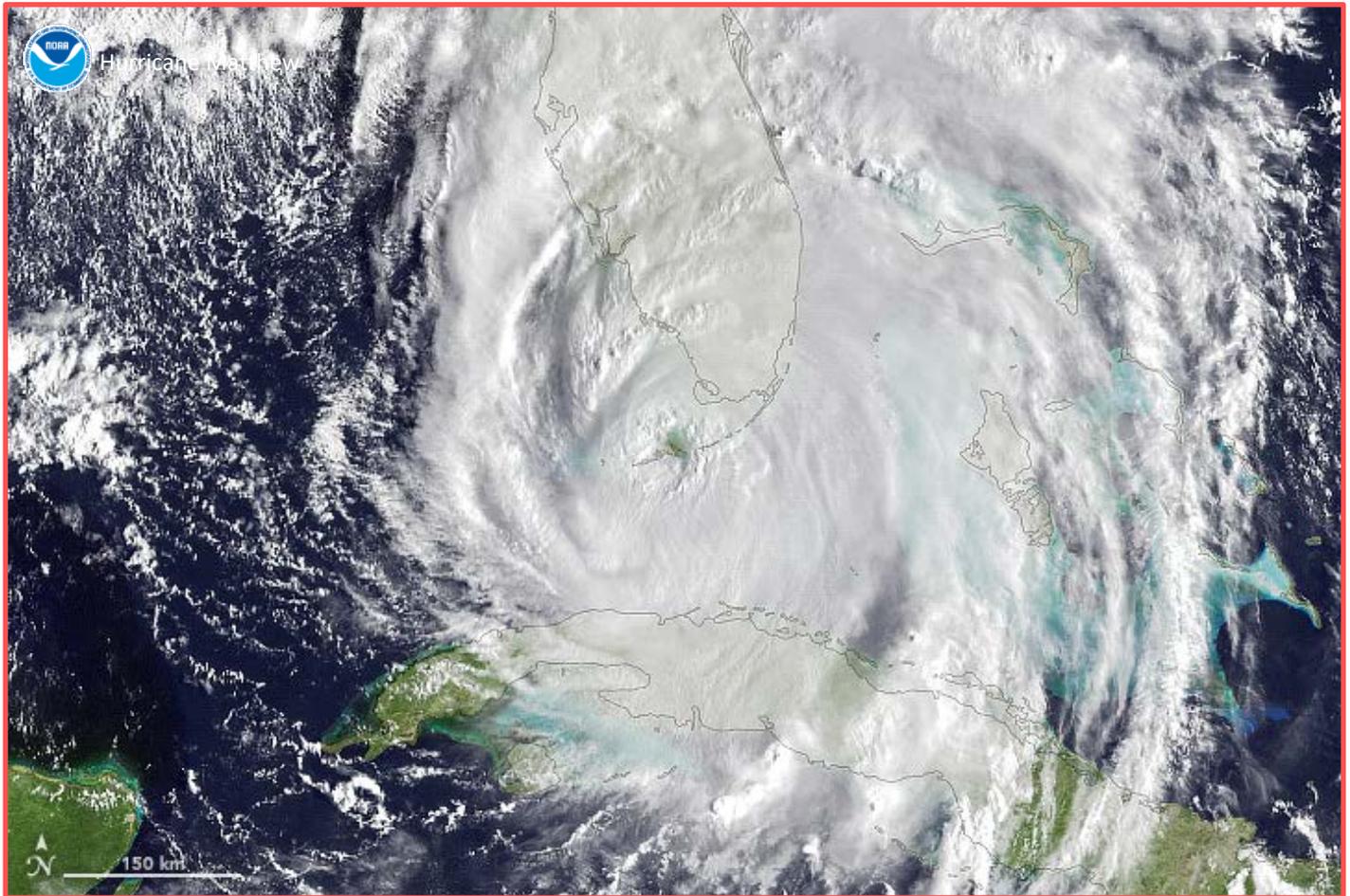# Florida Commission on Hurricane Loss Projection Methodology

Professional Team Report
2017 Hurricane Standards

Florida Public Hurricane Loss Model
Florida International University

On-Site Review
February 18-20, 2019

Additional Verification Review: April 29-30, 2019

On February 18-20, 2019, the Professional Team visited Florida International University (FIU) in Miami, Florida to review the Florida Public Hurricane Loss Model. The following individuals participated:

FIU

Bachir Annane, Senior Research Associate III, CIMAS/HRD

Hector Cen, Research Assistant, Florida International University

Shu-Ching Chen, Ph.D., Professor, Director, Distributed Multimedia Information Systems
    Laboratory, School of Computing and Information Sciences, College of Engineering and
    Computing, Florida International University

Steve Cocke, Ph.D., Scholar/Scientist, Department of Meteorology and COAPS,
    Florida State University

Josemar Faustino Da Cruz, Ph.D. Candidate in Computer Science, Florida Institute of Technology

Gail Flannery, FCAS, MAAA, Consulting Actuary, AMI Risk Consultants, Inc., Miami, Florida

Raul Garcia, M.S. Computer Science student, Software Engineer, Florida International University

