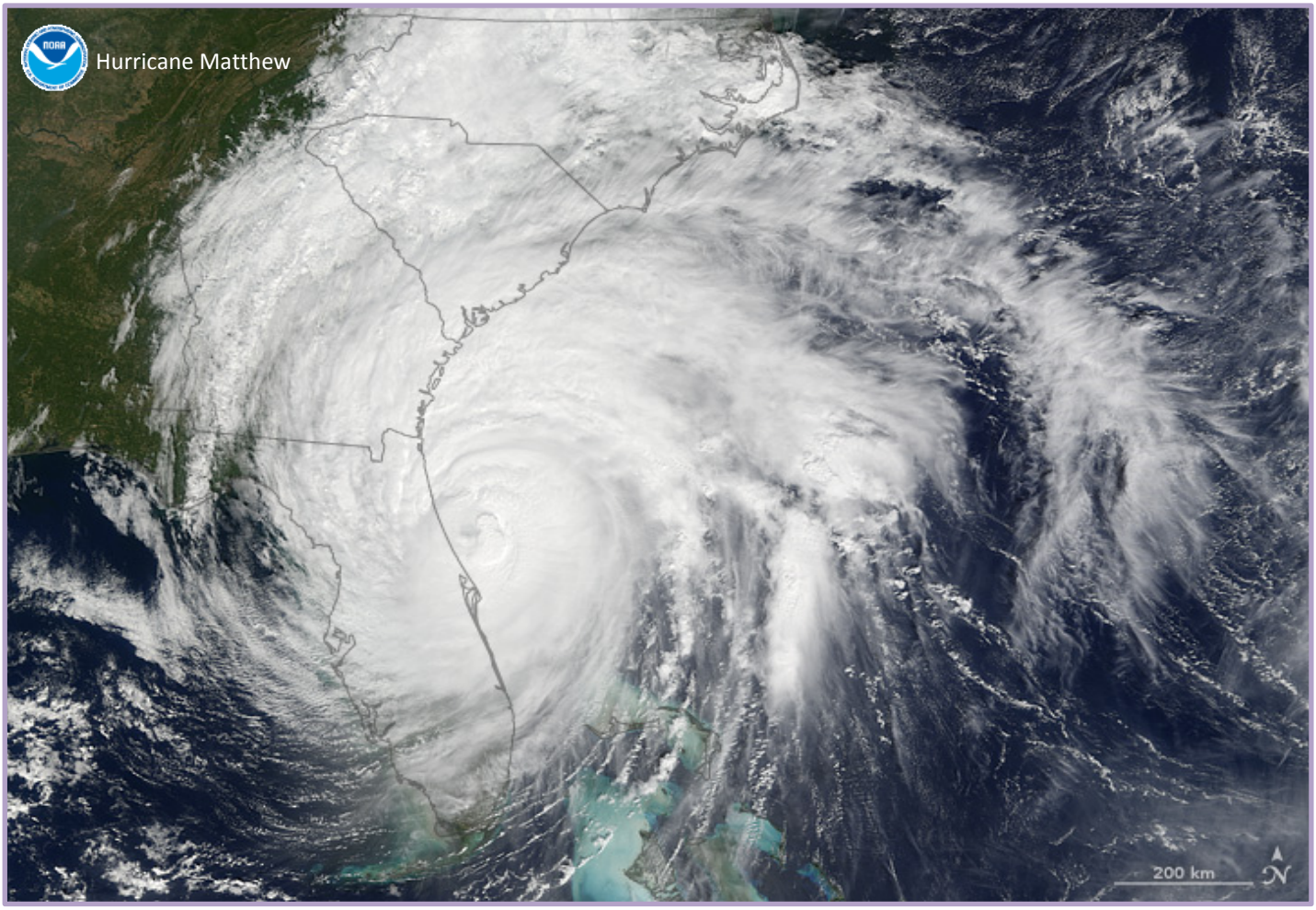
Florida Commission on Hurricane Loss Projection Methodology

Professional Team Report

2015 Standards



Florida Public Hurricane Loss Model

Florida International University

On-Site Review

March 13-15, 2017

On March 13-15, 2017, 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
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
Sneh Gulati, Ph.D., Professor, Department of Mathematics and Statistics, Florida International University
Kurt Gurley, Ph.D., Associate Professor, Department of Civil and Coastal Engineering, College of Engineering, University of Florida
Hsin-Yu Ha, Ph.D. Computer Science, Florida International University
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
Diana Machado, M.S. Computer Science student, Software Engineer, Florida International University
Jean-Paul Pinelli, Ph.D., 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
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

Professional Team

Jenni Evans, Ph.D., Meteorologist
Paul Fishwick, Ph.D., Computer Scientist
Mark Johnson, Ph.D., Statistician, Team Leader
Michael Smith, FCAS, FSA, MAAA, OMCAA, 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 an explanation for the error in generating the weighted average loss costs for mobile homes and commercial residential in the previously submitted Form A-4B under the 2013 Standards. The shell script that caused the error could not be located due to the script owner

graduating. FIU discussed how the error was discovered and the changes implemented to keep scripts and data together in order to prevent a recurrence of the error.
During the course of the audit, errors were discovered in the loss costs for Form V-3 and Figure 63, Model versus Actual ALE Loss, in both the current submission (version 6.2) and the previously accepted model submission (version 6.1). Figure 53 (Model versus Actual Structural Loss), Figure 54 (Model versus Actual Appurtenant Structure Loss), and Figure 62 (Model versus Actual Contents Loss) in the previously accepted model submission (version 6.1) are also incorrect. Form V-3 and Figures 53-54 and 62-63 are to be corrected as reviewed and verified on-site by the Professional Team.

The Professional Team, during the March 13-15, 2017 audit of the Florida Public Hurricane Loss Model Version 6.2, observed several instances of continued problems related to non-optimal modeler inter-team communication. The Professional Team recommends that the modeler continue to improve the level and quality of the modeler inter-team communication specified in the Professional Team Report of February 2-4, 2015 & May 4, 2015 (page 4).

Revised Forms A-3 and S-5 were submitted February 27, 2017 in time for the on-site review.

FIU provided a discussion of the significant model changes. Changes to the meteorology component included:

1. Update to the recent version of HURDAT2 (February 17, 2016) including storms through the 2015 hurricane season and reanalysis through 1955.
2. Update to the ZIP Code database to the March 2015 ZIP Code boundaries.

