that Wakulla County has limited frame condo unit exposures compared to Franklin County, and that a larger percentage of the structures were built before 1995 in Wakulla County, while the majority of the structures in Franklin County were built between 1995 and 2011.

    Reviewed a comparison between Franklin and Wakulla Counties for known and unknown roof types with Franklin County consisting primarily of unknown roof types and Wakulla County having more of a split between known and unknown roof types.

30. Form A-8, Table 43, page 458-460: Explain the increases in number of hurricanes compared to the current accepted model.

    Discussed that the increase in number of hurricanes compared to the current accepted model is due to the change in the PML calculation.

    Discussed that the number of events are different for the 2017 and 2023 FHCF exposure datasets due to the 2023 FHCF exposure dataset having more locations impacted by more events from the stochastic event set.

31. Form A-8, Table 44, page 461: Explain the non-zero differences between Form A-8 and Form S-2 for the common return periods.

    Discussed that the model was run with 100 samples for Form A-8 and run with 5 samples for Form S-2.

    Reviewed table of the annual exceedance probability for 100 samples compared to results for 5 samples using both the 2017 and 2023 FHCF exposure datasets.

Audit

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

    Reviewed the change for calculating PML curves.

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 the calculation of the return periods in Form A-8.

    Reviewed portions of the year loss table with event ID, year, year frequency, and event loss used to compute Form A-8.

    Reviewed map of the windspeeds and track of 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.

    Discussed that the event set consists of 300,000 years of simulation and that the annual number of storms follow a negative binomial distribution.

    Discussed that the uncertainty captures the variation of loss due to sampling at each return period.

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

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

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

    Reviewed maps of loss costs with land friction factors.

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.

   Reviewed the “Actuarial Forms QA Plan" document outlining the procedures to verify the individual hurricane loss cost relationships.

   Reviewed table of key tests performed to verify the loss cost relationships in Standard A-6.

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 their reasonableness.

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

   Discussed during review of the individual model updates.

   Reviewed maps of the percentage differences in loss costs due to changes in the hazard model for frame and masonry.

   Reviewed maps of the percentage differences in loss costs due to changes in the hazard and vulnerability components for manufactured homes. Reviewed map of the loss cost differences in manufactured homes affected by the exposure makeup by county and the vulnerability curve changes at different windspeeds.

   See PVLs #26 – 29.

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

   See PVL #25.

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

    Reviewed the methodology for calculation of uncertainty intervals.

COMPUTER/INFORMATION HURRICANE STANDARDS
Paul Fishwick, 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.

Pre-Visit Letter

32. CI-1: Discuss the progress made on communication and documentation enhancements as given in the 2023 Professional Team On-Site Review Report.

Reviewed the "Model Development Process" and "Model Handover Process" documentation.

Discussed the interaction between R&D and software teams, working groups on coding guidelines, and training for model developers on software processes and tools.

Audit

1. The central repositories will be reviewed.

   Discussed the use of Microsoft SharePoint as the primary document repository. Discussed that documents are version controlled and history is maintained by SharePoint.

   Reviewed examples of software development related documents stored online. Discussed that access is to authorized users only. Discussed that contents of the site are backed up regularly in compliance with Aon's security policy.

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

   Reviewed the documentation, including equations and variable mapping, for calculating the hurricane model windfield.

   Reviewed the documentation, including equations and variable mapping, for external and internal pressure coefficients for walls and roof types.

   Reviewed documentation on deriving the demand surge function.

   Reviewed the ELEMENTS user guide and input data guides.

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.

   All 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.

   Discussed that architecture, design, and technical notes along with requirements specifications are created and stored separately from the source code.

   Reviewed examples of the ELEMENTS application architecture, design, and technical notes in "ELEMENTS DCF Architecture Design."

   Reviewed examples of software requirements specification for ELEMENTS in "Florida Hurricane v3.0 Software Requirements" documentation.

Discussed that source code is maintained using Microsoft Azure DevOps.

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 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.

   Reviewed the Florida Hurricane (FCHLPM) Model v3.0 version specific software requirements documentation.

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

   Reviewed the requirements documentation for the updated tropical cyclone asymmetry parameterization.

   Reviewed the requirements documentation for the demand surge function.

   Reviewed the requirements documentation for planned changes to the hurricane model.

CI-3 Hurricane Model Organization and Component Design

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

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

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 flowchart for calculating hurricane surface gust values at a given location.

   Reviewed flowchart of the code to obtain terrain factor applied to the surface gust that produces the final gust value.

   Reviewed the vulnerability simulator flowchart.

   Reviewed the demand surge estimation flowchart.

   Reviewed other flowcharts throughout the review.

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

   Reviewed specifications for interfaces in the architecture and design documents.

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

Reviewed examples of database schemata and ELEMENTS data import, hazard, and loss processing.

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

Reviewed different levels of flowcharts for model components in the "Architecture, Design, and Technical Notes."

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 workflow of IF professionals involved in development of the hurricane model.

Reviewed the model handover 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 hurricane model is only available in the ELEMENTS application and on Microsoft Windows machines.

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

Reviewed the flowchart standards followed by the Modeler. Discussed that the majority of flowcharts use UML and ISO 5807.

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.

Audit

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

   Reviewed the windfield model code for calculating the axisymmetric windfield profile and applying the translational asymmetry factor.

   Reviewed the implementation of external and internal pressure coefficients for roof types and walls.

   Reviewed implementation of the demand surge function.