Kurt Gurley, Ph.D., Associate Professor, Department of Civil and Coastal Engineering, College
    of Engineering, University of Florida

Shahid Hamid, Ph.D., CFA, Professor and Chairman Department of Finance, College of Business,
    Florida International University

Mahmood Khan, Ph.D. Candidate in Civil Engineering Hydrology, West Virginia University

Golam Kibria, Ph.D., Professor, Mathematics and Statistics, College of Arts and Sciences, Florida
    International University

Yuepeng Li, Ph.D., Research Scientist, Laboratory for Coastal Research, Florida International
    University

Diana Machado, M.S. Computer Science student, Software Engineer, Florida International
    University

Andres Paleo, Ph.D. Candidate, University of Florida Engineering

Jean-Paul Pinelli, Ph.D., P.E., Professor, Civil Engineering Department, Florida Institute of
    Technology

Samira Pouyanfar, Ph.D. Computer Science Candidate, Florida International University

Maria Presa Reyes, Ph.D. Computer Science student, Florida International University

Dongwook Shin, Ph.D., Associate Research Scientist, Florida State University

Mei-Ling Shyu, Professor, Electrical and Computer Engineering, College of Engineering,
    University of Miami

Mehedi Hason Tarek, Ph.D. Candidate in Civil Engineering Hydrology, West Virginia University

Yudong Tao, M.S. Student, Electrical and Computer Engineering, College of Engineering,
    University of Miami

Haiman Tian, Ph.D. Computer Science Candidate, Florida International University

Tianyi Wang, Ph.D. Candidate in Computer Science, Florida International University

Wensong Wu, Ph.D., Associate Professor, Statistics, Florida International University

Karthik Yarasuri, Ph.D. Candidate, University of Florida Engineering

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. FIU provided a general overview of the model. FIU then provided an explanation of the error in completing Forms A-3A and A-3B as reported to the Commission on February 4, 2019. The error involved a misalignment of losses for some of the ZIP Codes in the forms. The total losses and associated maps were not affected. FIU discussed how the error was discovered and the changes implemented to prevent a recurrence of the error.

FIU discussed the changes in Florida Public Hurricane Loss Model 6.3 resulting in a 2.44% increase in modeled loss costs:
1. Update to the recent version of HURDAT2 (May 1, 2018) including storms through the 2017 hurricane season.
2. Update to the ZIP Code database to April 2017 ZIP Code boundaries.
3. Update to ZIP Code centroid locations.

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 5 of this report, FIU is to present the following information to the Commission during the meeting to review the model for acceptability:
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 research and analysis results on changes to the 2014 and 2017 Florida Building Codes.

Additional Verification Review – April 29 & 30, 2019

FIU submitted additional revisions to the original November 2018 submission on April 1, 2019. The Professional Team completed an additional verification review of Florida Public Hurricane Loss Model 7.0 on April 29 & 30, 2019 in Miami.

The following individuals participated in the additional verification review.

FIU
Bachir Annane, Senior Research Associate III, CIMAS/HRD
Shu-Ching Chen, Ph.D., Professor, Director, Distributed Multimedia Information Systems
    Laboratory, School of Computing and Information Sciences, College of Engineering and
    Computing, Florida International University
Steve Cocke, Ph.D., Scholar/Scientist, Department of Meteorology and COAPS,
    Florida State University
Gail Flannery, FCAS, MAAA, Consulting Actuary, AMI Risk Consultants, Inc., Miami, Florida
Raul Garcia, M.S. Computer Science student, Software Engineer, Florida International University
Kurt Gurley, Ph.D., Associate Professor, Department of Civil and Coastal Engineering, College
    of Engineering, University of Florida
Shahid Hamid, Ph.D., CFA, Professor and Chairman Department of Finance, College of Business,
    Florida International University

Golam Kibria, Ph.D., Professor, Mathematics and Statistics, College of Arts and Sciences, Florida International University

Yuepeng Li, Ph.D., Research Scientist, Laboratory for Coastal Research, Florida International University

Diana Machado, M.S. Computer Science student, Software Engineer, Florida International University

Daniel Martinez, Student Assistant, Florida International University

Jean-Paul Pinelli, Ph.D., P.E., Professor, Civil Engineering Department, Florida Institute of Technology

Dongwook Shin, Ph.D., Associate Research Scientist, Florida State University

Mei-Ling Shyu, Professor, Electrical and Computer Engineering, College of Engineering, University of Miami

Haiman Tian, Ph.D. Computer Science Candidate, Florida International University

Tianyi Wang, Ph.D. Candidate in Computer Science, Florida International University

Wensong Wu, Ph.D., Associate Professor, Statistics, Florida International University

Professional Team
Paul Fishwick, Ph.D., Computer Scientist
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 additional verification review began with a discussion on the model and processing changes to exclude law and ordinance coverage for personal residential loss costs as given in the modeled specifications for Forms A-1, A-4A, and A-4B. During the 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 G-1, Disclosure 4 (pages 76-96)
   Incomplete as the South Florida Building Code 1961 and 1994 references cited in the submission are not given in the Vulnerability Standards reference list.