Changes to the vulnerability component included:

3. Update of exposure statistics in the personal residential and low-rise commercial residential models leading to changes in the weighted matrices.
4. Calculation of soffit areas of hip and gable roof buildings in the low-rise commercial residential model.
5. Correction in the handling of wind driven rain variable #2 (WDR2).
6. Removal of rain sampling bounds.

The Professional Team recommends FIU present the following information to the Commission during the meeting to review the model for acceptability:

1. Justification for the construction classes and characteristics used in the model.
2. Justification for modifications to the building vulnerability functions due to building codes and their enforcement including use of year of construction and/or geographical location of the building if used as a surrogate for building code and code enforcement.
3. Methodology for reinforced masonry and the exposure data and its consistency with the prevailing Florida Building Code and code enforcement.
4. Method for excluding storm surge losses from the modeled losses.
5. Detailed discussion of Form V-3 as specified on page 55 of the *Report of Activities*.
6. Detailed discussion of relativities in Form A-6 as specified on pages 55-56 of the *Report of Activities*, including changes made during the on-site review.

The Professional Team reviewed the following corrections to be included in the revised submission which is to be provided to the Commission no later than 10 days prior to the meetings for reviewing models for acceptability. Page numbers below correspond to the January 3, 2017 revised submission provided in response to the deficiencies.

- Page 57, G-1 Disclosure 2 – Figure 16 flowchart revised to mitigate graphical anomalies
- Page 66, G-1 Disclosure 2 – text on stated constraint revised for clarification
- Page 106, G-1 Disclosure 5 – text added to clarify changes to the calculation of soffit areas
- Page 174, S-1 Disclosure 4 – text added for probable maximum loss
- Page 187, S-5 Disclosure 1 – company labels corrected in Table 15 (now Table 16)
- Page 193 & Appendix R, Form S-5 – corrected to exclude Hurricane Rita (2005)
- Page 210, V-1 Disclosure 3 – text corrected to remove "additional claims data"
- Page 214, V-1 Disclosure 3 – text corrected to remove "new claims data"
- Page 246, V-1 Disclosure 13 – Figure 57 flowchart revised to mitigate graphical anomalies
- Page 259, V-2 Disclosure 2 – Figure 61 flowchart revised to mitigate graphical anomalies
- Page 262, V-2 Disclosure 5 – Figure 62 flowchart revised to mitigate graphical anomalies
- Page 261, V-2 Disclosure 5 – reference to disclosure 18 corrected
- Page 264, V-2 Disclosure 6 – Figure 63 replaced with the correct figure
- Page 280, Form V-3 – corrected
- Page 311, A-5 Disclosure 1 – revised for consistency on stated constraint clarification
- Page 312, A-5 Disclosure 3 – text revised to remove statement on 95% damage ratio
- Page 336, Form A-6 – text added to provide explanation for all the apparent anomalies
- Appendix G, Form A-6 – revised to correct commercial residential values for the deductible and number of stories sensitivities and to correct commercial residential labels in the submission
- Appendix H, Form A-7 – revised for corrections made in Form A-6
- Appendix I, Form A-8 – Part B revised for consistency with Table 13 (Standard S-1 Disclosure 4)
- Appendix K, Form M-1 – revised to include Hurricane Florence (1953)
- Appendix Q, Form S-4 – company labeling revised

Report on Deficiencies

The Professional Team reviewed the following deficiencies cited by the Commission at the December 13, 2016 meeting. The deficiencies were eliminated by the established time frame, and the modifications have been verified.

1. A list of acronyms used in the submission is not included, non-responsive to Acceptability Process II.A.5.m requirement (page 49) in the *Report of Activities*.

2. Standard G-1, Disclosure 5.A.2 (page 106)
   Response is unclear as changes in the Low-rise Commercial Residential model appear to result in changes to loss costs in Florida.

3. Standard G-1, Disclosure 5.B.1 (page 107)
   Response is non-responsive as "all model changes combined" is not given.

4. Standard G-2, Disclosure 2.C (page 122)
   Response is incomplete as personnel in Figure 29 have not been updated.

5. Standard G-2, Disclosure 3.A (page 123)
   Response is incomplete as the date of the actuarial review has not been given.

6. Form M-1 (pages 155-157 and 478-479)
   Form M-1 being split between pages 155-157 and 478-479 is non-responsive to the Acceptability Process II.A.5.l requirements (page 49) in the *Report of Activities*.

7. Form M-3 (pages 159-161 and 486-487)
   Form M-3 being split between pages 159-161 and 486-487 is non-responsive to the Acceptability Process II.A.5.l requirements (page 49) in the *Report of Activities*.

8. Standard S-1, Disclosure 1 (page 162)
   Response is unclear related to the chi-square goodness-of-fit test for landfalling hurricanes in the final paragraph.

9. Standard V-3.A (page 261)
   Response is incomplete as the impact of mitigation measures on associated uncertainties is not given.

10. Standard A-1 (page 280)
    Standard A-1 is non-responsive to the Acceptability Process II.A.5.d requirements (page 48) in the *Report of Activities*.

11. Standard A-1, Disclosure 1 (page 280)
    Response is incomplete as a sample calculation for determining the property value is not given.

12. Standard A-1, Disclosure 2 (page 280)
    Response is incomplete as a sample calculation for determining the amount of depreciation and the actual cash value losses is not given.

13. Standard A-2 (page 294)
    Standard A-2 is non-responsive to the Acceptability Process II.A.5.d requirements (page 48) in the *Report of Activities*.

14. Standard A-3 (page 295)
    Standard A-3 is non-responsive to the Acceptability Process II.A.5.d requirements (page 48) in the *Report of Activities*.

15. Standard A-4 (page 299)
    Standard A-4 is non-responsive to the Acceptability Process II.A.5.d requirements (page 48) in the *Report of Activities*.

16. Standard A-5 (page 304)
    Standard A-5 is non-responsive to the Acceptability Process II.A.5.d requirements (page 48) in the *Report of Activities*.

17. Standard A-6 (page 307)
    Standard A-6 is non-responsive to the Acceptability Process II.A.5.d requirements (page 48) in the *Report of Activities*.

18. Form A-6 (pages 449-450)
    Response is unclear as both the 18th and 20th floors are listed.

Discussion on Inquiries

The Professional Team discussed the following inquiries identified by the Commission at the December 13, 2016 meeting. The Professional Team will prepare a report on the inquiries to the Commission after discussions with all modelers are complete and prior to the 2017 standards committee meetings.

