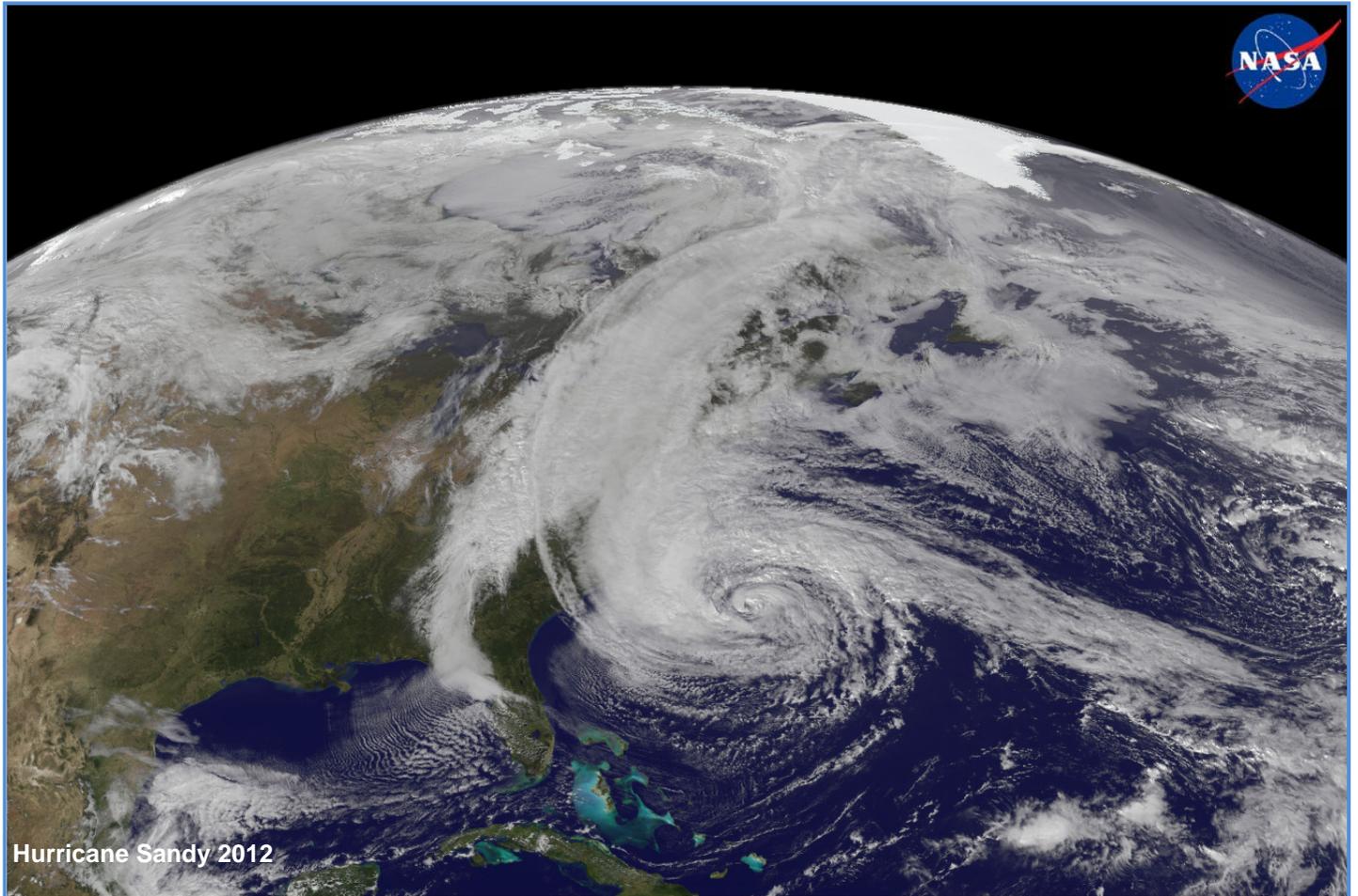


# **Florida Commission on Hurricane Loss Projection Methodology**



## **Professional Team Report 2011 Standards**

**Applied Research Associates**

**On-Site Review  
April 2-4, 2013**

**Additional Verification Review  
May 6, 2013**

On April 2-4, 2013, the Professional Team visited on-site at Applied Research Associates, Inc. (ARA) in Raleigh, North Carolina. The following individuals participated in the review:

**ARA**

Matthew Chamberlain, FCAS, MAAA, Actuarial Consultant (via phone)  
Chris Gorski, Staff Computer Scientist  
Francis M. Lavelle, Ph.D., P.E., Vice President  
David Mizzen, M.S.C.E., Staff Scientist  
Partha Sarathi, Ph.D., Staff Scientist  
Jeffrey C. Sciaudone, P.E., Senior Scientist  
William Skinner, Director of Catastrophe Modeling Solutions  
Chris Townsend, Computer Scientist  
Peter J. Vickery, Ph.D., P.E., Principal Engineer  
Lisa West, Division Administrator

**Professional Team**

Jenni Evans, Ph.D., Meteorologist  
Paul Fishwick, Ph.D., Computer Scientist  
Mark Johnson, Ph.D., Statistician, Team Leader  
Marty Simons, ACAS, Actuary  
Masoud Zadeh, Ph.D., P.E., Structural Engineer  
Melissa Gunter, Staff  
Donna Sirmons, Staff

The review began with introductions and an overview of the audit process. ARA provided a detailed presentation of the changes made in HurLoss Version 6.0:

- Model software implementation revised to utilize a web-based user-interface, a SQL Server database to store input and output data, and a multi-processor architecture allowing distributed portfolio processing.
- Steel or reinforced concrete frame commercial-residential buildings damage functions and modifiers expanded to address the effects of building heights in excess of eight stories, the variation of losses by floor level, and the variation of losses due to building code era (year built), design windspeed, opening protection, roof cover material type, and roof cover strength.
- Demand surge component modified so that losses by coverage with demand surge are capped at the original coverage limits.
- Hurricane model updated to include data from the 2010 and 2011 hurricane seasons and updated the sea-surface temperature and wind shear data sets through to 2011.
- Land use/land cover database updated to the 2006 National Land Cover Database.
- ZIP Codes updated to use June 2012 data and ARA centroid location methodology.
- Revised coding for the four “additional risk characteristics” fields in the 2007 FHCF aggregate exposure data for consistency with modeling of the output ranges.

During the audit, it was discovered that ARA did not run the output ranges (Form A-4) with the deductible amounts given in the output range specifications. As specified in the Report of Activities, if a problem necessitates the regeneration of the output ranges and the revised output ranges are not provided ten days prior to the on-site review, Standard A-6 will not be verified

during the initial on-site review. Other standards also cannot be verified pending the review of Form A-4 (Output Ranges).

Also during the audit, it was discovered that ARA unnecessarily remapped several ZIP Codes in the FHCF industry exposure data. This error will necessitate the regeneration of Forms A-2, A-3, A-4, A-5, A-8, S-2, and S-5.

The Professional Team was unable to verify Standards G-3 (Risk Location), A-6 (Loss Output), S-1 (Modeled Results and Goodness-of-Fit), and S-6 (Comparison of Projected Hurricane Loss Costs). Consequently, G-1 (Scope of the Computer Model and Its Implementation), G-4 (Independence of Model Components), C-4 (Implementation), and C-5 (Verification) also could not be verified as they require the verification of the aforementioned standards. At the exit briefing, modeler options as given in the Report of Activities were presented to the modeler.

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 correspond to the January 8, 2013 submission.

- Page 34, G-2, Disclosure 2
- Page 49, M-1, Disclosure 1
- Page 51, M-2
- Page 54, M-2, Disclosure 1
- Page 61, M-4, Disclosure 7
- Page 63, M-5, Disclosure 1
- Page 64, M-5, Disclosure 2
- Page 66, M-5, Disclosure 2, Figure 17
- Page 79, V-3.A
- Page 155, Form M-3
- Page 156, Form M-3, Figure 37
- Page 164, Form V-2
- Page 233, Form S-3

### **Additional Verification Review – May 6, 2013**

ARA submitted revisions to the original November 1, 2012 model submission under the 2011 Standards on April 29, 2013. The Professional Team completed an additional verification review on May 6, 2013 in Raleigh.

The following individuals participated in the additional verification review.