2. Standard G-3, Disclosure 5 (page 117)
   Non-responsive as a description of the process for updating wind-borne debris and roughness ZIP Code-based databases is not given.

3. Standard V-1.E (page 186)
   Incomplete regarding hurricane vulnerability functions.

4. Forms A-4A.C and D (Appendix G, page 408) and A-4B.C and D (Appendix H, page 429)
    Non-responsive as a list of ZIP Codes for which there are hurricane loss costs but no exposure or a list of ZIP Codes for which there are no hurricane loss costs but there is exposure are not given or addressed.

Discussion on Issues

The Professional Team reviewed in detail the following issues identified by the Commission at the January 7, 2019 meeting. The modeling organization 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 20, G-1.B – Figure 1 revised to conform to modeler flowchart standards.
2. Page 22, G-1, Disclosure 2 – Language added to clarify date of year as part of stochastic track initialization.
3. Pages 37-62, G-1, Disclosure 2 – Figures 10, 11, 17, and 18 revised to conform to flowchart standards.
4. Pages 64-65, G-1, Disclosure 2 – Text removed to clarify procedure for calculating expected losses.
5. Page 80, G-1, Disclosure 4 – Florida Building Commission Analysis of Changes in the Florida Building Code references added.
6. Page 97, G-1, Disclosure 4 – Computer Science Standards updated to Computer/Information Science Standards.
7. Page 103, G-1, Disclosure 5.B – Disclosure wording updated; added updates to ZIP Code databases.
8. Page 105, G-1, Disclosure 5.C – Reference to HURDAT2 corrected in Figure 20.
9. Page 113, G-2, Disclosure 2.C – Figure 24 revised to conform to flowchart standards.
10. Page 117, G-3, Disclosure 1 – Language added to clarify the wind speed correction module.
11. Page 117, G-3, Disclosure 3 – Language added on how the geocoding tool is used.
12. Page 117, G-3, Disclosure 4 – Language added on the classification of coastal/inland for each ZIP Code.
13. Page 117, G-3, Disclosure 5 – Language added to clarify the two databases for the WBDR list of ZIP Codes.
14. Page 133, M-4, Disclosure 6 – Roughness values lookup table reference added.
15. Page 136, M-4, Disclosure 10 – Language edited to accommodate revised Form M-2.
16. Page 137, M-5.A – Text updated to delete "recent."
17. Pages 147-148, S-1, Disclosure 1 – Language associated with the inappropriate K-S goodness-of-fit tests removed.
18. Pages 156-157, S-1, Disclosure 4 – Tables 14 and 15 corrected.
19. Pages 188-191, V-1, Disclosure 2 – Figures 48-50 revised to conform to flowchart standards.
20. Page 193, V-1, Disclosure 2 – Text corrected to remove "additional claims data" which was removed in the previous submission and reappeared in the current submission prior to revision.
21. Page 196, V-1, Disclosure 3 – Text corrected to remove "new claims data" which was removed in the previous submission and reappeared in the current submission prior to revision.
22. Page 220, V-1, Disclosure 7 – Language added on Florida Building Code research and analysis.
23. Page 228, V-1, Disclosure 12 – Figure 55 revised to conform to flowchart standards.
24. Pages 238-239, V-2, Disclosure 2 – Figures 58 and 59 revised to conform to flowchart standards.
25. Page 242, V-2, Disclosure 5 – Figure 60 revised to conform to flowchart standards.
26. Page 253, V-3, Disclosure 9 – Missing Figure 68 added.
27. Page 282, A-3, Disclosure 1 – Language added on treatment of law and ordinance coverage.
28. Page 298, A-6, Disclosure 17 – Reference to Form A-4 corrected to Forms A-4A and A-4B.
29. Page 299, A-6, Disclosure 18 – Incorrect references to HURDAT corrected to HURDAT2.
30. Pages 311-315, Form A-3B – Map titles corrected to A-3B.
31. Page 349, CI-6, Disclosure 2 – Language revised to eliminate contradiction on trigger roles and to add windspeed correction model under a trigger role.
32. Pages 363-371, Forms A-2A and A-2B – Modified to use the same storm classifications as used in completing Forms M-1 and S-1.
33. Page 480, Form A-6, Building Code/Enforcement (Year Built) Sensitivity – Table headings corrected for Manufactured Homes.
34. Page 556, Form S-1 – Historical Probability for 10 or more corrected.
35. Page 568, Form S-4 – Figure 112 heading corrected.

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 5.B, page 103: Reconcile the impact of all model changes with Form S-5 (page 176).

3. G-1, Disclosure 5, page 105: Discuss the variations of impact on county level loss costs due to HURDAT2 updates in Figure 20. Provide the driving forces for the changes in Clay, Hendry, Holmes, and Volusia Counties.

4. G-1, Disclosure 5, page 106: Discuss the variations of impact on county level loss costs due to ZIP Code Centroid updates in Figure 21. Explain no changes in Baker, Columbia, DeSoto, Seminole, Suwannee, and Wakulla Counties.

Verified: ~~NO~~   YES

Professional Team Comments:

Not verified pending review of open items.

