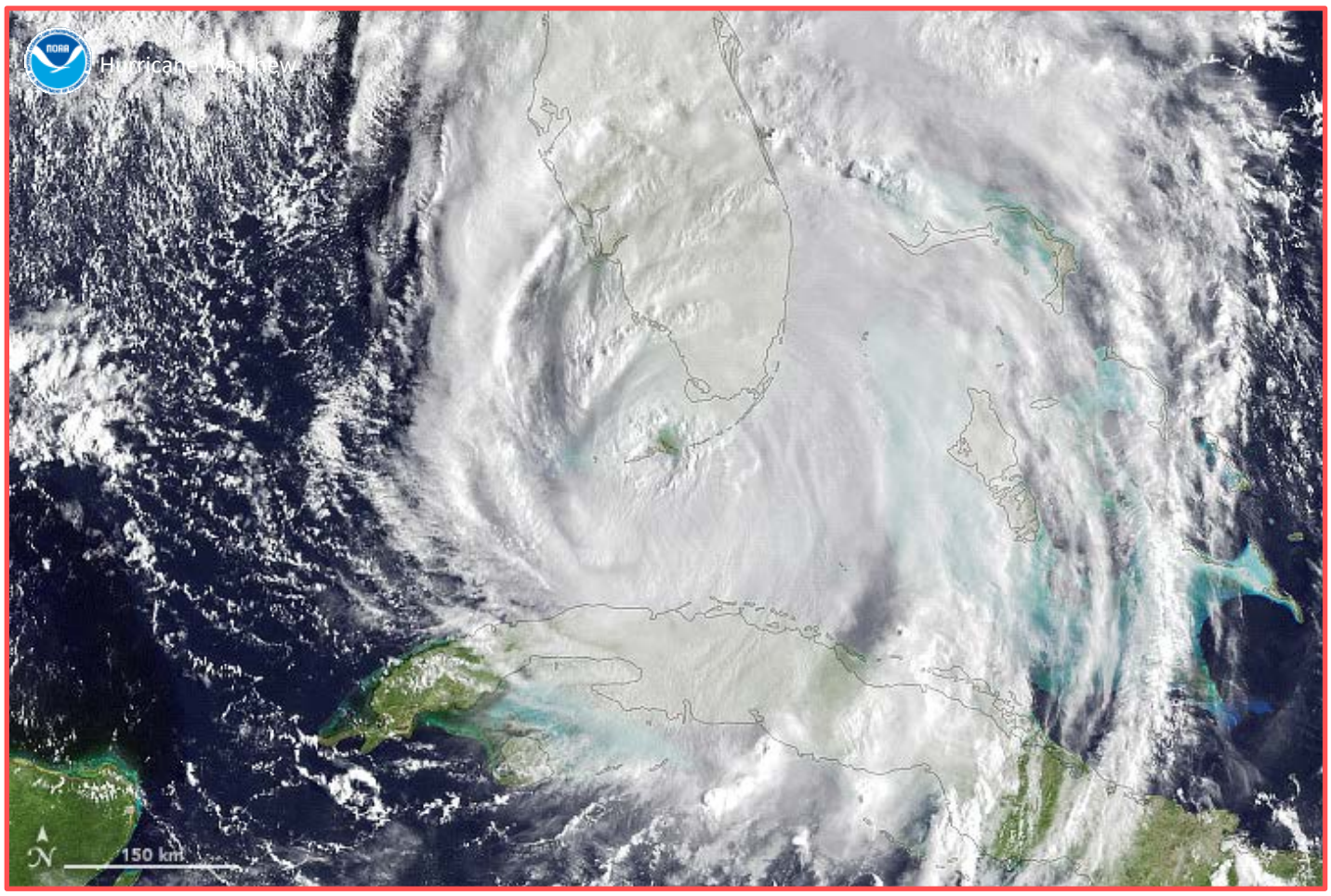
Florida Commission on Hurricane Loss Projection Methodology

Professional Team Report
2017 Hurricane Standards



Risk Management Solutions, Inc.

On-Site Review
March 25-27, 2019

Additional Verification Review: May 20-21, 2019

On March 25-27, 2019, the Professional Team visited Risk Management Solutions, Inc. (RMS) in Newark, California. The following individuals participated in the review:

RMS
Yasuyuki Akita, Geospatial Modeler
Florian Arfeuille, Ph.D., Catastrophe Risk Modeler, Model Development
Enrica Bellone, Ph.D., Senior Director, Model Development (via video conference)
Suman Bhattacharya, Director, Software Development
David Carttar, Senior Director, Software Development (via video conference)
Kay Cleary, FCAS, MAAA, FCA, Actuary & Director (via video conference)
Peter Datin, Ph.D., Senior Principal Modeler, Model Development
Michael Drayton, Ph.D., Consultant
David Gatey, Ph.D., Senior Director
Jara Imbers, Ph.D., Principal Modeler
Sonja Jankowfsky, Senior Modeler
Jo Kaczmarska, Ph.D., FIA, Senior Principal Modeler
Mahmoud Kamalzare, Ph.D., Modeler, Model Development
Ran Li, Ph.D., Geospatial Modeler
Joss Matthewman, Ph.D., CCRA, Senior Director
Akwasi Mensah, Ph.D., Lead Modeler
Hailey Mitchell, CCRA, PMP, Lead Model Specialist, Models & Data
Christos Mitas, Ph.D., Vice President Model Development
Derek Neal, Senior Product Manager
Christina Robertson, CCRA, Lead Modeler, Model Development
Chris Sams, Senior Product Manager, Geospatial Development
Emilie Scherer, Ph.D., CCRA, Consultant
Chana Seitz, Modeler, Model Development
Jayant Srivastava, Vice President, Core Products
Beth Stamann, Senior Documentation Specialist
Derek Stedman, Lead Modeler
Yogesh Vani, Director, Software Development
Rajkiran Vojjala, Vice President, Model Development
Jeff Waters, Senior Product Manager, Model Product Management
Holly Widen, Ph.D., Product Manager, Model Product Management
Michael Young, M.E.Sc., P.E., Vice President, Model Product Management

Professional Team
Paul Fishwick, Ph.D., Computer Scientist
Tim Hall, Ph.D., Meteorologist
Mark Johnson, Ph.D., Statistician, Team Leader
Stuart Mathewson, FCAS, MAAA, CPCU, Actuary
Masoud Zadeh, Ph.D., P.E., Structural Engineer
Donna Sirmons, Staff

The review began with introductions and an overview of the audit process by the Professional Team.

RMS provided explanations of processing errors in completing Form A-7 and Form M-1. RMS discussed review of the QA processes to ensure the errors do not recur. RMS discussed a change in

their method for defining by-passing hurricanes in Form M-1 and Forms A-2A and A-2 which resulted in a correction of Form M-1.

RMS provided an overview of the RMS North Atlantic Hurricane Models Version 18.1 (Build 1945) and the following significant changes in the model:

- Updates to the geocoding module to include March 2018 postal code vintage data.
- Integration of U.S. Postal Service street information to supplement existing street geocoding files.
- Stochastic event set updated to the May 2017 version of HURDAT2 and the 1956-1960 reanalysis data.
- Historical footprint for Hurricane Donna (1960) revised and footprints for Hurricane Hermine (2016) and Hurricane Matthew (2016) added.
- Reaggregation of wind hazard for all events against updated March 2018 ZIP Code data and boundaries.
- New secondary modifier options to reflect the Insurance Institute for Business and Home Safety Fortified Commercial program standards.

The model updates resulted in an overall 2.6% decrease in modeled loss costs. RMS also discussed other changes made to benefit users of RMS software that did not affect personal and commercial residential losses in Florida.

The audit continued with a thorough review of each standards section. In the course of the audit, it was determined that several standards could not be verified pending review of open items. At the exit briefing, modeler options as given in the *2017 Hurricane Standards Report of Activities* were noted.

In addition to the Issues identified by the Commission at the January 7, 2019 meeting and listed on page 4 of this report, RMS is to present the following information to the Commission during the Trade Secret session of the meeting to review the model for acceptability as specified on page 60 of the *2017 Hurricane Standards Report of Activities*:

1. Detailed information and discussion of Forms V-3 and V-5
2. Detailed information and discussion of relativities in Form A-6.

The Professional Team additionally recommended presentation of the architecture consisting of Risk Modeler™ 2.1 on RMS Risk Intelligence™ platform and comparison to the primary platform RiskLink® 18.1 (Build 1945).