#### **ARA**

Francis M. Lavelle, Ph.D., P.E., Vice President  
Peter J. Vickery, Ph.D., P.E., Principal Engineer

#### **Professional Team**

Paul Fishwick, Ph.D., Computer Scientist  
Mark Johnson, Ph.D., Statistician, Team Leader

Marty Simons, ACAS, Actuary  
Donna Sirmons, Staff

The additional verification review began with a discussion of the outstanding issues. ARA confirmed no additional changes were discovered or made since the April 29, 2013 revised submission.

ARA began with a presentation on the revised ZIP Code mapping approach necessitated by the discovery of some ZIP Code problems on the initial on-site review. These problems led to a comprehensive revision of the ZIP Code mapping process. The corresponding verification of the process was reviewed.

The Professional Team reviewed all materials in the re-submission that were impacted by the corrections noted previously.

All standards are now verified by the Professional Team.

### **Report on Deficiencies**

The Professional Team reviewed the following deficiencies cited by the Commission at the December 17, 2012 meeting. The deficiencies were corrected by the established time frame, and the corrections have been verified.

1. Model Submission Checklist (page 7)  
Response is unclear. Item 6d is marked “Yes,” but Form S-6 was not provided in the submission.
2. Standard G-1, Disclosure 2 (page 23, line 7)  
Response is unclear as there are six papers in *The Journal of Structural Engineering* given on page 121 over the period 1995 to 2005. The response should indicate which parts of these papers are relevant to HurLoss 6.0.
3. Standard G-1, Disclosure 5.A (page 24)  
Response is unclear. Clarify “minor” change (1) of “upward effect on modeled loss costs (-4%).”
4. Standard G-1, Disclosure 5.C (page 25)
  - a. Color-coded maps by county reflecting the percentage difference in average annual zero deductible statewide loss costs for each model component change were not provided. Only one overall map is provided in Figure 3 which blends the changes due to damage functions and modifiers, two new hurricane seasons, land use/land cover database and ZIP Codes updates.
  - b. Map provided in Figure 3 is unclear. The text indicates Figure 3 is “for a default wood frame structure,” whereas the legend indicates it is for “FHCF 2007.” Furthermore, if the map is indeed for a default wood frame structure, it does not represent changes as described on page 24 in 5.A.2 with regard to

changes in “damage functions and modifiers for steel or reinforced concrete frame commercial-residential buildings.”

- c. Maximum and minimum values and locations were not provided in Figure 3 as required by II.A.5.e.3 in the *Report of Activities (page 46)*: “Maps will use three colors – blue, white, and red, including shades of blue and red, with dark blue and dark red designating the lowest and highest quantities, respectively. The color legend and associated map shall be comprised of an appropriate number of intervals to provide readability. The maximum and minimum values and locations shall be provided.”
5. Standard G-5, Disclosure 1 (page 41)  
Response is unclear as the same response was provided in the final submission under the 2009 Standards and was not updated to reflect the current submission.
6. Standard V-1.C (page 64)  
Response is non-responsive to the standard requirement.
7. Standard V-1.D (page 64)  
Response is non-responsive to the standard requirement.
8. Standard V-1, Disclosure 13 (page 68)  
Response is non-responsive as Form S-3 does not provide demonstration of consistency of vulnerability functions with insurance data.
9. Standard V-1, Disclosure 14 (page 68)  
Response is non-responsive as Form S-3 does not provide demonstration of consistency of vulnerability functions with insurance data.
10. Form G-4 (page 132) – COMPLETE  
Response is incomplete as there is no signature on the form and the Actuarial Report was not provided in the submission.  
\*\*Note – Completed Form G-4 and Actuarial Report received on November 7, 2012.
11. Form M-2 (pages 141-143)  
Response is incomplete as minimum values and locations were not provided in Figures 27-29 as required by II.A.5.e.3 in the *Report of Activities (page 46)* and maximum values are different from those provided in the text.
12. Form A-1 (pages 156-158)  
Response is incomplete as maximum and minimum values and locations were not provided in Figures 33-35 as required by II.A.5.e.3 in the *Report of Activities (page 46)*.
13. Form A-3 (pages 179-181)  
Figures 36-40 are non-responsive as the requirement is for personal and commercial residential modeled loss costs rather than just commercial residential as provided.