1. Investigate the condo-unit floor location impact on loss costs. How is lack of floor location treated?

2. Investigate aspects of the model and inputs that could lead to the greatest reduction in the uncertainty in model outputs (e.g., hurricane frequency, damage functions, incorrect data input, granularity of exposure location (ZIP Code centroid versus street address) data input).

3. Investigate how contamination of claims data (flood loss counted as wind loss) impacts validation and model output.

4. Investigate how the treatment of inland versus coastal exposures has an effect on the spatial evaluation of vulnerability functions.

Professional Team Pre-Visit Letter

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

Pre-Visit Letter

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 just as easily have been handled 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).

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 standards in the 2015 *Report of Activities*, and (4) responses to the audit items for each standard in the *Report of Activities*.

Provide an explanation for each loss cost change of more than 5% from the loss costs produced in the previous submission using the 2012 Florida Hurricane Catastrophe Fund (FHCF) exposure data to the corresponding loss costs produced in the current submission using the 2012 FHCF exposure data.

If changes have been made in any part of the model or the modeling process from the descriptions provided in the original 2015 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.

Refer to the On-Site Review section of the *Report of Activities as of November 1, 2015* for more details on materials to be presented to the Professional Team. Please pay particular attention to the requirements under Presentation of Materials on pages 73-74. In addition, please provide six printed copies of the tables required in Standard CI-1, Audit 6.
For your information, the Professional Team will arrive in business casual attire.

The pre-visit comments are grouped by standards sections.

GENERAL STANDARDS – Mark Johnson, Leader

G-1 Scope of the Model and Its Implementation*

*(*Significant Revision)*

A. The 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 model, (2) used to validate the model, (3) used to project modeled loss costs and probable maximum loss levels, and (4) used to create forms required by the Commission in the 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 representative or primary technical papers that describe the underlying 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 model, since the initial submission for each subsequent revision of the submission, will be reviewed.

   A. Model changes:
      1. A summary description of changes that affect, or are believed to affect, the personal or commercial residential loss costs or 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 loss costs based on the 2012 Florida Hurricane Catastrophe Fund's aggregate personal and commercial residential exposure data found in the file named "hlpm2012c.exe" for:
      1. All changes combined, and
      2. Each individual model component and subcomponent change.

C. For any modifications to Form A-4, Output Ranges, since the initial submission, additional versions of Form A-5, Percentage Change in Output Ranges:
   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 loss costs based on the 2012 Florida Hurricane Catastrophe Fund's aggregate personal and commercial residential exposure data found in the file named "hlpm2012c.exe" for each model component change:
   1. Between the previously accepted model and the revised model,
   2. Between the initial submission and the revised submission, and
   3. Between any intermediate revisions and the revised submission.

Pre-Visit Letter

1. G-1, Disclosure 2, page 66: Explain the stated constraint in the penultimate paragraph "net loss is ≥ 0 and ≤ limit – deductible."

2. G-1, Disclosure 5.C, Figure 21, page 110: Verify that the "extreme" counties correspond to the biggest changes in ZIP Code Centroids. For example, compute the change in centroid location distance and match with the largest changes in the figure (e.g., Washington, Monroe, Union, Bradford counties).

3. G-1, Disclosure 5.C, Figure 22, page 111: Explain why Okaloosa and Nassau counties are the most affected. Explain the difference in values between Hamilton and Suwannee counties.

4. G-1, Disclosure 5.C, Figure 23, page 112: Explain what is driving the differences seen in the panhandle (increases) versus the southeast coast (decreases).

5. G-1, Disclosure 5.C, Figure 24, page 113: Explain how Alachua County (0.01 to 10.00) avoided a 20% increase compared to its neighboring counties.

Verified: YES

Professional Team Comments:

Noted that the stated constraint on page 66 is confusing and will be removed. The net loss cannot be negative and for an outcome where the net loss is negative, it is replaced by zero.

Reviewed the loss costs due to the ZIP Code changes. The modeler examined the impact of the ZIP Code changes on the losses by ZIP Code rather than by county and verified that the changes in losses by ZIP Code corresponded well with the changes in ZIP Code centroids and associated population-weighted roughness.

Reviewed graphical comparison of the rank of the ZIP Code loss versus the rank of the change in centroid movement and the rank of the change in roughness. Reviewed several ZIP Codes in detail.

Reviewed the percentage changes in Figure 22 for Okaloosa, Nassau, Hamilton, and Suwannee counties. Reviewed the changes in vulnerability statistics from version 6.1 to version 6.2. The differences in 2-story, roof shape, and metal roof cover drive the differences in losses in these counties.

Reviewed the percentage changes in Figure 23 for the panhandle and the southeast. Discussed the panhandle is divided between windborne debris region (WBDR) and inland areas with newer buildings and predominantly frame buildings. The southeast is divided between HVHZ and WBDR with older buildings and predominantly masonry buildings. Reviewed the differences in vulnerability statistics from version 6.1 to version 6.2.

Reviewed the percentage changes in Figure 24 for Alachua County and neighboring counties. Modeler stated the predominance of 1-story buildings in the neighboring rural counties and the effect of the model changes on vulnerability being more pronounced for 1-story buildings result in the larger variation in losses in the neighboring counties than in Alachua County.

Discussed with the modeler the importance of treating database scripts in the same archival approach defined in Standard G-1.D, Item 4.

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

A. 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 model and 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). These individuals shall certify Forms G-1 through G-6, Expert Certification forms, as applicable.

Audit

1. The professional vitae of personnel and consultants engaged in the development of the model and responsible for the current 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 model under consideration will be reviewed. Signatories on the individual forms will be required to provide a description of their review process.

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

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

Pre-Visit Letter

6. G-2, Disclosure 2.B, page 121: Provide resumes of new personnel.

Verified: YES

Professional Team Comments:

Reviewed resumes of new personnel:

- Nicholas Miller, Ph.D. Civil Engineering candidate, Florida Institute of Technology, Melbourne, FL; M.S. Civil Engineering, Florida Institute of Technology, Melbourne, FL; B.S. Civil Engineering, Florida Institute of Technology, Melbourne, FL
- Diogo Ferreira Pacheco, Ph.D. Computer Science candidate, Florida Institute of Technology, Melbourne, FL; M.S. Computer Engineering, Polytechnic School of Pernambuco, Recife-PE, Brazil; B.S. Computer Engineering, Polytechnic School of Pernambuco, Recife-PE, Brazil
- Maria Presa Reyes, Ph.D. Computer Science candidate, Florida International University, Miami, FL; M.S. Computer Science, Florida International University, Miami, FL; B.S. Computer Science, Florida International University, Miami, FL
- Dongwook Shin, Ph.D., Meteorology, Florida State University, Tallahassee, FL; M.S. Meteorology, Florida State University, Tallahassee, FL; B.S. Atmospheric Sciences, Pusan National University, Korea
- Juan Sotomayor, M.S. Computer Science, Florida International University, Miami, FL; B.S. Software Engineering, Universidad de Especialidades Espiritu Santo, Guayaquil, Guayas, Ecuador; A.S. Programmer, Escuela Superior Politecnica, Guayaquil, Guayas, Ecuador
- Yudong Tao, M.S. Electrical & Computer Engineering, University of Miami, Miami, FL; B.S. Microelectronics, Fudan University, Shanghai, China
- Karthik Yarasuri, Ph.D. Civil Engineering, University of Florida, Gainesville, FL; B.S. Civil Engineering, Jawaharlal Nehru Technological University, Hyderabad, India

Discussed the departure of computer science students that graduated and Dr. Mark Powell who is now employed by Risk Management Solutions.