*****Additional Verification Review – May 20 & 21, 2019*****

The Professional Team completed an additional verification review of the RMS North Atlantic Hurricane Models Version 18.1 (Build 1945) on the primary platform RiskLink® 18.1 (Build 1945) and the functionally equivalent cloud-based Risk Modeler™ 2.1 on RMS Risk Intelligence™ platform.

The following individuals participated in the additional verification review.

RMS
Enrica Bellone, Ph.D., Senior Director, Model Development
Suman Bhattacharya, Director, Software Engineering Core Products

David Carttar, Senior Director, Software Development (via video conference)
Kay Cleary, FCAS, MAAA, FCA, Actuary & Director (via video conference)
Peter Datin, Ph.D., Senior Principal Modeler, Model Development (via video conference)
Ran Li, Ph.D., Geospatial Modeler
Akwasi Mensah, Ph.D., Lead Modeler, Model Development
Hailey Mitchell, CCRA, PMP, Lead Model Specialist, Models & Data
Meghan Purdy, Director, Platform Product Management
Christina Robertson, CCRA, Lead Modeler, Model Development
Jayant Srivastava, Vice President, Core Products
Beth Stamann, Senior Documentation Specialist (via video conference)
Derek Stedman, Lead Modeler
Jeff Waters, Senior Product Manager, Model Product Management
Michael Young, M.E.Sc., P.E., Vice President, Model Product Management

Professional Team
Paul Fishwick, Ph.D., Computer Scientist
Tim Hall, Ph.D., Meteorologist
Mark Johnson, Ph.D., Statistician, Team Leader
Stuart Mathewson, FCAS, MAAA, CPCU, Actuary
Masoud Zadeh, Ph.D., P.E., Structural Engineer
Donna Sirmons, Staff

RMS provided an explanation of the model and application structure on the two software platforms, RiskLink® 18.1 (Build 1945) and the cloud-based Risk Modeler™ 2.1 on RMS Risk Intelligence™. During the additional verification review, open items from the initial on-site review were reviewed and discussed in detail as well as new issues that surfaced during the course of the audit.

After resolution of open items, all standards are now verified by the Professional Team.

Report on Deficiencies

The Professional Team reviewed the following deficiencies cited by the Commission at the January 7, 2019 meeting. The deficiencies were eliminated by the established time frame, and the modifications have been verified.

1. Standard V-1.A (page 106)
   Non-responsive as to "Any development of the building hurricane vulnerability functions based on rational structural analysis, post-event site investigations, and laboratory or field testing shall be supported by historical data."

2. Standard V-1, Disclosure 8 (page 114)
   Non-responsive as "the relationship between building structure and appurtenant structure hurricane vulnerability functions and their consistency with insurance claims data" is not given.

Discussion on Issues

The Professional Team reviewed in detail the following issues identified by the Commission at the January 7, 2019 meeting. RMS is to present this information to the Commission during the Trade Secret session of the meeting to review the model for acceptability.

1. For Standard V-1, Audit item 7, how the county as well as statewide building codes are reflected in the model vulnerability functions.
2. For Standard V-1, Audit item 9, how the building codes are reflected in the model vulnerability functions, including whether current statewide and county building codes are incorporated.

3. Justification if the high-velocity hurricane zone included in the statewide Florida Building Code is not reflected in the model vulnerability functions.

4. For Standard M-4, Audit item 8, the science underlying the maximum windspeeds in Form M-2.

5. Form A-6, Building Code/Enforcement (Year Built) Sensitivities, in particular for Manufactured Homes.

Discussion on Inquiry

The Professional Team discussed the following inquiry included in the *2017 Hurricane Standards Report of Activities* and discussed by the Commission at the January 7, 2019 meeting. The Professional Team will prepare a report on the inquiry to the Commission after discussions with all modelers are complete and prior to the 2019 hurricane standards committee meetings.

Impact of Legal and Claims Environment

> Investigate the impact of the legal and claims environment (e.g., assignment of benefits, attorney fees, increased litigation) on modeled hurricane loss costs and hurricane probable maximum loss levels. Is the impact of the legal and claims environment evident in the claims data provided to the modeling organizations for validation of the modeled hurricane loss costs and hurricane probable maximum loss levels? Should the impact of the legal and claims environment be incorporated in the hurricane model results, and if so, how? Should the impact of the legal and claims environment be incorporated into the hurricane standards?

Professional Team Pre-Visit Letter

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

The purpose of the pre-visit letter is to outline specific issues unique to the modeler's submission, and to identify lines of inquiry to be followed during the on-site review to allow adequate preparation by the modeler. Aside from due diligence with respect to the full submission, various questions that the Professional Team is certain to ask the modeler during the on-site review are provided in this letter. 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 that will be held if requested by the modeler. One goal of the potential conference call is to address

modeler questions related to this letter or other matters pertaining to the on-site review. The overall intent is to expedite the on-site review and to avoid last minute preparations that could have been undertaken earlier.

Some of this material may have been shown or may have been available on a previous visit by the Professional Team. The Professional Team will also be considering material in response to deficiencies and issues designated by the Florida Commission on Hurricane Loss Projection Methodology (Commission) during the January 7, 2019 conference call meeting.
It is important that all material prepared for presentation during the on-site review be presented using a medium that is readable by all members of the Professional Team simultaneously.

The on-site schedule is tentatively planned to proceed in the following sequence: (1) presentation by the modeler of new or extensively updated material related to the model; (2) section by section review commencing within each section with pre-visit letter responses; (3) responses to new or significantly changed hurricane standards in the 2017 *Hurricane Standards Report of Activities*, and (4) responses to the audit items for each hurricane standard in the 2017 *Hurricane Standards Report of Activities*.

If changes have been made in any part of the model or the modeling process from the descriptions provided in the original 2017 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 all revised forms where any output changed. For each revised form, provide an additional form with cell-by-cell differences between the revised and originally submitted values.

Refer to the On-Site Review section of the *Hurricane Standards Report of Activities as of November 1, 2017* for more details on materials to be presented to the Professional Team. Particular attention should be paid to the requirements under Presentation of Materials on pages 80-81. These requirements are reproduced at the conclusion of this letter.

For your information, the Professional Team will arrive in business casual attire.

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

Editorial Items

Editorial items were noted by the Professional Team in the pre-visit letter for correction prior to their arrival in order to facilitate efficiency during the on-site review. Additional editorial items were also noted during the audit. The Professional Team reviewed the following corrections that are to be included in the revised submission provided to the Commission no later than 10 days prior to the meeting to review the model for acceptability. Page numbers below correspond to the November 2018 initial submission.

1. Page 2, inside cover – Risk Modeler version and platform name updated.
2. Page 7, Hurricane Model Identification – Risk Modeler version and platform name updated.
3. Page 17, G-1, Disclosure 1 – Risk Modeler version and platform name updated.
4. Page 19, G-1, Disclosure 2 – Number of stochastic events corrected, text added under Vulnerability or Damage Assessment Module for clarification on Figure 3.
5. Page 24, G-1, Disclosure 3 – Figure 3 flow diagram updated.
6. Pages 28 and 30, G-1, Disclosure 4 – Additional Vulnerability Standards references added.