14. Form A-4 (pages 185-189)  
Response is incomplete as only 0% deductible output ranges are provided and not those corresponding to the specified deductibles.
15. Form A-5.A (page 192)  
Response is incomplete as percentage change from prior commercial residential loss costs was not provided. Percentage change from prior specified deductible output ranges was also not provided.
16. Form A-5.C (pages 193-196)
  - a. Response is incomplete as maximum and minimum values and locations were not provided as required by II.A.5.e.3 in the *Report of Activities* (page 46).
  - b. Response is incomplete as color-coded map by county reflecting the percentage change in the average loss costs with specified deductibles for commercial residential was not provided.
17. Form S-4.C (page 217)  
Response is unclear. Clarify the axis values in Figure 51.

### **Report on Issues**

At the conclusion of the additional verification review, the Professional Team subset discussed the following issues identified by the Commission at the December 17, 2012 meeting. The modeler will give a detailed presentation to the Commission on these issues during the trade secret session of the meeting to review the model for acceptability.

1. Development of loss costs in the model and changes in the loss costs from the last change in the model, specifically how the model treats coastal versus inland loss costs. Be prepared to fully explain the process for incorporating changes in the model including the analyses of the underlying data. More detail to be provided in the presentation and discussion of Form A-5.
2. Describe if the model makes assumptions for adjustor errors or contract ambiguity.

### **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).

The goal of the Professional Team on-site review is to provide the Commission with a clear and thorough report of the model, subject to non-disclosure restrictions on proprietary information. All modifications, adjustments, assumptions, or other criteria that were included in producing the information requested by the Commission in the submission should be disclosed and will be reviewed.

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 Professional Team will review selected computer code in conjunction with the reviews performed for each section. Computer code should be readily available in a format that will allow simultaneous visualization by the entire Professional Team. Access to critical articles or materials referenced in the submission or during the on-site review should be available on-site for the Professional Team. The Professional Team should be provided access to internet connections through the Professional Team members' laptops for reference work that may be required while on-site.

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 2011 Report of Activities, and (4) responses to the audit items for each standard in the Report of Activities.

Be prepared to have available for the Professional Team's consideration, all insurance company claims data received since 2004, including all data related to the 2004 and 2005 hurricane seasons. Be prepared to describe any processes used to amend or validate the model that incorporates this data.

Provide an explanation for each loss cost change of more than 5% from the loss costs produced in the previous submission using the 2007 Florida Hurricane Catastrophe Fund (FHCF) exposure data to the corresponding loss costs produced in the current submission using the 2007 FHCF exposure data.

When the Professional Team arrives on-site, provide five (5) printed copies of all figures with scales for the X and Y axes labeled that are not so labeled in the submission. Label the figures with the same figure number as given in the submission. Also, provide five (5) printed copies of Form V-3 and the electronic file used to complete Form V-3 on a

removable drive medium. This material will be used during the on-site review and will be returned when the on-site review is complete. Additionally, provide five (5) printed copies of Form A-6 (all 8 worksheets) and the electronic file(s) used to complete Form A-6 and Form A-7. The electronic files will be examined only on-site and will be deleted from the Professional Team member's laptop at the conclusion of the review.

Be prepared to provide for the Professional Team's review all engineering data (post event surveys, tests, etc.) received since the review by the Professional Team in 2009. Be prepared to describe any processes used to amend or validate the model that incorporates this data.

If any changes have been made in any part of the model or the modeling process from the descriptions provided in the original 2011 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 of the form changed.

As part of the on-site review, the Professional Team is charged with obtaining information regarding the two issues noted in the deficiency letter that will be later considered during the trade secret portion of the Commission meeting.

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 Computer Model and Its Implementation\****(\*Significant Revision)*

- A. The computer model shall project loss costs and probable maximum loss levels for residential property insured damage 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/or modeling organization documents.**