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

Discussed the impact on county level loss costs due to HURDAT2 updates related to new and revised storms in the updated HURDAT2, change in length of the historical record, and sampling error differences.

Discussed the impact on county level loss costs due to ZIP Code centroid updates related to differences in centroid locations and roughness lengths.

Deferred numerous questions to subject matter sections.

Additional Verification Review Comments

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.

Verified: ~~NO~~   YES

Professional Team Comments:

Not verified pending expert certifications after revisions.

Reviewed resumes of new personnel:

- Hector Cen, Ph.D. in Computer Science (on hold), Florida International University, Miami, FL; M.S. in Computer Science, Florida International University, Miami, FL; M.S. in Information Technology, Florida International University, Miami, FL; B.S. in Informatics, Universidad Centroccidental "Lisandro Alvarado," Barquisimeto, Venezuela
- Josemar Faustino Da Cruz, Ph.D. in Computer Science, Florida Institute of Technology, Melbourne, FL; B.S. in Information Systems, Lutheran University of Brazil, Canoas, Brazil
- Daniel Martinez, pursuing B.S. in Accounting, Florida International University, Miami, FL
- Roberto Vicente Silva de Abreu, B.S. in Civil Engineering, Florida Institute of Technology, Melbourne, FL; B.S. in Civil Engineering, FACIG, Brazil; M.S. in Wind Engineering, Florida Institute of Technology, Melbourne, FL
- Tianyi Wang, Ph.D. in Computer Science, Florida International University, Miami, FL; M.S. in Computer Science, Florida International University, Miami, FL; M.S. in Accounting, Washington State University College of Business, Pullman, WA; B.S. in Accounting, Tianjin University of Finance and Economics, Tianjin, China
- Wensong Wu, Ph.D. in Statistics, University of South Carolina, Columbia, SC; M.S. in Mathematics, University of South Carolina, Columbia, SC; B.S. in Computational Mathematics, Nanjing University, Nanjing, China

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

Additional Verification Review Comments

Verified after review of expert certifications in revised Forms G-1, G-3, 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

5. G-3, page 116: Present geographic representations of the previous versus current ZIP Code centroids.

6. G-3, Disclosure 3, page 117: Explain the tool used to convert street address to latitude and longitude and the methodology for assigning ZIP Codes.

7. G-3, Disclosure 5, page 117: 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 geographic maps of ZIP Codes and comparisons of centroid movements and boundaries for the entire state. Reviewed in detail several Florida ZIP Codes that experienced the largest centroid movements.

Discussed the process used for processing geographic input 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 review of open items.

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.

Noted that a prior error, corrected in the previous submission for version 6.2, was resurrected in the current submission for version 6.3, leading to a review of the entire 6.3 submission document and the process of preparing the submission.

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Additional Verification Review Comments

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Verified after review 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

9. Form M-1, pages 542-543: Reconcile the historical Florida Cat-4 landfalls as listed in Form M-1 and Form A-2A Base Hurricane Storm Set.

10. Form M-1, pages 542-543: Explain the classification for NoName02 (1919) in Form M-1 and Forms A-2A and A-2B.

Verified: YES

Professional Team Comments:

Discussed the differences in classification of historical Florida landfalls between Forms A-2A and A-2B compared to Form M-1.

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

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:

Discussed the source of covariate values, SST and outflow temperature, during simulations.

Discussed the assignment of dates to stochastic events.

Discussed that storm-track speed and heading transition PDFs are based on full HURDAT2, not just landfalling HURDAT2.

Discussed the continental-shelf depth threshold.

Discussed the use of regression coefficients for the Holland B parameter developed in-house.

Discussed the error term in the Holland B parameter.

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:

No changes in the process for developing landfall frequency distributions.

No changes in hurricane parameter distributions.

Reviewed distribution fits to Rmax, Holland B, and landfall frequencies, as part of statistics Form S-3.

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

11. Form M-2, pages 545-548: 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.

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 all values in the revised Form M-2 maps are for over land only.

Reviewed maps of maximum windspeeds for historical storms with .03 m roughness length applied to over land.

Discussed the differences between the historical record windspeeds and the 100-year return period windspeeds for open terrain wind exposure.

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.

Pre-Visit Letter

8. M-5, Disclosure 3, pages 139-140: Discuss the surface-wind coastal transition function using the internal boundary layer. Elaborate on the duration over which this transition occurs.

Verified: YES

Professional Team Comments:

Discussed the conversion of winds to actual terrain conditions using the wind conversion methodology of Vickery et al. (2009) to adjust the wind to actual roughness and using the gust factor methodology of Vickery and Skerlj (2005) to compute 3-second gust winds.

Discussed the vertical variation of wind, terrain conversions, and coastal transition of winds. Reviewed the coastal transition function.

Discussed the use of Vickery et al. (2005) overland-weakening method used as in the literature instead of re-fit in-house to more recent data.

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.

Verified: YES

Professional Team Comments:

Reviewed Form M-3.

No change in the methodology that would violate these logical relationships.

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

12. S-1, Disclosure 4, page 156: Explain the change in the Estimated Loss Level relative to the previous submission. Explain the narrowness of the uncertainty bounds.