7. Page 42, G-1 – Page header corrected.
8. Page 36, G-1, Disclosure 5A – Text added for clarification on the geocoding module.
9. Page 49, G-2, Disclosure 2A & B – Meghan Purdy added to Table 6 and listed as a new employee.
10. Page 50, G-2, Disclosure 2C – Figure 8 updated.
11. Page 51, G-2, Disclosure 3A – "Associate Profession" for Dr. Robert Hart corrected, text updated to reflect relevancy of reviews.
12. Page 52, G-2 – Page header corrected.
13. Page 55, G-3, Disclosure 5 – Text added for clarification on the process for updating hurricane model ZIP Codes, page header corrected.
14. Page 63, M-2, Disclosure 7 – Text added for clarification on central pressure.
15. Page 78, M-4 – Page header corrected.
16. Page 83, M-5 – Page header corrected.
17. Page 98, S-1 – Page header corrected.
18. Page 104, S-5 – Page header corrected.
19. Page 105, S-6, Disclosure 1 – Number of storms corrected.
20. Page 113, V-1, Disclosure 6 – Table 15 revised to add unknown to manufactured homes and floor area categories, and to update floor area values used in the model.
21. Page 115, V-1, Disclosure 9 – square-foot floor area band updated.
22. Page 126, V-3, Disclosure 7 – Text added for clarification on vulnerability uncertainty.
23. Page 133, A-1, Disclosure 6 – number of square-foot bands used for weighted average for unknown updated.
24. Page 139, A-4, Disclosure 5 – Text added for clarification on the date of exposure used for loss validation.
25. Page 147, CI-1 – Page header corrected.
26. Page 149, CI-2 – Page header corrected.
27. Page 153, CI-4 – Page header corrected.
28. Page 156, CI-5 – Page header corrected.
29. Pages 158-159, CI-6, Disclosure 1 – Text corrected and Figure 49 updated.
30. Page 161, CI-6 – Page header corrected.
31. Page 167, Form G-4 – Signatory changed to be a P.E.
32. Pages 174-175, Form M-1 – Table 19 and Figure 50 updated.
33. Pages 327-336, Form A-7 – Revised for numerical issues.
34. Page 338, Form A-8A – Legend labels updated for Figure 92.
35. Pages 339-340 and 344-345, Forms A-8A and A-8B, Part A – Expected Annual Hurricane Losses rounded.
36. Page 343, Form A-8B – Legend labels updated for Figure 93.
37. Page 350 and 357, Appendix B – Hurricane project responsibilities for Peter Datin updated and Meghan Purdy added.

GENERAL STANDARDS – Mark Johnson, Leader

G-1 Scope of the Hurricane Model and Its Implementation

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

B. The modeling organization shall maintain a documented process to assure continual agreement and correct correspondence of databases, data files, and computer source code to slides, technical papers, and modeling organization documents.

C. All software and data (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 Standards and shall be located in centralized, model-level file areas.

Audit

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

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

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

4. Maps, databases, and data files relevant to the modeling organization's submission will be reviewed.

5. The following information related to changes in the hurricane model, since the initial submission for each subsequent revision of the submission, will be reviewed.
   A. Hurricane model changes:
      1. A summary description of changes that affect, or are believed to affect, the personal or commercial residential hurricane loss costs or hurricane probable maximum loss levels,
      2. A list of all other changes, and
      3. The rationale for each change.
   B. Percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2012 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named "hlpm2012c.exe" for:
      1. All changes combined, and
      2. Each individual hurricane model component and subcomponent change.

C. For any modifications to Form A-4A, Hurricane Output Ranges (2012 FHCF Exposure Data), since the initial submission, additional versions of Form A-5, Percentage Change in Hurricane Output Ranges (2012 FHCF Exposure Data):
   1. With the initial submission as the baseline for computing the percentage changes, and
   2. With any intermediate revisions as the baseline for computing the percentage changes.

D. Color-coded maps by county reflecting the percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2012 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named "hlpm2012c.exe" for each hurricane model component change:
   1. Between the previously-accepted hurricane model and the revised hurricane model,
   2. Between the initial submission and the revised submission, and
   3. Between any intermediate revisions and the revised submission.

E. Percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named "hlpm2017c.exe" for:
   1. All changes combined, and
   2. Each individual hurricane model component and subcomponent change.

F. For any modifications to Form A-4B, Hurricane Output Ranges (2017 FHCF Exposure Data), since the initial submission, a version of Form A-5, Percentage Change in Hurricane Output Ranges using the 2017 FHCF Exposure Data and Form A-4B, Hurricane Output Ranges (2017 FHCF Exposure Data):
   1. With the initial submission as the baseline for computing the percentage changes, and
   2. With any intermediate revisions as the baseline for computing the percentage changes.

G. Color-coded maps by county reflecting the percentage difference in average annual zero deductible statewide hurricane loss costs based on the 2017 Florida Hurricane Catastrophe Fund personal and commercial residential zero deductible exposure data found in the file named "hlpm2017c.exe" for each hurricane model component change:
   1. Between the initial submission and the revised submission, and
   2. Between any intermediate revisions and the revised submission.

Pre-Visit Letter

1. Describe the process used to prepare the 2017 FHCF personal and commercial residential zero deductible exposure data to produce the various forms which use it. Indicate the problematic entries requiring further investigation.

2. G-1, Disclosure 2, page 18: Explain the adjustment of the stochastic track set toward landfall targets.

3. G-1, Disclosure 5, page 36: Explain how the interim updates mesh with G-1, Disclosure 5.

4. G-1, Disclosure 5, page 38: Explain the driving forces for Holmes County in Figure 4.

5. G-1, Disclosure 5, page 39: Explain the driving forces for Glades, Lafayette, and Wakulla Counties in Figure 5.

6. G-1, Disclosure 5, page 40: Explain the driving forces for Walton County in Figure 6.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Discussed the process used to review and prepare the 2017 FHCF exposure data.

Discussed the adjustment of landfall rates to match the smoothed landfall rates at gates.

Discussed the increase in loss costs in Holmes County due to the reassignment of a ZIP Code in Walton County to Holmes County.

Discussed the increase in loss costs for Glades and Wakulla Counties and the decrease in loss costs for Lafayette County due to the ZIP Code-level hazard aggregation updates.

Discussed the increase in loss costs for Walton County due to a ZIP Code being converted from a point ZIP Code to a polygonal ZIP Code and being assigned to the non-coastal vulnerability region.

Reviewed the 2007 Decision and Order on Massachusetts Property Insurance Underwriting Association Rate Filings by the Massachusetts Department of Insurance.

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

Reviewed the architecture of the primary platform RiskLink® 18.1 (Build 1945) and the functionally equivalent Risk Modeler™ 2.1 on RMS Risk Intelligence™ cloud-based platform.

Reviewed the differences between the model platforms.

Verified after resolution of open items.

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

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 (licensed Professional Engineer), statistics (advanced degree), actuarial science (Associate or Fellow of Casualty Actuarial Society or Society of Actuaries), meteorology (advanced degree), and computer/information science (advanced degree or equivalent experience and certifications). These individuals shall certify Expert Certification Forms G-1 through G-6 as applicable.

Audit

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

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

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

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

Pre-Visit Letter

7. G-2, Disclosure 1.E, page 44: Provide a hard copy of the 2007 Massachusetts Property Insurance Underwriting Association decision.

8. G-2, Disclosure 2.B, page 49: Provide resumes of new contributors to the model.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending expert certifications.

Reviewed resumes of new personnel:

- Christopher Allen, Ph.D. in Meteorology & Climate Science, Oxford University, Oxford, England; Certificate of Higher Education in Mathematics, University of London, London, England; B.A. in Geography, Oxford University, Oxford, England
- Florian Arfeuille, Ph.D. in Climate Science, Swiss Federal Institute of Technology, Zürich, Switzerland; M.S. in Climate Science, University of Versailles, Hauts-de-Seine, France
- Zachary Gellis, B.S. in Meteorology, Pennsylvania State University, State College, PA
- Mahmoud Kamalzare, Ph.D. in Structural Engineering, University of Southern California, Los Angeles, CA; M.S. in Electrical Engineering, University of Southern California, Los Angeles, CA; M.S. in Structural Engineering, University of Southern California, Los Angeles, CA; M.S. in Structural Engineering, Sharif University of Technology, Tehran, Iran; B.S. in Civil Engineering, Sharif University of Technology, Tehran, Iran
- Hailey Mitchell, B.S. in Meteorology, Pennsylvania State University, State College, PA
- Chana Seitz, M.S. in Meteorology, Florida State University, Tallahassee, FL; B.S. in Meteorology, North Carolina State University, Raleigh, NC
- Kim Shuss, B.S. in Computer Science, California State University, Hayward, CA
- Jeffrey Waters, M.S. in Tropical Meteorology and Climatology, Pennsylvania State University, State College, PA; B.S. in Meteorology-Geography, Ohio University, Athens, OH

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

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

Reviewed resume:

- Meghan Purdy, B.A. in Geological and Earth Sciences, Harvard University, Boston, MA

Verified after review of revised expert certification on Forms G-1, G-4, G-5, G-6 and G-7.

G-3 Insured Exposure Location

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

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

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

D. If any hazard or any hurricane model vulnerability components are dependent on ZIP Code databases, the modeling organization shall maintain a logical process for ensuring these components are consistent with the recent ZIP Code database updates.