G-3 Insured Exposure Location

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

B. ZIP Code centroids, when used in the 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 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. Model ZIP Code-based databases will be reviewed.

Pre-Visit Letter

7. G-3, Disclosure 4, page 126: Explain the reasons for calculating population-weighted roughness. Explain what is meant by distance to coast for each incoming wind direction.
8. G-3, Disclosure 4, page 126: Explain the Wind-borne Debris Region ZIP Codes.

Verified: YES

Professional Team Comments:

Reviewed geographic displays of ZIP Codes and comparisons of new centroid locations to previous locations for the entire state. Reviewed several ZIP Code centroid changes in detail.

Reviewed the changes of losses due to ZIP Code changes.

Discussed the windborne debris region ZIP Codes. Reviewed the manual process used to update the windborne debris region ZIP Codes when the ZIP Code database is updated.

Discussed the use of population-weighted roughness of the ZIP Code when the ZIP Code is being used to specify the location of the policy rather than street address.

G-4 Independence of Model Components

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

Audit

1. The model components will be reviewed for adequately portraying hurricane phenomena and effects (damage, loss costs, and 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 model, and (3) consistency between the results of one component and another.

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

Verified: YES

Professional Team Comments:

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

G-5 Editorial Compliance

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

Audit

1. An assessment that the person(s) who has reviewed the submission has experience in reviewing technical documentation and that such person(s) is familiar with the submission requirements as set forth in the Commission's Report of Activities as of November 1, 2015 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 Forms G-1 through G-6, Expert Certification forms, for accuracy and completeness will be assessed.

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

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

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

Verified: YES

Professional Team Comments:

Editorial items noted 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.

Meteorological Standards – Jenni Evans, Leader

M-1 Base Hurricane Storm Set*

*(*Significant Revision)*

A. The Base Hurricane Storm Set is the National Hurricane Center HURDAT2 as of June 9, 2015 (or later), incorporating the period 1900-2014. Annual frequencies used in both model calibration and 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 currently accepted scientific literature and statistical techniques. 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 landfall distribution will be reviewed.

3. Changes to the modeling organization Base Hurricane Storm Set from the previously accepted 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 model will be reviewed.

5. Modeled probabilities will be compared with observed hurricane frequency using methods documented in currently accepted scientific 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. M-1, page 129: Changes in the Base Hurricane Storm Set will be reviewed.

Verified: YES

Professional Team Comments:

Discussed the new historical catalog based on HURDAT2 as of February, 2016.

Reviewed the following updates to the historical catalog:

- HURDAT2 reanalysis project (1951-1955) and the inclusion of the 2014-2015 seasons
- Hurricane Hazel (1953) upgraded to a hurricane resulting in an added Florida landfall
- Hurricane Florence (1953) modified

Form M-1 updated to include modification of Hurricane Florence (1953).

Discussed the differences that can occur with regards to storms included in Forms M-1 and A-2.

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 currently accepted scientific literature.

Audit

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

2. Graphical depictions of hurricane parameters as used in the 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 currently accepted scientific 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 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 model will be reviewed.

Verified: YES

Professional Team Comments:

Discussed no changes in sources of historical parameters.

Reviewed graphical comparison of the change in asymmetry versus parameter configuration for Rmax, B, and Central Pressure.

M-3 Hurricane Probabilities

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. 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 Scale.

Saffir-Simpson Hurricane 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 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 model variables or to develop databases will be reviewed.

5. Form S-3, Distributions of Stochastic Hurricane Parameters, will be reviewed for the probability distributions and data sources.

Verified: YES

Professional Team Comments:

Discussed no change in the process for developing the landfall frequency distributions.

Discussed no change in hurricane parameter distributions.

M-4 Hurricane Windfield Structure*

*(*Significant Revision)*

A. Windfields generated by the 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 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 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 model will be reviewed.

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

5. For windfields not previously reviewed, detailed comparisons of the 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 model, where applicable, will be reviewed.

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

Verified: YES

Professional Team Comments:

Discussed no change in methodology for converting land use and land cover (LULC) data into roughness factors.

Discussed that shifts in ZIP Code centroids resulted in changes in roughness in the forms (maps), but there was no change in the underlying LULC data.

Discussed that the equation prescribing the symmetric storm is based on a constant value of Coriolis parameter assigned to each storm.

M-5 Landfall and Over-Land Weakening Methodologies

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

Audit

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

2. Comparisons of the model's 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., landfall, boundary layer) will be reviewed. The region within 5 miles of the coast will be emphasized. Color-coded snapshot maps of roughness length and spatial distribution of over-land and over-water windspeeds for Hurricane Jeanne (2004), Hurricane Dennis (2005), and Hurricane Andrew (1992) at the closest time after landfall will be reviewed.

Verified: YES

Professional Team Comments:

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

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's sensitivity analyses will be reviewed.

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

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

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

Pre-Visit Letter

10. M-6, page 153: Methods (including any software) used in verifying logical relationships among hurricane characteristics will be reviewed.

11. Form M-3, pages 486-487: The wind-pressure relation for weaker storms (higher pressure) will be reviewed.

Verified: YES

Professional Team Comments:

Discussed methodology and statistical tests used in evaluating logical relationships for:

- Change in asymmetry versus change in translation speed
- Mean windspeed as a function of roughness
- Gust windspeed as a function of roughness
- Wind-pressure relation for weaker storms
- Rmax and central pressure

Reviewed parameter configuration documentation on the logical relationship testing for Rmax, B, and central pressure.