14. Form S-3, page 562: Indicate the forms and output calculations that were impacted by the more extensive HURDAT2 data through 2017 being used.

Verified: ~~NO~~   YES

Professional Team Comments:

Not verified pending review of open items.

Discussed the change in the estimated loss level due to the new set of stochastic storms adding another 1,000 years of simulation.

Discussed the narrowness of the uncertainty interval due to increased number of storms in simulations and decreased spread of top order statistics.

Reviewed various goodness-of-fit tests and their *p*-values for the Holland B and Rmax parameters.

Discussed the inappropriate use of Kolmogorov-Smirnov goodness-of-fit tests for the Holland B and Rmax parameters, and hence its elimination from the submission.

Reviewed comparison of modeled versus historical hurricane frequency goodness-of-fit.

Reviewed comparison between the modeled and observed Holland B parameter distribution.

Reviewed uncertainty in loss costs for selected counties based on the 59,000 years of simulation.

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 no changes in model methodology from the previous submission and no new sensitivity tests completed.

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 no changes in model methodology from the previous submission and no new uncertainty tests completed.

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.

Verified: YES

Professional Team Comments:

Reviewed the change to 59,000 years of simulation for stochastic convergence.

Discussed Hamilton County surfacing in the simulation runs due to having the least exposure and the smallest number of events.

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.

Pre-Visit Letter

13. S-5, Disclosure 1, pages 166-167: Explain no change in Table 16 results relative to the previous submission.

15. Form S-4, page 564: Discuss the apparent bias in the results from these comparisons as a whole (i.e., modeled results tend to be greater than historical results).

Verified: ~~NO~~   YES

Professional Team Comments:

Not verified pending review of open items.

Discussed no change in Table 16 from the previous submission due to no change in the vulnerability and wind model and the use of the same ZIP Codes and validation data as used in the previous submission. No new validation data was reviewed.

Discussed that the data presented in Form S-4 were a random selection.

Reviewed comparison of personal residential actual versus modeled losses using 66 data sets for 20 companies and 7 hurricanes. Reviewed scatter plot, paired t-test and concordance correlation coefficient statistics.

Reviewed comparison of commercial residential actual versus modeled losses for 2 companies and 5 hurricanes. Reviewed scatter plot.

Additional Verification Review Comments

Verified after resolution of open items.

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.

Verified:　　~~NO~~　　YES

Professional Team Comments:

Not verified pending review of open items.

Reviewed Form S-5.

Discussed the differences between the percentage change from the previous submission as given in Form S-5 and in G-1 Disclosure 5.

Additional Verification Review Comments

Verified after resolution 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

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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

16. V-1.D, page 186 and Disclosures 6 and 7, pages 218-220: 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.

17. V-1.D, page 186 and Disclosures 6 and 7, pages 218-220: Present the databases and comment on wind-borne debris region and high velocity hurricane zone implemented in the current model per Florida Building Code 2010 and their applicability to residential buildings constructed after Florida Building Codes 2014 and 2017.

18. V-1, Disclosure 3, pages 192-215: Explain how exposures with no claims are incorporated in the data and how the premium files were used in developing vulnerability functions.

20. Form V-1, pages 571-576: Explain how Form V-1 was completed with respect to the current model.

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.

Discussed modeler research and analysis of the 2014 and 2017 Florida Building Codes (FBC) and the potential need to update the model to include structures built under the analyzed version of the FBC.

Reviewed samples from the Florida Building Commission Analysis of Changes documents for each FBC subcode.

Reviewed maps of the wind-borne debris region based on the 2010 FBC and high velocity hurricane zone (Miami-Dade and Broward counties) implemented in the model. Discussed no change in the wind-borne debris region.

Discussed how exposures with no claims are incorporated in the validation data.

Discussed the process for completing Form V-1 starting with model-based vulnerability functions.

Discussed differences from the previous submission Form V-1 related to terrain roughness changes in ZIP Codes and ZIP Code boundary changes.

Discussed how the model accounts for statewide and regional building codes in the vulnerability functions.

Discussed how building vulnerability functions account for upgrades to current code when estimating repair costs.

Reviewed plots of the coefficient of variation as a function of windspeed and as a function of mean damage ratio.

Reviewed comparison between frame and manufactured homes vulnerability curves.

Discussed FEMA 488 MAT team report on the performance of manufactured housing in Hurricane Charley (2004).

Discussed Grosskopf, K.R. (2005) "Manufactured housing and the 2004 hurricane season: assessing the effectiveness of hazard mitigation," Journal of Emergency Management 3(5) on hurricane survivability of pre-1994 HUD and post-1994 HUD manufactured housing through Hurricanes Charlie, Frances, Ivan, and Jeanne (2004).

Discussed the damage assessment of manufactured home damage related to Hurricane Charlie (2004) by R.C. Stroh, Director of Shimberg Center for Affordable Housing, Dean of Research at University of Florida.

Discussed the Institute for Building Technology and Safety report submitted to HUD on the performance of manufactured homes in Hurricane Charlie (2004).