E. Geocoding methodology shall be justified.

Audit

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

Pre-Visit Letter

9. G-3, page 53: Present geographic representations of the previous versus current ZIP Code centroids.
10. G-3, Disclosure 5, page 55: Explain no updating of the ZIP Code database for vulnerability and inventory regions.
11. G-3, Disclosure 5, page 55: Provide the number of ZIP Codes used in the various forms. Provide a list of all new and retired ZIP Codes relative to the previous submission.

Verified: YES

Professional Team Comments:

Reviewed the ZIP Code aggregation methodology for creating aggregate hazard.

Reviewed geographic displays of ZIP Codes and comparisons of centroid movements and boundary shifts for the entire state.

Discussed that the ZIP Code database for vulnerability and inventory regions was updated to reflect the March 2018 U.S. postal code data.

Reviewed the number of ZIP Codes used in completion of the submission forms. Discussed the process for identifying and processing ZIP Code changes between the 2012 and 2017 FHCF exposure data.

G-4 Independence of Hurricane Model Components

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

Audit

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

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

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

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

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

Verified after resolution of outstanding issues from other standards.

G-5 Editorial Compliance

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

Audit

1. An assessment that the person who has reviewed the submission has experience in reviewing technical documentation and that such person is familiar with the submission requirements as set forth in the Hurricane Standards Report of Activities as of November 1, 2017 will be made.

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

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

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

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

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

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

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 per Audit item 3, but cannot guarantee that all editorial difficulties have been identified. The modeler is responsible for eliminating such errors.

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

Verified after resolution of open items.

Meteorological Standards – Tim Hall, Leader

M-1 Base Hurricane Storm Set*

*(*Significant Revision)*

A. The Base Hurricane Storm Set is the National Hurricane Center HURDAT2 as of April 11, 2017 (or later), incorporating the period 1900-2016. Annual frequencies used in both hurricane model calibration and hurricane model validation shall be based upon the Base Hurricane Storm Set. Complete additional season increments based on updates to HURDAT2 approved by the Tropical Prediction Center/National Hurricane Center are acceptable modifications to these data. Peer reviewed atmospheric science literature may be used to justify modifications to the Base Hurricane Storm Set.

B. Any trends, weighting, or partitioning shall be justified and consistent with current scientific and technical literature. Calibration and validation shall encompass the complete Base Hurricane Storm Set as well as any partitions.

Audit

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

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

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

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

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

6. Form M-1, Annual Occurrence Rates, will be reviewed for consistency with Form S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year.

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

Pre-Visit Letter

15. Form M-1, page 174: Explain the classification for NoName02 (1919) in Form M-1 and Forms A-2A and A-2B.

16. Form M-1, page 174: Explain the difference between modeled and historical by-passing hurricanes in Form M-1.

17. Form M-1, page 174: Reconcile the inconsistency between historical by-passing hurricanes in Form M-1 and in Forms A-2A and A-2B.

18. Form M-1, page 174: Reconcile the inconsistency between modeled total Florida landfalls in Form M-1 and Form S-1.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of open items.

Reviewed the data and methodology for updating the historical event set.

Reviewed the change in Hurricane Donna (1960) track and intensity based on the HURDAT2 reanalysis project, including Hurricane Ethel (1960) adjacent state landfall.

Reviewed the addition of 2016 Hurricanes Hermine and Matthew.

Reviewed the classification for NoName02 (1919) as a Category 4 hurricane landfalling in Dry Tortugas in Forms M-1, A-2A and A-2B.

Discussed the Rmax and central pressure for NoName02 (1919) at the two closest six hourly HURDAT2 points to landfall.

Discussed the relationship of historical counts in Form M-1 and historical counts used to calibrate stochastic event frequencies.

Reviewed the revised Form M-1 correcting the inconsistency between historical by-passing hurricanes in Forms M-1, A-2A and A-2B.

Discussed that the inconsistency between modeled total Florida landfalls in Form M-1 and Form S-1 is due to rounding differently in the forms.

Reviewed comparison of stochastic landfall rates by gate before and after Hurricane Hermine (2016).

Reviewed the new methodology for defining by-passing hurricane intensities and using by-passing hurricane frequencies to calibrate the stochastic model.

Discussed the Form M-1 generation error impacting the numbers of modeled Florida by-passing hurricanes. Discussed how the error occurred, how it was detected, and actions taken to prevent reoccurrence.

Reviewed comparison of HURDAT2 and stochastic by-passing hurricanes by category.

Reviewed revised Form M-1. Discussed why no changes were made in Forms A-2A and A-2B.

Discussed the impact on loss costs due to the by-pass recalibration.

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

Verified after resolution of open items.

M-2 Hurricane Parameters and Characteristics

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

Audit

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

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

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

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

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

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

Verified: YES

Professional Team Comments:

Reviewed the methodology for calculating landfall and by-passing frequencies.

Discussed the methodology to determine landfall targets by gates using historical storm landfalls.

M-3 Hurricane Probability Distributions

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

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

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

Saffir-Simpson Hurricane Wind Scale:

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

Audit

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

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

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

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

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

Verified: YES

Professional Team Comments:

Discussed the method for deriving X1 and N parameters for the windfield.

Reviewed plot of X1 dependency on Rmax and translation speed.

Reviewed method to adjust stochastic event-set landfall frequencies and intensities to historical-based landfall frequencies and intensities.

Discussed the landfall parameter calibration methodology.

Discussed assignment of date to stochastic events.

M-4 Hurricane Windfield Structure

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) 2011 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 windfield shall account for the effects of the vertical variation of winds if not accounted for in the vulnerability functions.

Audit

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

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

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

4. The previous and current hurricane parameters used in calculating the hurricane loss costs for the LaborDay03 (1935) and NoName09 (1945) hurricane landfalls will be reviewed. Justification for the choices used will be reviewed. The resulting spatial distribution of winds will be reviewed with Form A-2A, Base Hurricane Storm Set Statewide Hurricane Losses (2012 FHCF Exposure Data) and Form A-2B, Base Hurricane Storm Set Statewide Hurricane Losses (2017 FHCF Exposure Data).

5. For windfields not previously reviewed, detailed comparisons of the hurricane model windfield with Hurricane King (1950), Hurricane Charley (2004), Hurricane Jeanne (2004), and Hurricane Wilma (2005) will be reviewed.

6. For windfield and pressure distributions not previously reviewed, time-based contour animations (capable of being paused) demonstrating scientifically-reasonable windfield characteristics will be reviewed.

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

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

Pre-Visit Letter

12. M-4, Disclosure 1, page 68: Explain the dependence of the wind profile parameters X1 and N on Rmax and translation speed.

13. M-4, Disclosure 1, page 68: Explain the optimization of the Willoughby et al., 2006 wind profile.

19. Form M-2, pages 178-184: Ensure that open-terrain roughness length was applied only over land. If not, provide the Form M-2 maps with open-terrain applied only on land points.

20. Form M-2, page 182: Explain the white patches surrounded by blue in the center of the state in Figure 56.

Commission Issue:

4. For Standard M-4, Audit item 8, the science underlying the maximum windspeeds in Form M-2.

Verified: YES

Professional Team Comments:

Discussed the dependence of the wind profile parameters X1 and N on Rmax and translation speed, as well as the other fixed parameters.

Reviewed the value of beta that relates the storm-moving to fixed reference frames.

Reviewed the time series model and the time steps sequence.

Discussed the data and process used to optimize and validate the parameters in the model's modified version of the Willoughby et al. (2006) windfield profile.

Reviewed the modified windfield profile equation and the values for the different parameters.

Discussed that windspeeds in Form M-2 are based on ZIP Code smoothed to a regular grid and open-terrain roughness length was applied to all areas over land.

Reviewed Form M-2 with more finely-resolved color bands.

Reviewed the variable resolution grid site coefficients for 90-degree wind direction.

Discussed the maximum windspeed locations for the 100-year and 250-year return periods for open terrain and actual terrain.

M-5 Hurricane Landfall and Over-Land Weakening Methodologies

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

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

Audit

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

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

3. The detailed transition of winds from over-water to over-land (i.e., hurricane landfall, boundary layer) will be reviewed. The region within 5 miles of the coast will be emphasized. Color-coded snapshot maps of roughness length and spatial distribution of over-land and over-water windspeeds for Hurricane Jeanne (2004), Hurricane Dennis (2005), and Hurricane Andrew (1992) at the closest time after landfall will be reviewed.

Verified: YES

Professional Team Comments:

Discussed no change in the model over-land weakening rate methodology.

Reviewed map of roughness coefficients and derivation from roughness lengths.