**Audit**

1. The main intent of the audit is to determine the capabilities of the model and to assess its implementation for purposes of Florida projected insured loss costs and probable maximum loss levels. Copies of all representative or primary technical papers that describe the underlying model theory shall be made available.
2. The process defined in Standard G-1.B will be: (1) reviewed for its inclusion of all stages of the modeling process, and (2) traced using the Computer Standards for one or more items listed in the response to Disclosure 5.
3. All software (1) located within the model, (2) used to compile data used by the model, (3) used to validate the model, (4) used to project model loss costs and probable maximum loss levels, and (5) used to create forms required by the *Report of Activities*:
  - a. Shall fall within the scope of the Computer Standards;
  - b. Shall be located in centralized, model-level file areas; and
  - c. Shall be reviewable interactively (viewed simultaneously by all Professional Team members in conjunction with the review of each standard).
4. Maps, databases, or data files relevant to the modeling organization's submission will be reviewed.
5. Provide the following information related to changes in the model from the initial submission this year to each subsequent revision.
  - A. Model changes:
    1. A summary description of changes that affect, or believe 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 for:
    1. All changes combined, and
    2. Each individual model component change.
  - C. For any modifications to Form A-4 since the initial submission, additional versions of Form A-5:

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 for each model component change:
1. Between the previously accepted submission and the revised submission,
  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.B, page 19: Illustrate and explain, in detail, the documented process used to comply with Standard G-1.B.
2. G-1, Disclosure 5.A, page 24: Provide in detail the supporting material for the changes to the model from the previous final submission. Describe the process implemented to assure that "These changes have no impact on the loss estimates produced by the model."
3. G-1, Disclosure 5.A, page 24: Provide in detail the updating of damage functions and modifiers. Describe why the change, how it was implemented, what are the results, improvements, and comparisons with previous corresponding damage functions and modifiers.
4. G-1, Disclosure 5.A & B, pages 24-25: Explain the process used to determine the magnitude of impact of changes individually and in combination. The percent change due to the updates in modeling of high-rise building shall be computed by comparing the model results with change, and keeping everything else the same. Explain in the case of land use / land cover an upward change (~2%).
5. G-1, Disclosure 5.C, page 25: Explain the apparent anomaly indicated in Figure 3 for Suwannee County. Explain an increase of 67.9% based on the changes to the model.

**Verified:    NO    YES**

### Professional Team Comments:

This standard cannot be verified pending verification of Standards G-3, A-6, S-1, and S-6.

Discussed procedures for maintaining, revising, and verifying the model.

Discussed the process and reviewed the test results for verifying changes to the statewide loss costs as a result of model updates and revisions.

Reviewed the shift in distribution due to the additional damage functions implemented for modeling buildings higher than 80', unit floor location within building, and building code era and building location.

Reviewed the process used to determine the magnitude of impact of the model changes individually and in combination.

Discussed the percentage change in loss costs for Suwannee County due to ZIP Code updates from the November to the January resubmission. Reviewed the incremental impacts as given in Figures 3-10. Identified Figures needing further revision.

Reviewed differences in ARA and FHCF ZIP Code databases for Suwannee County.

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

Reviewed percentage changes in average annual zero deductible statewide loss costs due to the revised ZIP Code mapping and all model changes combined.

Verified after resolution of outstanding issues with Standards G-3, A-6, S-1 and S-6.

**G-2 Qualifications of Modeling Organization Personnel and Consultants**

- 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 or any modifications to an accepted model shall be reviewed by either modeling organization personnel or consultants in the following professional disciplines: structural/wind engineering (licensed Professional Engineer), statistics (advanced degree), actuarial science (Associate or Fellow of Casualty Actuarial Society), meteorology (advanced degree), and computer/information science (advanced degree). These individuals shall certify Forms G-1 through G-6 as applicable and shall abide by the standards of their profession.**

**Audit**

1. The professional vitae of modeling organization personnel and consultants responsible for the current model and information on their predecessors if different than current personnel will be reviewed. Background information on individuals providing testimonial letters in the submission shall be provided.
2. Forms G-1, G-2, G-3, G-4, G-5, G-6, 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. Discuss any 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.

**Pre-Visit Letter**

6. G-2, Disclosure 2.B, page 32: Resumes for the new employees listed should be available.
7. G-2, Disclosure 3.B, page 34: The 2012 actuarial review by Matt Chamberlain should be available.