Discussed the Simmons, K. and Sutter, D., "Manufactured home building regulations and the February 2, 2007 Florida tornadoes," Natural Hazards 46:415-425, 2008, article examining the effect of the new HUD regulations on the performance of manufactured homes in a tornado.

Discussed the need for addressing HUD code 1976 in the model.

Reviewed Form A-6.

Additional Verification Review Comments

Reviewed the methodology to include or exclude law and ordinance costs in modeled losses. Reviewed the implementation in the revised model version 7.0.

Reviewed damage ratio comparisons with and without law and ordinance for 1-story weak masonry in north and south Florida.

Reviewed table of reduction factors in expected damage after removal of law and ordinance by construction type across windspeeds.

Discussed that there were no changes in the strong building vulnerability functions as no law and ordinance is added to the strong building vulnerability functions.

Reviewed claims data for frame structures and post-1994 manufactured homes from Hurricane Charley (2004), Hurricane Frances (2004), Hurricane Jeanne (2004), Hurricane Dennis (2005), Hurricane Katrina (2005), and Hurricane Wilma (2005).

Reviewed graphical comparison between frame and post-1994 manufactured homes claims data.

Reviewed the revised flowchart for mapping personal residential policies to vulnerability matrices and its implementation in the code.

Reviewed revised flowcharts for development of building vulnerability functions.

Verified after resolution 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.

Verified: ~~NO~~   YES

Professional Team Comments:

Not verified pending review of open items.

Discussed vulnerability functions for contents and time element as a function of windspeed.

Discussed each building vulnerability function has an associated contents and time element vulnerability function.

Discussed no change in content and time element vulnerability functions.

Additional Verification Review Comments

Reviewed revised flowcharts for development of contents and time element vulnerability functions.

Verified after resolution 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

19. Form V-3, Disclosure 7, pages 249-252: Provide, in Excel, the data (mean and +/- one standard deviation at the given windspeeds) in Figures 62-65.

21. Form V-2, pages 577-578: Explain how Form V-2 was completed with respect to the current model.

22. Form V-4, page 580: Explain the "0" entries for Roof Covering ASTM D7158 Class H Shingles.

Verified: ~~NO~~   YES

Professional Team Comments:

Not verified pending review of open items.

Reviewed graphical comparisons of the coefficient of variation between mitigated and unmitigated masonry and frame structures.

Discussed the process for completing Form V-2. Discussed no changes in Form V-2 from the previous submission since the vulnerability model did not change.

Discussed no differences in Form V-4. Discussed changes in Form V-2 to the reference structure shingles and to the mitigated structure opening protection could potentially result in differences.

Additional Verification Review Comments

Reviewed the application of law and ordinance factors to the vulnerability matrices adjusting damage percentages and application of thresholds for roof cover, roof sheathing, and windows.

Discussed that there is no differentiation for law and ordinance coverage in windborne debris regions or high velocity hurricane zones.

Discussed that there were no changes in Form V-3 loss costs.

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Verified after resolution 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

23. A-1, page 268: 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)

24. A-1, Disclosure 4, page 270: Explain what difference in loss costs may result from choosing Actual Cash Value or Replacement Cost.

25. A-1, Disclosures 7 and 8, page 280: Quantify the difference in model output that may result from changing the order of input or removing/adding policies.

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.

Discussed that the model cannot be modified by the client as the model is only executed by FIU Computer Science staff. Discussed that clients have no access or ability to adjust model components.

Discussed that there are no differences in loss costs when selecting actual cash value or replacement cost. The impact on loss costs between actual cash value and replacement cost is incorporated in the calibration of the vulnerability functions.

Discussed that the difference in model output is sensitive to the size of the exposure portfolio and the number and type of assignments made.

Reviewed the testing performed by the Computer Science team confirming that model output is consistent, but not identical, given the same complete input in any order.

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

26. A-2.B, page 281: Provide a hard copy of the documented procedure.

Verified: ~~NO~~   YES

Professional Team Comments:

Not verified pending review of open items.

Reviewed the documented procedure distinguishing wind-related hurricane losses from other peril losses.

Additional Verification Review Comments

Verified after resolution of open items.

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

27. A-3, Disclosures 1-4, pages 282-285: Show a calculation of loss costs and probable maximum loss levels for the minimum Manufactured Home loss costs in Form A-1 (i.e., ZIP Code 32096 in Hamilton County).

Verified: YES

Professional Team Comments:

Discussed the actuary's statement that the methods referenced in A-3.A-D are actuarially sound.

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

Additional Verification Review Comments

Reviewed revised Disclosure 1 to add additional language addressing the treatment of law and ordinance.

Discussed with the modeler investigation of law and ordinance application to commercial residential occupancy.

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

28. A-4, Disclosure 1, page 287: 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.

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

Additional Verification Review Comments

Verified after resolution 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

29. A-5, Disclosure 3, page 293: Explain the calculation of Insurance Hurricane Loss.

Verified: ~~NO~~   YES

Professional Team Comments:

Not verified pending review of open items.

Reviewed the calculation for Insurance Hurricane Loss.