Reviewed maps of roughness length and spatial distribution of winds over-land and over-water for Hurricane Andrew (1992), Hurricane Jeanne (2004), and Hurricane Dennis (2005).

Reviewed variation of roughness coefficients with distance from coast.

M-6 Logical Relationships of Hurricane Characteristics

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

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

Audit

1. Form M-3, Radius of Maximum Winds and Radii of Standard Wind Thresholds, and the modeling organization sensitivity analyses will be reviewed.

2. Justification for the relationship between central pressure and radius of maximum winds will be reviewed. The relationships among intensity, Rmax, and their changes will be reviewed.

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

4. Methods (including any software) used in verifying these logical relationships will be reviewed.

Pre-Visit Letter

14. M-6, Disclosure 1, page 86: Provide the value of beta in the windfield construction. Explain its method of selection and provide any references.

Verified: YES

Professional Team Comments:

Reviewed the windfield profile parameter values and the method for selection.

Reviewed windfield plots illustrating asymmetry increasing with translation speed.

STATISTICAL STANDARDS – Mark Johnson, Leader

S-1 Modeled Results and Goodness-of-Fit

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

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

Audit

1. Forms S-1, Probability and Frequency of Florida Landfalling Hurricanes per Year, S-2A, Examples of Hurricane Loss Exceedance Estimates (2012 FHCF Exposure Data), S-2B, Examples of Hurricane Loss Exceedance Estimates (2017 FHCF Exposure Data), and S-3, Distributions of Stochastic Hurricane Parameters, will be reviewed. Justification for the distributions selected, including for example, citations to published literature or analyses of specific historical data, will be reviewed.

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

Pre-Visit Letter

21. S-1, Disclosure 3, page 89: Review the Hurricane Matthew (2016) insurance data.

22. S-1, Disclosure 6, page 96: Provide additional detail on the chi-square test results for Figure 38 that led to a p-value change from 0.48 to 0.24.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of open items.

Discussed that storm frequency was the only stochastic parameter updated in the current version of the model.

Reviewed the Hurricane Matthew (2016) claims data.

Reviewed the Chi-Square test methodology and the change in test results from the previous submission due to new storms added, reanalysis storm changes, and stochastic rate changes.

Discussed the appropriateness of using Kolmogorov-Smirnov goodness-of-fit tests for hurricane parameters.

Discussed the treatment of far-field pressure as a non-stochastic value.

Reviewed calculations of Chi-Square goodness-of-fit tests for translational speed.

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

Verified after resolution of open items.

S-2 Sensitivity Analysis for Hurricane Model Output

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

Audit

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

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

Verified: YES

Professional Team Comments:

Discussed annual standard sensitivity tests performed.

S-3 Uncertainty Analysis for Hurricane Model Output

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

Audit

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

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

Verified: YES

Professional Team Comments:

Discussed annual standard uncertainty analyses performed.

S-4 County Level Aggregation

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

Audit

1. A graph assessing the accuracy associated with a low impact area such as Nassau County will be reviewed. If the contribution error in an area such as Nassau County is small, the expectation is that the error in other areas would be small as well. The contribution of simulation uncertainty via confidence intervals will be reviewed.

Pre-Visit Letter

23. S-4, page 101: Provide the loss convergence evidence in support of Standard S-4.

Verified: YES

Professional Team Comments:

Reviewed the process for generating the ultimate size of the stochastic storm set.

Reviewed convergence results for Nassau, Lafayette, Holmes, Glades, Wakulla, and Walton Counties.

S-5 Replication of Known Hurricane Losses

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 both 2004 and 2005.

Audit

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

2. The following documentation will be reviewed:
    a. Publicly available documentation referenced in the submission in hard copy or electronic form,
    b. The data sources excluded from validation and the reasons for excluding the data from review by the Commission (if any),
    c. An analysis that identifies and explains anomalies observed in the validation data, and

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

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

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

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

Verified: YES

Professional Team Comments:

Reviewed validation comparisons of actual loss to modeled loss estimates given in Form S-4.

S-6 Comparison of Projected Hurricane Loss Costs

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

Audit

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

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

Pre-Visit Letter

24. S-6, Disclosure 1, page 105: Reconcile the number of hurricanes with the number of hurricanes given in Forms A-8A and A-8B.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of open items.

Reviewed the number of stochastic events relevant for various forms.

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

Reviewed Form S-5 results generated on the Risk Modeler 2.1 platform and compared with Form S-5 results generated on the primary RiskLink 18.1 (Build 1945) platform.

Verified after review of open items.

VULNERABILITY STANDARDS – Masoud Zadeh, Leader

V-1 Derivation of Building Hurricane Vulnerability Functions

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

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

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

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

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

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

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

Audit

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

2. Historical data in the original form will be reviewed with explanations for any changes made and descriptions of how missing or incorrect data were handled. When historical data is used to develop building hurricane vulnerability functions, the goodness-of-fit of the data will be reviewed. Complete

reports detailing loading conditions and damage states for any laboratory or field testing data used will be reviewed. When rational structural analysis is used to develop building hurricane vulnerability functions, such analyses will be reviewed for a variety of different building construction classes. Laboratory or field tests and original post-event site investigation reports will be reviewed.

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

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

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

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

7. Documentation and justification for all modifications to the building hurricane vulnerability functions due to statewide and county building codes and their enforcement will be reviewed. If year of construction and/or geographical location of building is used as a surrogate for building code and code enforcement, complete supporting information for the number of year of construction groups used as well as the year(s) and/or geographical region(s) of construction that separates particular group(s) will be reviewed.

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

9. The effects on building hurricane vulnerability from local and regional construction characteristics and statewide and county building codes will be reviewed including whether current statewide and county building codes are reflected.

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

11. The percentage of damage at or above which the hurricane model assumes a total structure loss will be reviewed.
12. A plot comparing building structure and appurtenant structure hurricane vulnerability functions will be reviewed.

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

14. Form V-1, One Hypothetical Event, will be reviewed.

Pre-Visit Letter

25. V-1, Disclosure 3, pages 108-110: Provide the additional claims data. Explain how it was incorporated into the current model.

26. V-1, Disclosure 4, pages 110-111: Explain the method and data used to develop mean damage ratio-coefficient of variation relationships. Provide the number and examples of such relationships.

27. V-1, Disclosure 6, page 113: Explain the 493 building vulnerability classes and how they relate to Table 15. Explain the no "unknown" for Year of Construction for Manufactured Homes. Explain the basis for 2008/2009-year band for Manufactured Homes.

28. V-1.D, page 106 and Disclosures 6 and 7, pages 113-114: Provide research, if any, with regards to Florida Building Code 2014 and Florida Building Code 2017, conclusions drawn, and the impact on the current model.

29. V-1, Disclosure 9, page 115: Explain the logic when input data are conflicting and how the logic is implemented.

30. V-1, Disclosure 12, page 116: Explain the "options specifically designed to alter/eliminate water infiltration when the roof cover fails (secondary water resistance)."

33. Form V-1, pages 204-205: Explain how Form V-1 was completed with respect to the current model.

34. Form V-1, page 204: Explain the similarity between mean Manufactured Home damage ratios and Wood Frame and Masonry damage ratios.

Commission Issues:

1. For Standard V-1, Audit item 7, how the county as well as statewide building codes are reflected in the model vulnerability functions.

2. For Standard V-1, Audit item 9, how the building codes are reflected in the model vulnerability functions, including whether current statewide and county building codes are incorporated.

3. Justification if the high-velocity hurricane zone included in the statewide Florida Building Code is not reflected in the model vulnerability functions.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of open items.

Reviewed the new claims data received from Hurricane Matthew (2016).

Reviewed plot of the mean damage ratio-coefficient of variation (MDR-CV) vulnerability curves representing the different combinations of primary characteristics.

Discussed that claims data from the 2004 and 2005 Florida landfalling hurricanes from multiple clients were used to develop the MDR-CV relationships.

Reviewed examples of MDR-CV data analyses for year built and construction type.

Reviewed samples of the 493 building vulnerability classes by occupancy, construction class, number of stories, year band, and floor area.

Reviewed an updated Table 15 revised to include unknown year built for manufactured homes and unknown floor area.

Discussed the basis for the post-2009 year band for manufactured homes.

Reviewed the process for selecting appropriate vulnerability curves when input data are conflicting. Reviewed flowchart for vulnerability curve selection.