Reviewed Form M-3. Discussed that, for 980mb storms, smaller 3rd quartile values of 110mph radii compared to Rmax occurs at different values of Rmax.

Discussed that number of storms in 980mb Rmax bin is 33,123, compared to 258 storms in the 110mph wind radius for 980mb.

Reviewed storm parameters for an example hurricane with minimum pressure = 980mb and winds exceeding 110mph: Rmax = 29.65 km, B = 2.04, Δp = 32.64mb.

STATISTICAL STANDARDS – Mark Johnson, Leader

S-1 Modeled Results and Goodness-of-Fit

A. The use of historical data in developing the model shall be supported by rigorous methods published in currently accepted scientific literature.

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

Audit

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

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

Verified: YES

Professional Team Comments:

Discussed various goodness-of-fit tests and their updated *p*-values.

Reviewed hurricane frequency distribution fit.

Reviewed uncertainty limits for probable maximum loss levels.

S-2 Sensitivity Analysis for 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 currently accepted 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., 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:

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

S-3 Uncertainty Analysis for Model Output

The modeling organization shall have performed an uncertainty analysis on the temporal and spatial outputs of the model using currently accepted 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 model output as the input variables are simultaneously varied.

Audit

1. The modeling organization's 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., 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:

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

S-4 County Level Aggregation

At the county level of aggregation, the contribution to the error in 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:

Discussed the basis for 58,000 years of simulation as a greater than adequate bound for determining stochastic convergence.

S-5 Replication of Known Hurricane Losses

The model shall estimate incurred 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 loss experience may be used to replicate structure-only and contents-only losses. The replications shall be produced on an objective body of loss data by county or an appropriate level of geographic detail and shall include 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 model assessed by comparing projected losses produced by the model to actual observed losses incurred by insurers at both the state and county level,
   b. The version of the model used to calculate modeled 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 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 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 losses or the modeled losses, and
   j. The treatment of flood losses, including storm surge losses, in the actual losses or the modeled 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 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

12. S-5, Disclosure 1, page 182: Company H, Hurricane Dennis, Modeled Loss of $2,142,032.00 is the only modeled loss that did not change from Disclosure 1 in the previous submission. Tracing of how the values in Table 14 were populated will be reviewed.

Verified: YES

Professional Team Comments:

Discussed no change in the modeled loss for Hurricane Dennis (2005) from the previous submission. The claims data for Company H was composed of only manufactured home policies. There were no changes in the manufactured home weighting matrices therefore no change in the loss costs.

Reviewed the company naming conventions to assess updates to modeled losses as compared to actual losses.

S-6 Comparison of Projected Hurricane Loss Costs

The difference, due to uncertainty, between historical and modeled annual average statewide 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 Loss Costs – Historical versus Modeled, will be reviewed for consistency with Standard G-1, Scope of the 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 model under consideration, and
   e. Exposure assumptions.

Pre-Visit Letter

13. Form S-5, page 190: Explain the differences between the Historical values given in Form S-5 and Form A-2.

14. Form S-5, page 190: Explain the differences between the Modeled values given in Form S-5 and Form S-2.

Verified: YES

Professional Team Comments:

Discussed reasons for errors in the original submitted Form S-5 and changes to the process for improved quality assurance checks to eliminate these types of errors in the future.

Discussed the differences between the historical values given in the revised Form S-5 and Form A-2 due to the inclusion of Hurricane Rita (2005) in Form S-5 and the exclusion of Hurricane Rita (2005) in Form A-2.

VULNERABILITY STANDARDS – Masoud Zadeh, Leader

V-1 Derivation of Building Vulnerability Functions*

*(*Significant Revision)*

A. Development of the building 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 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 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 vulnerability functions.

E. 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 vulnerability functions shall include damage as attributable to windspeed and wind pressure, water infiltration, and missile impact associated with hurricanes. Building 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 model since the previously accepted 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 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 vulnerability functions, the goodness-of-fit of the data will be reviewed. Complete reports detailing loading conditions and damage states for any laboratory or field testing data used will be

reviewed. When rational structural analysis is used to develop building 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 vulnerability functions must be available for review in hard copy or electronic form.

4. Multiple samples of building 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 vulnerability functions and associated uncertainties will be reviewed.

7. Documentation and justification for all modifications to the building vulnerability functions due to 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 vulnerability from local and regional construction characteristics and building codes will be reviewed.

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 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 model assumes a total loss will be reviewed.

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

Verified: YES

Professional Team Comments:

Discussed the changes in the Low-rise Commercial Residential model to calculate hip roof soffit areas differently than the gable soffit areas to reflect the different geometries. The change increases vulnerability for hip roof constructions.

Discussed the changes in the net penetrable areas for gable and hip roof soffit areas. The change increases vulnerability for hip and gable roof constructions.

Reviewed graphical comparison of the change in the weighted vulnerability curves from version 6.1 to version 6.2 due to the change in the hip roof soffit area calculations.

Reviewed vulnerability functions for hip and gable roofs.

Discussed the change in the wind driven rain model (WDR) to sample the WDR2. The model first samples the total WDR and WDR1 and computes WDR2 as WDR-WDR1.

Reviewed graphical comparison of the change in weighted vulnerability curves from version 6.1 to version 6.2 due to the change in the calculation of water ingress from breaches in soffit areas.

Discussed the change in wind driven rain sampling to utilize the entire range of simulation data rather than using the previous interval of [-0.5 to +0.75] standard deviations. Discussed reason for change due to no real justification for limiting the sample space. The change causes a slight decrease in vulnerability for windspeeds above 120 mph.

Reviewed graphical comparison of the change in weighted vulnerability curves from version 6.1 to version 6.2 due to the change in wind driven rain sampling.

Discussed the change in exposure statistics used to weight the vulnerability matrices for Commercial Residential Low-Rise buildings based on a new exposure study involving 22 counties and the change in exposure statistics used to weight the vulnerability matrices for Personal Residential based on the new exposure study involving 51 counties that account for approximately 97% of Florida's population. Reviewed the provided reference:

> Michalski, J., (2016) Building Exposure Study in the State of Florida and Application to the Florida Public Hurricane Loss Model, Master thesis, Department of Civil Engineering and Construction Management, Florida Tech, Melbourne, Florida.

Discussed the implementation of results and summary provided in the above reference.

Discussed the treatment of unknown masonry constructions. Reviewed vulnerability curves for reinforced masonry and unreinforced masonry constructions. If the building structure is unknown, the vulnerability curve is assigned based on the year built.

Discussed manufactured home vulnerability curves.

Discussed the process to review Florida Building Code versions and their application in the model.