Additional Verification Review Comments

Verified after resolution 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

30. A-6, Disclosure 18, page 299: Reconcile percentage change with overall changes quoted on page 103 and page 176.

31. A-6, Disclosure 19, page 299: 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.

32. Form A-1, pages 359-361: Explain the large changes in ZIP Codes 33630, 33945, and 32240.

33. Forms A-3A and A-3B, pages 373-407: Explain the significant increases in totals for Hurricane Charley (2004) and Hurricane Jeanne (2004) and the small decrease in Hurricane Ivan (2004) going from A-3A to A-3B.

34. Form A-3A, pages 373-389: Explain the changes for Hurricane Charley (2004) in ZIP Codes 34266 and 34269 relative to the previous submission.

35. Forms A-4A and A-4B, pages 409-449: Explain the weighting procedure used to determine the county averages for DeSoto and Gulf Counties.

36. Forms A-4A and A-4B, pages 409-449: Explain the process used to identify apparent anomalies and to determine the reasons for the apparent anomaly. Also refer to page 357.

37. Form A-4B, 0% Deductible, pages 430-439: 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: Alachua Low, Franklin Low, Seminole Low
        Renters: Calhoun Low, Wakulla High
        Condo Unit: Charlotte Low, Okaloosa Low

38. Form A-4B, pages 430-449: Explain, in general, how the ordering of Frame loss costs versus Masonry loss costs can reverse for 0% Deductible and Specified Deductible. In particular, consider:

        Owners Frame and Masonry, Clay Low
        Owners Frame and Masonry, Lafayette Low
        Condo Unit Frame and Masonry, Santa Rosa Low

39. Form A-4B, page 442: 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.

40. Form A-4B, page 443: With Form A-1 having only two ZIP Codes for Gulf County (32456 and 32465), explain the values given in Form A-4B for Gulf County Low, Average, and High for Frame Owners, Masonry Owners, and Manufactured Homes.

41. Form A-5, page 451: Explain the increase in North for Frame Renters for $0 Deductible Output Ranges and the decrease in North for Frame Renters for Specified Deductible Output Ranges.

42. Forms A-8A and A-8B, pages 520-528: Explain the categorization of the data between Contents and Buildings for Condo Unit Owners and Renters.

43. Forms A-8A and A-8B, pages 520-528: Reconcile the total number of hurricanes in Form A-8A and Form A-8B.

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.

Discussed the difference in calculating the percentage change in Form S-5 compared to the percentage changes in Standards G-1 and A-6.

Discussed how the model handles coinsurance.

Reviewed the large changes in ZIP Codes 33630, 33945, and 32240 in Form A-1 attributed to significant changes in the point ZIP Codes that are mapped to the embedded regional ZIP Codes.

Discussed the error in completing Forms A-3A and A-3B related to a misalignment of losses for some of the ZIP Codes in the forms. Reviewed revised Forms A-3A and A-3B.

Discussed the process used to determine the weighted county averages in Forms A-4A and A-4B. Reviewed several ZIP Code examples.

Discussed the process used to identify apparent anomalies in the output ranges. Reviewed several examples with reasonable explanations.

Discussed that applying the deductible does not have a uniform effect on loss costs by ZIP Code. Reviewed examples for owners frame and masonry with $0 deductible and specified deductibles.

Discussed the differences in Form A-5 in North for frame renters between $0 deductible and specified deductibles. The difference was attributable to the new stochastic storm set having more storms and more deductions, but roughly the same ground-up loss.

Discussed the classification of FHCF exposure data between contents and buildings for condo unit owners and renters.

Reviewed the differences in the total number of hurricanes in Forms A-8A and A-8B.

Discussed assigning 1-story for unknown number of stories for owners, renters, and condo frame and masonry for the deductible and construction sensitivities in Form A-6.

Discussed the impact of year built for manufactured homes for the building code/enforcement (year built) sensitivity in corrected Form A-6 between year built 1992 and 2004.

Reviewed Wilkinson, Margaret E. (1982), Estimating Probable Maximum Loss with Order Statistics, *Casualty Actuarial Society*, LXIX, pp. 195-209 reference used for estimating probable maximum loss levels.

Reviewed the revised processing steps for completing Forms A-3A and A-3B.

Reviewed modified Forms A-2A and A-2B using the same storm classifications used in completing Forms M-1 and S-1.

Reviewed comparison between the current and previous $0 deductible loss costs in Form A-1 for ZIP Code 32583 in Santa Rosa County.

Discussed frame versus masonry versus manufactured home results in Form A-6.

Additional Verification Review Comments

Reviewed the exclusion of law and ordinance done by multiplying affected building vulnerability functions by factors. Reviewed the law and ordinance factors that vary by windspeed and type of structure.

Reviewed the impact on the output ranges excluding law and ordinance.

Reviewed the decrease in statewide loss costs in Form A-4A in correctly excluding law and ordinance. The statewide loss costs for owners frame decreased by 1.41% and 1.06% for owners masonry. The largest reductions were in Monroe County, owners frame -5.37% and owners masonry -5.57%, with the majority of counties decreasing less than 1%.

Reviewed revised Forms A-1, A-4A, A-4B, A-5, A-6, and A-7 updated to exclude law and ordinance. Discussed the change in processing the losses for the impacted forms.