Discussed the secondary modifier options for roof cover addressing secondary water resistance.

Reviewed North Atlantic Hurricane Models Secondary Modifiers Reference Guide Version 18.1 secondary modifier descriptions section.

Reviewed the process for completing Form V-1. Discussed the mean damage ratios for manufactured home, wood frame, and masonry.

Discussed modeler research and analysis of the 2014 and 2017 Florida Building Codes (FBC) and determination not to include a new year-built band.

Discussed that local building code amendments and enforcement are included as long as they are more stringent than the FBC.

Discussed the impact on vulnerability of the changes in FBC 2014 and FBC 2017 compared to FBC 2010.

Discussed modeler research of Florida county building code ordinances. Reviewed FBC amendments adopted by Miami-Dade and Palm Beach Counties which improve building performance and are accounted for in the model year-built bands and vulnerability regions.

Discussed that building codes are reflected in the vulnerability curves through the four year-built bands and six vulnerability regions.

Reviewed map of the high velocity hurricane zone (Miami-Dade and Broward counties) implemented in the model.

Reviewed the manufactured home vulnerability functions for HUD Zones.

Reviewed the year-built bands for manufactured homes.

Discussed that users cannot modify the vulnerability curves and secondary modifier functions supplied in the model.

Reviewed Form A-6.

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

Reviewed the year and floor area bands in the Analysis Summary Reports for RiskLink 18.1 (Build 1945) and Risk Modeler 2.1. Discussed the differences among the reports and what was given in Table 15 under V-1, Disclosure 6. Reviewed a revised Table 15 updating the floor area values as implemented in the model.

Verified after review of open items.

V-2 Derivation of Contents and Time Element Hurricane Vulnerability Functions*

*(*Significant Revision)*

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

B. The relationship between the modeled building and contents hurricane vulnerability functions and historical building and contents hurricane losses shall be reasonable.

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

D. The relationship between the hurricane model building, contents, and time element hurricane vulnerability functions and historical building, contents, and time element hurricane losses shall be reasonable.

E. Time element hurricane vulnerability functions used by the hurricane model shall include time element hurricane losses associated with wind, missile impact, flood, and storm surge damage to the infrastructure caused by a hurricane.

Audit

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

2. Multiple samples of contents and time element hurricane vulnerability functions will be reviewed.

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

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

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

6. Documentation and justification of the following aspects or assumptions related to contents and time element hurricane vulnerability functions will be reviewed:
    a. The method of derivation and underlying data,
    b. Validation data specifically applicable to time element hurricane vulnerability,
    c. Coding of time element by insurers,
    d. The effects of demand surge on time element for the 2004 and 2005 hurricane seasons,
    e. Variability of time element hurricane vulnerability by building classification and characteristics,
    f. Statewide application of time element coverage,
    g. Time element vulnerability for various occupancies,
    h. The methods used to estimate the time, including uncertainty, required to repair or replace the property, and
    i. The methodology and validation for determining the extent of infrastructure damage and their effect on time element hurricane vulnerability.

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

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

Pre-Visit Letter

31. V-2.C, page 117: Demonstrate how "the time required to repair or replace a property used in the derivation of the time element vulnerability functions is inferred from the ratio of the time element claims and exposure values reported by insurance companies."

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of open items.

Discussed that time-element vulnerability is implemented through functional restoration times.

Reviewed the relationship between time element loss ratio and building damage ratio.

Reviewed comparison of time element damage ratio to building damage ratio based on insurance claims data.

Reviewed contents mean damage ratio and building mean damage ratio relationships for single-family dwelling, multi-family dwelling frame and masonry 1-story and 2+ stories, and commercial residential and steel 4+ stories.

Reviewed claims data on contents and comparisons to modeled contents vulnerability functions.

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

Verified after review of open items.

V-3 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 their 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 consider:

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

The modeling organization shall justify all hurricane mitigation measures considered by the hurricane model.

B. 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.

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

Audit

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

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

5. Implementation of individual hurricane mitigation measures and secondary characteristics will be reviewed as well as the effect of individual hurricane mitigation measures and secondary characteristics on damage. Any variation in the change over the range of windspeeds for individual hurricane mitigation measures and secondary characteristics will be reviewed. Historical data, technical literature, analysis

or judgment based on fundamental engineering principles used to support the assumptions and implementation of the hurricane mitigation measures and secondary characteristics will be reviewed.

6. 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 over the range of windspeeds for multiple hurricane mitigation measures and secondary characteristics will be reviewed.

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

Pre-Visit Letter

32. V-3, Disclosure 7, page 129: Explain the response in detail for bullets 1 and 2 and show they are implemented in the model.

35. Form V-2, page 207: Explain how Form V-2 was completed with respect to the current model.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of open items.

Discussed the Insurance Institute for Business and Home Safety (IBHS) Fortified Commercial hurricane standards released in 2017.

Reviewed the updated model fortified options to include select multi-family dwellings and commercial occupancies.

Reviewed new secondary modifier options for multi-family dwellings.

Reviewed fortified commercial modifier curves for multi-family dwellings and the underlying data.

Reviewed the Secondary Modifier Reference Guide.

Reviewed the impact on uncertainty of the vulnerability affected by secondary modifier options.

Reviewed an example of reduction of uncertainty on a vulnerability function.

Reviewed the process for completing Form V-2. Discussed differences from the previous submission Form V-2.

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

Reviewed Form V-2 results generated by the model using RiskLink 18.1 (Build 1945) and using Risk Modeler 2.1. Reviewed the absolute deviation in change in damage between the two results demonstrating functional equivalence.

Verified after review of open items.

ACTUARIAL STANDARDS – Stuart Mathewson, Leader

A-1 Hurricane Modeling 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.

Audit

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

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

Pre-Visit Letter

36. A-1, page 130: Explain how the input and output forms demonstrate that there is no requested or implemented, respectively, storm surge, storm frequency adjustment, or capability of the user to alter the meteorology, vulnerability, or actuarial components with reference to storm surge or storm frequency. (Commissioner Robert Lee review item)

37. A-1, Disclosure 5, page 132: Provide the current and previous table of relevant annual deductible factors.

Verified: YES

Professional Team Comments:

Discussed the actuary's statement that the model is actuarially sound and the thought process the actuary used when determining actuarial soundness.

Reviewed sample Analysis Summary Report indicating the user inputs settings.

Discussed that users cannot modify the vulnerability curves and secondary modifier functions supplied in the model.

Discussed that users can use different sets of simulated storm frequencies for analysis.

Reviewed the current and previous annual deductible factors provided by ZIP Code and by Type of Business.

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

Reviewed example model input and output forms for RiskLink 18.1 and Risk Modeler 2.1 identifying the model version and the profile settings.

Reviewed comparison between the Detailed Loss Model (DLM) profile in the RiskLink 18.1 platform and the Model profile in the Risk Modeler 2.1 platform.

Reviewed comparison between the output forms for RiskLink 18.1 and Risk Modeler 2.1.

Reviewed comparison between the Post Import Summary report for RiskLink 18.1 and Risk Modeler 2.1.

Discussed the differences and enhancements made in Risk Modeler 2.1.

A-2 Hurricane Events Resulting in Modeled Hurricane Losses*

*(*Significant Revision)*

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

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

Audit

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

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

3. The hurricane model will be reviewed to determine whether the hurricane model takes into account any damage resulting directly and solely from flood or hurricane storm surge. Hurricane losses associated with wind damage will be reviewed to determine the treatment of flood and hurricane storm surge.

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

Pre-Visit Letter

38. A-2.B, page 134: Provide a hard copy of the documented procedure.

Verified: YES

Professional Team Comments:

Reviewed the Windstorm Claims & Exposure Data Requirements documentation provided to clients when RMS issues a data call. Discussed the different claims data requirements and exposure data requirements.

Reviewed the procedure for separating hurricane claims affected by storm surge. Reviewed the claims analysis for Hurricane Ivan (2004).

A-3 Hurricane Coverages

A. The methods used in the calculation of building hurricane loss costs shall be actuarially sound.

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

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

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

Audit

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

2. The treatment of law and ordinance coverage will be reviewed. If it is not modeled, justification will be reviewed.

Pre-Visit Letter

39. A-3, Disclosures 1-4, pages 135-136: Show a calculation of loss costs and probable maximum loss levels for the minimum Masonry Owners loss costs in Form A-1 (i.e., ZIP Code 32331 in Madison County).