Discussed Florida Building Code and ASCE-7 design wind load standards and their application in development of the building vulnerability functions.

Discussed no new claims data received or analyzed for validation.

Discussed the process for completing Form V-1 and the loss ratios in comparison with the previous submission.

Reviewed mean damage ratios for frame and manufactured homes by windspeed bands in Form V-1.

Reviewed the construction, building code, building strength, and number of stories sensitivities in Form A-6.

Discussed appurtenant structure vulnerability does not vary by construction type.

Discussed no vulnerability difference for mid-high rise Commercial Residential by year built except for metal shutters requirement after 1994 in the high velocity hurricane zones and after 2002 elsewhere.

Discussed manufactured home vulnerabilities are separate for pre- and post-1994.

Discussed the windborne debris region ZIP Codes. Reviewed the manual process used to update the windborne debris region ZIP Codes when the ZIP Code database is updated.

Reviewed scatter plot comparison of modeled versus actual losses for structure, appurtenant structure, contents, and time element losses.

V-2 Derivation of Contents and Time Element Vulnerability Functions

A. Development of the contents and time element 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 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 vulnerability functions and historical building and contents losses shall be reasonable.

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

D. The relationship between the modeled building and time element vulnerability functions and historical building and time element losses shall be reasonable.

E. Time element vulnerability functions used by the model shall include time element coverage claims associated with wind, 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 model since the previously accepted 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 model will be reviewed.

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

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

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

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

6. Documentation and justification of the following aspects or assumptions related to contents and time element vulnerability functions will be reviewed:
   a. The method of derivation and underlying data,
   b. Validation data specifically applicable to time element 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 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 vulnerability.

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

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

Pre-Visit Letter

15. V-2, Disclosure 1, page 252: Explain, in spite of changes in the rain model, why there is no change in the contents vulnerability component.

16. V-2, Disclosure 1, page 252: Explain, in spite of changes in the rain model, why there is no change in the time element vulnerability component.

Verified: YES

Professional Team Comments:

Discussed changes in the rain intrusion model that affect the interior damage building component of the vulnerability model, and that no changes were implemented in the contents and time element components. Contents and time element losses are affected indirectly as they are a function of interior damage.

Reviewed appurtenant structure, contents, and time element losses in Form A-6.

Discussed no change in the vulnerability functions for contents and time element losses.

Discussed revised Figure 63 and source of error. Discussed the figure included in the current submission and the figure included in the previously accepted submission are incorrect. Discussed need to notify the Commission of the error in the previously accepted submission.

V-3 Mitigation Measures

A. Modeling of mitigation measures to improve a building's hurricane wind resistance, the corresponding effects on vulnerability, and their associated uncertainties shall be theoretically sound and consistent with fundamental engineering principles. These measures shall include fixtures or construction techniques that enhance the performance of the building and its 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 mitigation measures considered by the model.

B. Application of mitigation measures that enhance the performance of the building and its contents shall be justified as to the impact on reducing damage whether done individually or in combination.

Audit

1. Modifications to mitigation measures in the model since the previously accepted 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 model will be reviewed.

2. Form V-2, Mitigation Measures, Range of Changes in Damage, and Form V-3, Mitigation Measures, Mean Damage Ratios and Loss Costs (Trade Secret item), will be reviewed.

3. Implementation of individual mitigation measures will be reviewed as well as the effect of individual mitigation measures on damage. Any variation in the change over the range of windspeeds for individual mitigation measures will be reviewed. Historical data, technical literature, analysis or judgment based on fundamental engineering principles used to support the assumptions and implementation of the mitigation measures will be reviewed.

4. Implementation of multiple mitigation measures will be reviewed. The combined effects of these mitigation measures on damage will be reviewed. Any variation in the change over the range of windspeeds for multiple mitigation measures will be reviewed.

5. Mitigation measures used by the model that are not listed as required in this standard will be reviewed for theoretical soundness and reasonability.

Pre-Visit Letter

17. V-3, Disclosure 1, page 261: Discuss the secondary options/mitigation measures ASTM D3161 Class F and ASTM D7158 Class G and H shingles in the model.

Verified: YES

Professional Team Comments:

Discussed how the introduction of ASTM D3161 Class F, ASTM D7158 Class G and ASTM D7158 Class H shingles in Forms V-2 and V-3 did not require a change in the model, as the model already accounted for these types of shingles.

Discussed no change in mitigation measures and secondary characteristics in the model.

Compared loss costs provided for reference and mitigated structures in Form V-3 with those provided in Form A-1. Discussed observed discrepancies. Form V-3 was consequently revised in the current submission. As a result of this review, it was discovered the error also existed in the previously accepted model submission. The modeler will submit a revised Form V-3 for the previously accepted version.

Reviewed the results in Form V-2 and the revised Form V-3 with the previous submission. Confirmed consistency between Form V-2 and the revised Form V-3. The error discovered in Form V-3 was in the loss cost columns.

ACTUARIAL STANDARDS – Mike Smith, Leader

A-1 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 accepted actuarial, underwriting, and statistical procedures.

B. All modifications, adjustments, assumptions, inputs and input file identification, and defaults necessary to use the model shall be actuarially sound and shall be included with the model output report. Treatment of missing values for user inputs required to run the model shall be actuarially sound and described with the 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 model inputs and assumptions will be reviewed to determine that the model output report appropriately discloses all modifications, adjustments, assumptions, and defaults used to produce the loss costs and probable maximum loss levels.

Pre-Visit Letter

18. A-1, Disclosure 4, pages 281 & 285: Discuss how item (a) applies to the FHCF exposure data ("hlpm2012c.exe"), which includes multiple policies per line.

19. A-1, Disclosure 5, page 289: Provide the model output report for the run of the FHCF exposure data ("hlpm2012c.exe").

Verified: YES

Professional Team Comments:

Discussed processing of the FHCF exposure data. Lines with multiple policies are split into the number of risks indicated in the line. Insured values are split equally among policies from each line.

Reviewed a sample of the model output reports used for processing data in the model.

Discussed with actuary Gail Flannery her review of the process for reviewing exposure and claims data and her attestation that the methods are actuarially sound.

A-2 Event Definition

Modeled loss costs and 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.

Audit

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

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

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

Verified: YES

Professional Team Comments:

Discussed the review of landfalling and by-passing storms in the calculation of loss costs and probable maximum loss levels.

Gail Flannery commented on the reasonableness of procedures used to include storms that reach hurricane strength and produce minimum damaging windspeeds or greater on land in Florida.