Discussed that input records were modified to identify whether exposures included or excluded law and ordinance coverage.

Discussed that law and ordinance was incorrectly included in some Actuarial Forms in the currently-accepted model, and as such, a letter to Commissioner Yager is anticipated following the Report of Activities process.

Reviewed comparison between the original Form A-4A $0 deductible loss costs and the revised Form A-4A excluding law and ordinance for frame and masonry owners low loss costs in Alachua, Citrus, Pasco, Brevard, and Collier Counties.

Reviewed revised Forms A-5 and A-7 after removing law and ordinance from the previous Forms A-4 and A-6 to calculate the percentage changes.

Reviewed comparison of Forms A-1 and A-6 to the previous versions including law and ordinance.

Verified after resolution 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

44. CI-1.B, page 339: Relate the primary binder table of contents with the response to Standard G-1, Disclosure 5 (pages 103-107) by demonstrating individual table item compliance with Computer/Information Standards CI-1 through CI-7.

45. CI-1.D, page 340: Provide the table required by Standard CI-1, Audit Item 7.

46. CI-1.F, page 340: 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.

Discussed the new approach to managing model documentation using WordPress rather than MediaWiki, which was used for the previously-accepted model.

Reviewed the external list of acquired digital assets required by Audit #6.

Reviewed the revised table required by Audit #7.

Additional Verification Review Comments

Reviewed revised Personal Residential Input Data Specifications documentation.

Discussed with the modeler the continuing need to document transactions among team members. The documentation should be expressed as a combination of natural language and BPMN flowcharts.

Verified after resolution of outstanding issues from other standards.

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

47. CI-2, page 341: Provide requirements documentation that specifically relates to each model change identified in Standard G-1, Disclosure 5 (pages 103-107).

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.

Reviewed the requirements for Forms A-8A and A-8B.

Additional Verification Review Comments

Reviewed Requirements Document of Model Changes to FPHLM V6.3 to FPHLM V7.0 specifying the requirements for excluding law and ordinance coverage for personal residential policies.

Verified after resolution of outstanding issues from other standards.

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

48. CI-3.B, page 342: Provide the types of Unified Modeling Language diagrams used.

Verified: ~~NO~~   YES

Professional Team Comments:

Not verified pending review of open items.

Reviewed flowcharts describing control and data flows in the model.

Discussed the modeler's flowcharting approach.

Reviewed the flowcharting standard compliance.

Additional Verification Review Comments

Reviewed Diagram Guidelines documenting the use of ISO 5807, BPMN 2, and UML 2 standards for control and data flowcharts.

Reviewed revised flowchart for completing Forms A-8A and A-8B.

Reviewed the flowchart for application of law and ordinance factors.

Reviewed the flowchart for assigning vulnerability matrices to personal residential policies.

Reviewed the flowchart for completing Form A-6. Discussed the different review steps that did not catch the error in revised Form A-6 before submission to the Commission.

Reviewed all submission flowcharts revised to conform to flowchart standards.

Reviewed the revised flowchart for mapping personal residential policies to vulnerability matrices.

Verified after resolution 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 review of open items.

Discussed automation of certain processes that were performed manually.

Reviewed code fragments associated with the model, including scripts for form generation.

Reviewed revised procedure to mitigate future anomalies with respect to Forms A-3A and A-3B.

Additional Verification Review Comments

Reviewed code implementation for inclusion or exclusion of law and ordinance coverage in modeled losses.

Reviewed code implementation for the law and ordinance factor at given windspeeds.

Reviewed revised code for application of the law and ordinance factor in the input data for completing Form A-1.

Reviewed revised code for law and ordinance application in the vulnerability matrices adjusting damage percentages and application of thresholds for roof cover, roof sheathing, and windows.

Reviewed code implementation of mapping unweighted vulnerability matrices.

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

49. CI-5, pages 345-347: Provide complete and thorough verification procedures and output from the model changes identified in Standard G-1, Disclosure 5 (pages 103-107).

Verified: ~~NO~~   YES

Professional Team Comments:

Not verified pending verification of other standards.

Reviewed model verification methods.

Discussed verification approaches associated with Standard A-1, Disclosures 7 and 8.

Additional Verification Review Comments

Discussed testing completed on inclusion or exclusion of law and ordinance coverage from modeled losses.

Reviewed the test plan for the Insurance Loss Module update in version 7.0.

Reviewed the law and ordinance unit test cases conducted on the Insurance Loss Module update in version 7.0.

Verified after resolution of outstanding issues from other standards.

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

50. CI-6.D, page 348: 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.

Discussed the need to improve the policy for model revision to distinguish major versus minor revision identifications.

Additional Verification Review Comments

Reviewed the revised policy for model revision to distinguish major versus minor revision identifications.

Discussed that the major model version number was revised to Version 7.0 due to revisions in how input data is processed by the model and to the model input data specification.

Verified after resolution of outstanding issues from other standards.

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:

Discussed that there were no security breaches in the model since the previously-accepted model.

Discussed the ongoing institutional focus on tight security.