Verified: YES

Professional Team Comments:

Reviewed example calculation of loss costs and probable maximum loss levels for a particular ZIP Code from Form A-1.

Reviewed RMS Exceedance Probability Methodology documentation.

Discussed the calculation of Occurrence Exceedance Probability (OEP) curves and Annual Exceedance Probability (AEP) curves.

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

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 hurricane storm surge losses.

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

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

Audit

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

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

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

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

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

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

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

Pre-Visit Letter

40. A-4, Disclosure 1, page 137: Provide, in Excel, tables of 1,000 years descending from the Top Event corresponding to Forms A-8A and A-8B. For each year, show the value of each hurricane separately.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of open items.

Discussed that there was no impact on the demand surge factors related to the updates to the Industry Exposure Database (IED) and industry loss curves (ILC).

Reviewed the top 1,000 storms sorted by loss, and discussed the consistency with Forms A-8A and A-8B.

Discussed the date of the exposure used for loss validation.

Reviewed the data and methods used in the calculation of demand surge. Discussed no change in the demand surge methodology.

Discussed the impact of demand surge on loss cost estimates.

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

Verified after review of open items.

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.

Audit

1. The process used to determine the accuracy of the insurance-to-value criteria in data used to develop and validate the hurricane model results will be reviewed.

2. To the extent that insurance claims data are used to develop mathematical depictions of deductibles, policy limits, policy exclusions, and loss settlement provisions, the goodness-of-fit of the data to fitted models will be reviewed.

3. To the extent that insurance claims data are used to validate the hurricane model results, the treatment of the effects of deductibles, policy limits, policy exclusions, loss settlement provisions, and coinsurance in the data will be reviewed.

4. Treatment of annual deductibles will be reviewed.

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

Pre-Visit Letter

41. A-5, Disclosure 3, page 141: Explain the calculation of Insurance Hurricane Loss.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of open items.

Reviewed the annual deductible calculation.

Discussed the order of application for hurricane deductibles and policy limits.

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

Verified after review of open items.

A-6 Hurricane Loss Outputs and Logical Relationships to Risk

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Audit

1. The data and methods used for hurricane probable maximum loss levels for Form A-8A, Hurricane Probable Maximum Loss for Florida (2012 FHCF Exposure Data), and Form A-8B, Hurricane Probable Maximum Loss for Florida (2017 FHCF Exposure Data), will be reviewed. The hurricane associated with the Top Events will be reviewed.

2. The frequency distribution and the individual event severity distribution, or information about the formulation of events, underlying Form A-8A, Hurricane Probable Maximum Loss for Florida (2012 FHCF Exposure Data), and Form A-8B, Hurricane Probable Maximum Loss for Florida (2017 FHCF Exposure Data), will be reviewed.

3. The first and second moments of the Annual Aggregate and Annual Occurrence distributions underlying the tables in Form A-8A, Hurricane Probable Maximum Loss for Florida (2012 FHCF Exposure Data), and Form A-8B, Hurricane Probable Maximum Loss for Florida (2017 FHCF Exposure Data), will be reviewed.

4. The first and second moments of the frequency and severity distributions, or similar information about the event distributions, underlying the hurricane probable maximum loss levels shown in Parts B and C in Form A-8A, Hurricane Probable Maximum Loss for Florida (2012 FHCF Exposure Data), and Form A-8B, Hurricane Probable Maximum Loss for Florida (2017 FHCF Exposure Data), will be reviewed.

5. All referenced literature will be reviewed, in hard copy or electronic form, to determine applicability.

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

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

8. 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 Standard A-6, Hurricane Loss Outputs and Logical Relationships to Risk, will be reviewed. Forms A-1, Zero Deductible Personal Residential Hurricane Loss Costs by ZIP Code, A-2A, Base Hurricane Storm Set Statewide Hurricane Losses (2012 FHCF Exposure Data), A-2B, Base Hurricane Storm Set Statewide Hurricane Losses (2017 FHCF Exposure Data), A-3A, 2004 Hurricane Season Losses (2012 FHCF Exposure Data), A-3B, 2004 Hurricane Season Losses (2017 FHCF Exposure Data), A-6, Logical Relationship to Hurricane Risk (Trade Secret Item), and A-7, Percentage Change in Logical Relationship to Hurricane Risk, will be reviewed to assess coverage relationships.

9. The hurricane loss cost relationships among deductible, policy form, construction type, coverage, building code/enforcement, building strength, condo unit floor, number of stories, territory, and region will be reviewed.

10. The total personal and commercial residential insured hurricane losses provided in Forms A-2A, Base Hurricane Storm Set Statewide Hurricane Losses (2012 FHCF Exposure Data), A-2B, Base Hurricane Storm Set Statewide Hurricane Losses (2017 FHCF Exposure Data), A-3A, 2004 Hurricane Season Losses (2012 FHCF Exposure Data), and A-3B, 2004 Hurricane Season Losses (2017 FHCF Exposure Data), will be reviewed individually for total personal residential and total commercial residential insured hurricane losses.

11. Forms A-4A, Hurricane Output Ranges (2012 FHCF Exposure Data), A-5, Percentage Change in Hurricane Output Ranges (2012 FHCF Exposure Data), and A-4B, Hurricane Output Ranges (2017 FHCF Exposure Data), will be reviewed, including geographical representations of the data where applicable.

12. Justification for all changes in hurricane loss costs based on the 2012 FHCF Exposure Data from the previously-accepted hurricane model will be reviewed.

13. Form A-4A, Hurricane Output Ranges (2012 FHCF Exposure Data), and Form A-4B, Hurricane Output Ranges (2017 FHCF Exposure Data), will be reviewed to ensure appropriate relativities among deductibles, coverages, and construction types.

14. Apparent anomalies in the hurricane output ranges and their justification will be reviewed.

Pre-Visit Letter

42. A-6, Disclosure 19, page 145: Explain how the model would handle two examples for a commercial residential property with a $1 million value:
    a. 80% coinsurance clause with $600,000 policy limit
    b. First loss policy with $500,000 policy limit

    Include discussion of the inputs to the system.

43. Form A-1, pages 213-215: Explain the county changes from the previous submission for ZIP Codes 00053, 32455, 32461, 32645, and 33559.

44. Form A-1, pages 213-215: Explain the change in loss costs for ZIP Codes in Holmes County versus the results given in Figure 7 (page 41).

45. Form A-1, page 215: Explain the results in Franklin and adjacent counties in Figure 73.

46. Forms A-2A and A-2B, pages 216-223: Reconcile the decrease in the totals from Form A-2A to Form A-2B. Explain why Hurricane Charley (2004) increases from A-2A to A-2B.

47. Form A-2B, page 221: Explain the loss costs for NoName02 (1919).

48. Forms A-4A and A-4B, pages 283-313: Explain the weighting procedure used to determine the county averages for DeSoto and Gulf Counties.

49. Form A-4B, 0% Deductible, pages 300-306: Explain, in general, how the apparent anomalies in the shaded areas were resolved. In particular, explain the following cases for Frame loss costs less than Masonry loss costs:
    Owners: Santa Rosa Low, Wakulla Average, Walton Low
    Renters: Liberty Low, Wakulla Average
    Condo Unit: Okaloosa Low, Wakulla Low

50. Form A-4B, page 309: Explain how Commercial Residential is given as NA for Hardee County.

51. Form A-4B, page 301: With Form A-1 having only two ZIP Codes for Glades County (33471 and 33944), explain the values given in Form A-4B for Glades County Low, Average, and High for Frame Owners, Masonry Owners, and Manufactured Homes.

52. Form A-4B, page 303: With Form A-1 having only two ZIP Codes for Lafayette County (32013 and 32066) with "close" loss costs, explain the values given in Form A-4B for Lafayette County Low, Average, and High for Frame Owners, Masonry Owners, and Manufactured Homes.

53. Form A-4B, page 304: With Form A-1 having only three ZIP Codes for Okeechobee County (34972, 34973, and 34974), explain the values given in Form A-4B for Okeechobee County Low, Average, and High for Frame Owners, Masonry Owners, and Manufactured Homes.

54. Form A-5, pages 316-324: Explain the driving force for the double digit decreases in Lafayette County in multiple categories.

55. Forms A-8A and A-8B, pages 339-345: Explain the calculation of Expected Annual Hurricane Losses in Part A.

56. Forms A-8A and A-8B, pages 339-346: Explain the categorization of the data between Contents and Buildings for Condo Unit Owners and Renters.