A-3 Coverages

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

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

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

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

Audit

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

Verified: YES

Professional Team Comments:

Discussed with Gail Flannery her review of the building, appurtenant structure, contents, and time element loss costs calculations. She attested that the methods used are actuarially sound.

Discussed time element damages for mid/high-rise commercial residential buildings are not modeled.

Discussed the estimation of appurtenant structure loss costs.

A-4 Modeled Loss Cost and Probable Maximum Loss Considerations

A. Loss cost projections and probable maximum loss levels shall not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margin.

B. Loss cost projections and probable maximum loss levels shall not make a prospective provision for economic inflation.

C. Loss cost projections and probable maximum loss levels shall not include any explicit provision for direct hurricane storm surge losses.

D. Loss cost projections and 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 model's calculation of loss costs and probable maximum loss levels using relevant data and actuarially sound methods and assumptions.

Audit

1. How the 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 probable maximum loss levels will be reviewed.

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

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

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

6. How the model accounts for flood and storm surge losses will be reviewed.

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

Verified: YES

Professional Team Comments:

Discussed with Gail Flannery her review of the process for calculating loss costs and probable maximum loss levels.

Discussed with Gail Flannery her review of the demand surge model and the judgement used for Monroe County in determining demand surge factors for use in the model.

Discussed error in applying demand surge in previous version of Form A-3. Discussed change in process to avoid repeat of this type of error.

A-5 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 loss costs shall be reasonable.

C. Deductible 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 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 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 model in the relativities among corresponding deductible amounts for the same coverage will be reviewed.

Verified: YES

Professional Team Comments:

Discussed with Gail Flannery her review of the process for including deductibles and policy limits. She attested that the application of deductibles and policy limits is actuarially sound.

A-6 Loss Outputs and Logical Relationships to Risk

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

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

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

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

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

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

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

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

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

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

K. All other factors held constant, output ranges produced by the model shall in general reflect lower 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, and***
4. ***northern counties versus southern counties.***

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

L. For loss cost and 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 probable maximum loss levels for Form A-8, Probable Maximum Loss for Florida, will be reviewed. The hurricane associated with the Top Event will be reviewed.

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

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

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

5. The procedures used by the modeling organization to verify the individual loss cost relationships will be reviewed. Methods (including any software) used in verifying Standard A-6 will be reviewed. Forms A-1, Zero Deductible Personal Residential Loss Costs by ZIP Code, A-2, Base Hurricane Storm Set Statewide Losses, A-3, 2004 Hurricane Season Losses, A-6, Logical Relationship to Risk (Trade Secret item), and A-7, Percentage Change in Logical Relationship to Risk, will be reviewed to assess coverage relationships.

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

7. The total personal and commercial residential insured losses provided in Forms A-2, Base Hurricane Storm Set Statewide Losses and A-3, 2004 Hurricane Season Losses, will be reviewed individually for total personal residential and total commercial residential insured losses.

8. Forms A-4, Output Ranges, and A-5, Percentage Change in Output Ranges, will be reviewed, including geographical representations of the data where applicable.

9. Justification for all changes in loss costs from the previously accepted model will be reviewed.

10. Form A-4, Output Ranges, will be reviewed to ensure appropriate relativities among deductibles, coverages, and construction types.

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

Pre-Visit Letter

20. A-6, Disclosure 14, page 310: Provide an example illustrating the effects of coinsurance on commercial residential loss costs.

21. Form A-1, Figures 96-98, pages 359-361: Identify ZIP Codes with larger than expected loss costs relative to their more coastal or southerly neighboring ZIP Codes (e.g., northwest Palm Beach County, middle of Broward County adjoining the large swamp land ZIP Code) and justify the results.

22. Form A-3, pages 368-387: Provide Form A-3 with the percentage of residential zero deductible losses rounded to four decimal places.

23. Form A-3, page 318: Provide Figure 83 with tracks.

24. Form A-4, 0% Deductible, page 389: Brevard County has a low manufactured homes loss cost value of 1.815. For this same ZIP Code, provide the frame owners loss cost value.

25. Form A-4, 0% Deductible, page 394: Manatee County has a low manufactured homes loss cost value of 1.927. For this same ZIP Code, provide the frame owners loss cost value.

26. Form A-4, 0% Deductible, page 394: Martin County has high masonry renters loss cost value of 4.179. For this same ZIP Code, provide the frame renters loss cost value.

27. Form A-4, 0% Deductible, pages 392: Provide details on the computation of the weighted average for commercial residential losses for Hardee County, having commercial residential exposures in two ZIP Codes (as evidenced from data developed from the aggregate residential exposure data in the file “hlpm2012c.exe”).

28. Form A-4, 0% Deductible, page 393: Lafayette County has masonry construction in two of its four ZIP Codes (32013 with 1 row, $370,999 total insured value; 32066 with 33 rows, $80,648,944 total insured value). Explain the averaging and weighting scheme used to arrive at the reported value, supplying additional digits as necessary.

29. Form A-4, 0% Deductible page 393: Consider Lafayette County for manufactured homes. Again two ZIP Codes only contain exposure with one ZIP Code dominating. Explain the averaging and weighting scheme used to arrive at the reported manufactured homes value, supplying additional digits as necessary.

30. Form A-4, pages 389-408: Explain the weights used to obtain the average output range by county. Use Monroe County as an example.

31. Form A-5, pages 321-328 & 410: Explain the significant extreme changes.

32. Form A-8, page 335: Explain the separation between the lines in Figure 95. Provide an expanded graph above $120 billion.

33. Form A-8, pages 467-468: Provide the first and second moments of the Annual Aggregate and Annual Occurrence distributions underlying the tables. Also, provide the first and second moments of the frequency and severity distributions underlying the PMLs shown in Parts B and C.

Verified: YES

Professional Team Comments:

Discussed the variation in loss costs given in Form A-1 for Palm Beach and Broward counties due to variations in the roughness. Reviewed maps with ZIP Code boundaries and land use/land cover roughness. Discussed the effect of wind fetch on the losses.

Discussed no adjustments are made to the modeled loss costs for the effects of coinsurance. The model assumes Commercial Residential properties are insured to the required percentage of the value.

Reviewed revised Form A-3.

Reviewed the differences in loss cost results for manufactured homes and frame owners for Brevard County. Discussed no frame owners exposure in ZIP Code 32956 in Brevard County.

Reviewed the differences in loss cost results for manufactured homes and frame owners for Manatee County. Reviewed the exposure statistics by construction type. Reviewed the mean damage ratios for manufactured homes and frame owners year built 1955, 1975, and 1995 by windspeed bands.