   Discussed the model issue discovered while finalizing the initial November 4, 2024, submission that impacted loss results. Discussed that the issue involved implementation of the new Chance of Loss in the ELEMENTS platform and was discovered while reviewing anomalies in the contents and time element losses in Form A-6. Reviewed the "bug" found in the source code and details of the commit. Reviewed comparison between the old and new code.

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 coding guidelines documentation that covers numerous programming languages.

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

   Discussed the processes and procedures for automated and manual validation of hurricane model development in the data verification process document.

   Discussed the use of structured query language (SQL) for database management.

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

   Reviewed the traceability among components included in the "ELEMENTS Architecture and Design Document" and "Florida Hurricane Technical Notes" documentation.

   Reviewed the technical note documentation for Chance of Loss.

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 the comment block template.

   Reviewed examples in the codes examined.

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

   Reviewed the code analyzer report.

   Reviewed table of line counts with and without comments.

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

   Reviewed the variable mapping in the windfield source code.

   Reviewed the equation variable mapping in the vulnerability simulator for pressure coefficients for roof and walls.

   Reviewed the equation variable mapping for the demand surge function.

   Reviewed the “ELEMENTS Design Document.”

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

   Reviewed examples of comments in the different source codes reviewed.

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

   Discussed that the Florida Hurricane (FCHLPM) Version 3.0 model is only available on the ELEMENTS platform which is only available on Windows platform.

10. Network organization implementation will be reviewed.

    Reviewed the network organization diagram for ELEMENTS.

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.

    Reviewed the test plans and test cases documentation.

    Reviewed Azure DevOps for Sprint planning.

    Reviewed the vintage of code branching strategy.

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

    Discussed that automated procedures exist for form creation across all standards.

    Discussed the error impacting Forms V-2 and V-4 that was discovered while reviewing the questions received in the pre-visit letter. Discussed that a mistake was made in the entry of values into Form V-2 which propagated into Form V-4. Discussed that the error was limited to the values for the Masonry Building columns in the Mitigated Building row, and was caused by a manual error in copying the information into the form format. Discussed that an additional step will be added to the automated form output so that copying and formatting is no longer required, and that analysis of the results will be completed on the deliverable copy of the forms.

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 there have been no changes in physical unit conversions in the source code.

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.

   Reviewed an example of source code showing exception handling.

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

   Discussed that manual testing was conducted for the roof and wall pressure coefficients code.

   Reviewed the visual inspection and checks applied for selected storms after the initial development of the new asymmetry parameterization.

   Discussed the diagnostic script completed to generate footprints for all events in the Model Base Hurricane Set with only the asymmetry parameterization change.

   Discussed the need to improve verification testing and the use of verification tools. Reviewed a written R&D verification improvement plan including a process timeline concerning verification procedures, component testing, and data testing.

   Discussed the series of checks performed on various risk characteristics, including location, primary building characteristics, insurance terms, and secondary modifiers.

   Reviewed testing of the Chance of Loss parameter implementation.

   Reviewed the test plan and the test results for the corrected contents and time element Chance of Loss code. Discussed that the test plan also includes tests for related issues.

   Discussed the testing portfolio created for testing of loss results.

   Discussed that Microsoft unit test framework is used for unit testing.

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

   Reviewed documentation for testing strategy.

   Reviewed documentation of test cases.

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.

   Reviewed an example of cross checking of the PML and average annual loss calculations.

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

   Reviewed the flowchart for manual and automatic verification.

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

   Reviewed the Precisely geocoder testing and verification documentation.

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

   Reviewed test cases verifying model changes.

   Reviewed the “Florida Hurricane Version 3.0 Test Plan.”

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.

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

   Discussed that SQL Server Management Studio is the external user interface to extract additional data or analyses.

   Reviewed a live demonstration of the user interface.

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

   Reviewed the "ELEMENTS User Interface HCI Guidelines."

   Reviewed the use of wireframes for user interface design.

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

   Reviewed the interaction diagram showing logic of interface option selection when an acceptable Florida hurricane model is selected.

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 software development and testing processes documentation.

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

   Reviewed the model and platform versioning management 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.

   Reviewed source code available in DevOps. Discussed that documentation is available on SharePoint.

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

   Reviewed the document that tracks model changes since the initial submission.

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

   Reviewed the model and software platform 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 data and network security documentation. Discussed security measures that are taken.

   Discussed that there have been no changes in the policy since the previous model review.

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.

   Discussed that IF follows data retention and recovery protocols defined by the Aon Information Technology (IT) group.

   Discussed the data backup, retention, and recovery processes.

   Reviewed “IF Security” in the “Aon IT” documentation.

3. Security aspects of each platform will be reviewed.

   Discussed that the hurricane model can only be used with the ELEMENTS application which is only available on Windows platform.

   Discussed that ELEMENTS uses domain security groups to grant access to the application.

   Reviewed ELEMENTS architecture and deployment documentation.

Discussed that there have been no known security breaches.

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

Reviewed network security documentation addressing secured physical access to the data center, secured computer access, secured access to hurricane model components, and secured access to documentation and source code.

Discussed that all IF hardware resources are monitored and patched by Aon IT groups.

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 Florida Hurricane (FCHLPM) Model Version 3.0 implemented in ELEMENTS Version 18.1.

Discussed that an internal generative AI tool is being used for experimental use cases.

Discussed the use of GitHub Copilot for data documentation.

The use of AI will be discussed with the Commission during the trade secret session of the June 2025 meeting to review the model for acceptability.