57. Forms A-8A and A-8B, pages 340 and 345: Reconcile the total number of hurricanes.

Commission Issue:

5. Form A-6, Building Code/Enforcement (Year Built) Sensitivities, in particular for Manufactured Homes.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of open items.

Discussed the actuary's explanation of the methodology for producing loss costs and probable maximum loss levels.

Reviewed examples of how the model handles coinsurance.

Reviewed the ZIP Code changes in Form A-1 from the previous submission.

Discussed that the changes in Form A-1 in Holmes County were driven by the county reassignment of a ZIP Code.

Reviewed the results in Form A-1 for Franklin County and adjacent counties.

Discussed the decrease in losses from Form A-2A to Form A-2B related to changes in the FHCF exposure data. Discussed the results for Hurricane Charley (2004) in Forms A-2A and A-2B.

Discussed the loss costs for NoName02 (1919).

Reviewed the weighting procedure used for determining the county averages across all lines of business in DeSoto and Gulf Counties.

Reviewed the process used to identify apparent anomalies in the output ranges. Reviewed several examples all of which were resolved.

Discussed the reason for removing the one commercial residential exposure record in Hardee County in Form A-4B, resulting in an N/A in the form.

Reviewed the results for Glades County, Lafayette County, and Okeechobee County across all lines of business in Form A-1 and Form A-4B.

Reviewed the results for Lafayette County in Form A-5.

Reviewed the calculation of Expected Annual Hurricane Losses in Part A of Forms A-8A and A-8B.

Reviewed the differences in number of hurricanes included in Form A-8A and Form A-8B.

Reviewed Form A-6.

Discussed the 0.0% changes in Form A-7. A new Form A-7 with no rounding was provided which no longer showed 0.0% changes for any exhibits.

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

Reviewed Form A-1 results generated by the model using RiskLink 18.1 (Build 1945) and using Risk Modeler 2.1. Reviewed the absolute change in loss costs between the two results demonstrating functional equivalence.

Reviewed Form A-4B results generated by the model using RiskLink 18.1 (Build 1945) and using Risk Modeler 2.1. Reviewed the absolute change in loss costs between the two results demonstrating functional equivalence.

Reviewed Form A-8B results generated by the model using RiskLink 18.1 (Build 1945) and using Risk Modeler 2.1. Reviewed the percentage change in losses between the two sets of results demonstrating functional equivalence.

Verified after review of open items.

COMPUTER/INFORMATION 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 letters, slides, and unformatted text files.

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

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

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

Audit

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

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

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

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

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

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

7. The tables specified in CI-1.D that contain the items listed in Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 5 will be reviewed. The tables should contain the item number in the first column. The remaining five columns should contain specific document or file references for affected components or data relating to the following Computer/Information Standards: CI-2, Hurricane Model Requirements, CI-3, Hurricane Model Architecture and Component Design, CI-4, Hurricane Model Implementation, CI-5, Hurricane Model Verification, and CI-6, Hurricane Model Maintenance and Revision.

8. Tracing of the hurricane model changes specified in Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 5 and Audit 5 through all Computer/Information Standards will be reviewed.

Pre-Visit Letter

58. CI-1.B, page 146: Relate the primary binder table of contents with the response to Standard G-1, Disclosure 5 (pages 36-41) by demonstrating individual table item compliance with Computer/Information Standards CI-1 through CI-7.

59. CI-1.D, page 146: Provide the table required by Standard CI-1, Audit Item 7.

60. CI-1.F, page 147: Provide the list of all externally acquired hurricane model-specific software and data assets required by Standard CI-1, Audit Item 6.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Reviewed a table required by Standard CI-1, Audit item 7.

Reviewed the list of all externally acquired model specific software and data assets as described by Standard CI-1, Audit item 6.

Discussed the tools used to maintain documentation.

Reviewed the 2017 FHCF EDM Development Overview documenting the process used for processing the FHCF exposure data.

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

Verified after resolution of open items.

CI-2 Hurricane Model Requirements

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

Audit

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

Pre-Visit Letter

61. CI-2, pages 148-149: Provide requirements documentation that specifically relates to each model change identified in Standard G-1, Disclosure 5 (pages 36-41).

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Verified that the requirements were consistent with the changes in the model identified by Standard G-1 Disclosure 5.

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

Verified after resolution of open items.

CI-3 Hurricane Model Architecture and Component Design*

*(*Significant Revision)*

A. The modeling organization shall maintain and document (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, and (4) system model representations associated with (1)-(3). 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) shall be based on (1) a referenced industry standard (e.g., Unified Modeling Language (UML), Business Process Model and Notation (BPMN), Systems Modeling Language (SysML)), or (2) a comparable internally-developed standard which is separately documented.

Audit

1. The following will be reviewed:
    a. Detailed control and data flowcharts, completely and sufficiently labeled for each component,
    b. Interface specifications for all components in the hurricane model,
    c. Documentation for schemas for all data files, along with field type definitions,
    d. Each network flowchart including components, sub-component flowcharts, arcs, and labels, and
    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).

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

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

Pre-Visit Letter

62. CI-3.B, page 150: Provide the required document.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending review of open items.

Reviewed flowcharts describing control and data flows in the model and for generating submission forms.

Reviewed the RMS Flow Diagram Standard.

Reviewed the flowcharting standard compliance.

Reviewed revised flowcharting standards.

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

Reviewed the revised data flow diagram for completing Form A-7 in RiskLink 18.1 and in Risk Modeler 2.1.

Reviewed revised flowcharting standards for further clarifications.

Verified after review of open items.

CI-4 Hurricane Model Implementation

A. The modeling organization shall maintain a complete procedure of coding guidelines consistent with accepted software engineering practices.

B. The modeling organization shall maintain a complete procedure used in creating, deriving, or procuring and verifying databases or data files accessed by components.

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

D. The modeling organization shall maintain a table of all software components affecting hurricane loss costs and hurricane probable maximum loss levels 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.

E. 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.

F. The modeling organization shall maintain the following documentation for all components or data modified by items identified in Standard G-1, Scope of the Hurricane Model and Its Implementation, Disclosure 5 and Audit 5:

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

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

Audit

1. The interfaces and the coupling assumptions will be reviewed.

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

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

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

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

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

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

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

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Reviewed selected scripts and code for processing the FHCF exposure data.

Reviewed code and variable mapping for implementation of the modified Willoughby profile.

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

Reviewed the floor area input database.

Verified after resolution of open items.

CI-5 Hurricane Model Verification

A. General

For each component, the modeling organization shall maintain procedures 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. ***The modeling organization shall use testing software to assist in documenting and analyzing all components.***

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

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

4. ***Aggregation 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. ***The modeling organization shall use testing software to assist in documenting and analyzing all databases and data files accessed by components.***

2. ***The modeling organization shall perform and document integrity, consistency, and correctness checks on all databases and data files accessed by the components.***

Audit

1. 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.

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

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

4. 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.

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

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

Pre-Visit Letter

63. CI-5, pages 154-156: Provide complete and thorough verification procedures and output from the model changes identified in Standard G-1, Disclosure 5 (pages 36-41).

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Reviewed model verification methods.

Reviewed Test Plan for 2018 FCHLPM Actuarial Form Output documentation.

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

Verified after resolution of open items.

CI-6 Hurricane Model Maintenance and Revision

A. The modeling organization shall maintain a clearly written policy for hurricane model review, maintenance, and revision, including verification and validation of revised components, databases, and data files.

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

C. The modeling organization shall use tracking software to identify and describe all errors, as well as modifications to code, data, and documentation.

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

Audit

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

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

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

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

5. The list of all hurricane model revisions as specified in CI-6.D will be reviewed.

Pre-Visit Letter

64. CI-6.D, page 158: Provide the model version history over the past 5 years, leading up to the version identified in the submission.

Verified: ~~NO~~ YES

Professional Team Comments:

Not verified pending verification of other standards.

Reviewed table of model version history over the past 5 years.

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

Reviewed list of model versions available to run on the new software platform Risk Modeler 2.1 broken down by peril and region.

Reviewed revised policy for model revision to be consistent with the architecture of Risk Modeler 2.1 on Risk Intelligence.

Verified after resolution of open items.

CI-7 Hurricane Model Security

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

Audit

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

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

Verified: YES

Professional Team Comments:

Reviewed the modeler's security policy.

Discussed no known security breaches since the previously-accepted model.