Reviewed the differences in loss cost results for renters frame and renters masonry for Martin County. Reviewed the mean damage ratios for frame 1985 and masonry for 1965 by windspeed bands.

Reviewed the computation of the weighted average for Commercial Residential loss costs for Hardee County.

Discussed the averaging and weighting schemes used for the loss cost results for masonry and manufactured homes for Lafayette County.

Discussed weights for a ZIP Code used for the average output range by county in Form A-4 are based on total FHCF exposure and determined separately for each construction. Reviewed example of weights for owners masonry for several ZIP Codes.

Discussed the changes in Form A-5. The changes in Personal Residential were attributed to the aggregation of FHCF exposure data into year-built ranges and the model's retrofitting assumptions. The changes in Commercial Residential were attributed to the changes in the low-rise vulnerability model component.

Discussed Figure 95 and the reduction in Personal Residential modeled losses resulting in an increase in return time.

Verified the mean and standard deviation of the annual aggregate loss distribution shown in Form A-8, using the frequency and severity distributions underlying the probable maximum loss levels in Parts B and C.

Discussed the inconsistency in the probable maximum loss interval limits in Table 13 (Standard S-1, Disclosure 4) with Form A-8, Part B. Reviewed a revised Form A-8, Part B that corrected the inconsistencies.

Reviewed the results provided in Form A-6 in detail. Explanations for the assumptions made in completing the form were added to the submission document for resolution on the apparent anomalies.

Discussed the model assumption that appurtenant structure vulnerability does not vary by construction type and that the model assumes a mix of various types of exposures with some assumed to be strong (e.g., swimming pools).

Verified several calculations associated with annual aggregate, annual occurrence, and conditional tail expectation using the top 580 events.

Discussed the treatment of inland marine line of business.

COMPUTER/INFORMATION STANDARDS – Paul Fishwick, Leader

CI-1 Documentation

A. 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 model structure, detailed software description, and functionality. Documentation shall be indicative of accepted model development and software engineering practices.

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

D. The modeling organization shall maintain (1) a table of all changes in the model from the previously accepted 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.

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 tables specified in CI-1.D that contain the items listed in Standard G-1, Scope of the 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, Requirements, CI-3, Model Architecture and Component Design, CI-4, Implementation, CI-5, Verification, and CI-6, Model Maintenance and Revision.

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

Pre-Visit Letter

34. CI-1.B, page 337: Relate the primary binder table of contents with the response to Standard G-1, Disclosure 5 (pages 106-116) by demonstrating individual table item compliance with Computer/Information Standards CI-1 through CI-7.

Verified: YES

Professional Team Comments:

Discussed the use of MediaWiki for the creation and maintenance of internally accessible model documentation.

Reviewed the Florida Public Hurricane Loss Model (FPHLM) Release 6.2 User Manual, which was revised to mitigate (1) future year indexing problems in producing Form S-5, and (2) issues in processing Form A-3.

Reviewed the table required by Standard CI-1.D, which includes all items listed in Standard G-1, Disclosure 5.

Reviewed the insertion of additional cross-checking procedures for submission forms in each disciplinary area.

CI-2 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 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

35. CI-2, page 339: Provide requirements documentation that specifically relates to each model change identified in Standard G-1, Disclosure 5 (pages 106-116).

Verified: YES

Professional Team Comments:

Reviewed the requirements document, which included all items listed in Standard G-1, Disclosure 5.

Discussed process for developing requirements for model changes.

Reviewed revised requirements which included date, version, and relevant personnel identification.

Reviewed the insertion of “WSC (Wind Speed Correction)” in the requirements.

CI-3 Model Architecture and Component Design

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 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 model output.

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

Verified: YES

Professional Team Comments:

Discussed the modeler's use of the Unified Modeling Language (UML) for charting purposes (e.g., activity and use-case diagrams).

Discussed with the modeler the importance of having a uniform and consistent approach to UML diagramming.

Reviewed corrected UML diagrams in the submission.

Discussed the use-case diagram identifying the process for producing Form S-5.

CI-4 Implementation*

*(*Significant Revision)*

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 model representations (e.g., flowcharts) down to the code level.

D. The modeling organization shall maintain a table of all software components affecting loss costs and 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 Model and Its Implementation, Disclosure 5 and Audit 5:

1. A list of all equations and formulas used in documentation of the 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,
   e. Input and output parameter definitions.

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

7. 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: YES

Professional Team Comments:

Reviewed the script change associated with having a different soffit area calculation for gable versus hip roof types.

Discussed with the modeler that there were no new or revised equations introduced into model version 6.2.

Discussed with the modeler (1) that an originally erroneous script for producing Form A-4B was created for the 2013 Standards submission, and (2) that this script was entered interactively and not saved.

Discussed that the modeler has changed their form creation process so that all database queries in SQL are now saved in a file co-located with the FHCF exposure data file.

Reviewed the set of scripts for producing Form A-4B in the modeler's submission.

Discussed the need for increased communication and internal review within and across disciplines to increase the likelihood of appropriate implementation.

CI-5 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 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. The response to Disclosure 1 will be reviewed.

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

Pre-Visit Letter

36. CI-5, pages 343-345: Provide complete and thorough verification procedures and output from the model changes identified in Standard G-1, Disclosure 5 (pages 106-116).

Verified: YES

Professional Team Comments:

Discussed verification approaches used in the population-weighted roughness calculations associated with ZIP Code.

Discussed a verification approach implemented in Fortran for verifying logical relation to risk specified in Standard M-6.

Reviewed verification checks performed on vulnerability and meteorology components of the model.

CI-6 Model Maintenance and Revision

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

B. A revision to any portion of the model that results in a change in any Florida residential hurricane loss cost or probable maximum loss level shall result in a new 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 model versions since the initial submission for this year. Each 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 model revision and management will be reviewed.

3. Portions of the code, not necessarily related to recent changes in the 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 model revisions as specified in CI-6.D will be reviewed.

Pre-Visit Letter

37. CI-6.D, page 346: Provide the model version history over the past 5 years, leading up to the version identified in the submission.

Verified: YES

Professional Team Comments:

Discussed the use of Apache Subversion (SVN) for the versioning of an updated vulnerability script.

Discussed that there have not been any changes to the policy for model revision.

Reviewed the model revision history required by Standard C-6.D.

CI-7 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 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 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 related to the model under review, or since the previously accepted model.

Discussed that there have not been any changes to the written security policy since the previously accepted model.