**Verified: YES**

**Professional Team Comments:**

Reviewed resumes of new personnel:

- Matthew Chamberlain, FCAS, MAAA, Actuary, Milliman; M.S. Physics, Auburn University, Auburn, Alabama; B.S. Physics, The Ohio State University, Columbus, Ohio; B.A. Classics, The Ohio State University, Columbus, Ohio

- Chris Gorski, B.S. Computer Science, North Carolina State University, Raleigh, NC
- David Mizzen, B.E. Sc. Civil & Structural Engineering, The University of Western Ontario, Canada; M.S.C.E. Civil Engineering, Purdue University, West Lafayette, IN
- Partha Sarathi, Ph.D. Civil & Environmental Engineering, The University of Western Ontario, Canada; M.A.Sc. Civil & Environmental Engineering, The University of Windsor, Ontario, Canada; B.Sc. Civil Engineering, Bangladesh University of Engineering and Technology, Bangladesh
- Chris Townsend, B.B. Business Finance, University of North Carolina, Wilmington, NC

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

Reviewed the actuarial opinion letters provided by consulting actuary Matthew Chamberlain.

**G-3 Risk 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.***

**Audit**

1. Provide geographic displays for all ZIP Codes.
2. Provide geographic comparisons of previous to current locations of ZIP Code centroids.
3. Provide the third party vendor, if applicable, and a complete description of the process used to validate ZIP Code information.
4. The treatment of ZIP Code centroids over water or other uninhabitable terrain will be reviewed.

**Verified:    NO    YES**

**Professional Team Comments:**

Reviewed ARA mapping of FHCF ZIP Codes for the entire state of Florida in detail and discovered several ZIP Codes were unnecessarily remapped.

Reviewed the methodology for developing, updating and validating ZIP Code centroids.

Reviewed new boundaries used to compute several ZIP Code surface roughness values.

Reviewed the -0.3% change in statewide loss costs due to the changes in the ZIP Code centroid determinations.

Reviewed geographic displays of ZIP Codes and comparisons of new centroid locations to previous locations for the entire state.

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

Reviewed revised ZIP Code mappings and approach to ensure:

1. a ZIP Code is only re-mapped if it does not already exist as a polygon ZIP code,

2. a point ZIP Code is re-mapped to its “parent” ZIP Code whenever such a mapping is available, and
3. ZIP Codes that cannot be re-mapped using 1. or 2. above are re-mapped using the latest ZIP Code mappings from previous years following the rules in 1. and 2. above.

Reviewed numerous ZIP Code mappings and the resulting changes in loss costs.

## **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. Demonstrate that the model components adequately portray 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 and (2) the basis of their integration. For example, a model would not meet this standard if an artificial calibration adjustment had been made to improve the match of historical and model results for a specific hurricane.
2. Describe all changes in the model since the previous submission that might impact the independence of the model components.

**Verified:    NO    YES**

### **Professional Team Comments:**

This standard cannot be verified pending verification of Standards G-3, A-6, S-1, and S-6.

### **\*\*\*Additional Verification Review Comments\*\*\***

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

Verified after resolution of outstanding issues with Standards G-3, A-6, S-1 and S-6.

## G-5 Editorial Compliance

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

### Audit

1. Demonstrate that the person or persons who have reviewed the submission has had experience in reviewing technical documentation and such person or persons is familiar with the submission requirements as set forth in the Commission's *Report of Activities as of December 31, 2011*.
2. Describe all changes to the submission document since the previously accepted submission that might impact the final document submission.
3. Demonstrate that the submission has been reviewed for grammatical correctness, typographical accuracy, completeness, and inclusion of extraneous data or materials.
4. Demonstrate that the submission has been reviewed by the signatories on Forms G-1 through G-6 for accuracy and completeness.
5. The modification history for submission documentation will be reviewed.
6. A flowchart defining the process for form creation will be reviewed.
7. Form G-7 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.

Discussed with Frank Lavelle the process used by Lisa West for editorial review.

## Meteorological Standards – Jenni Evans, Leader

### M-1 Base Hurricane Storm Set\*

(\*Significant Revision)

- A. Annual frequencies used in both model calibration and model validation shall be based upon the National Hurricane Center HURDAT starting at 1900 as of August 15, 2011 (or later). Complete additional season increments based on updates to HURDAT approved by the Tropical Prediction Center/National Hurricane Center are acceptable modifications to these storm sets. Peer reviewed atmospheric science literature can 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's Base Hurricane Storm Set will be reviewed.
2. Provide a flowchart illustrating how changes in the HURDAT database are used in the calculation of landfall distribution.
3. Reasoning and justification underlying any modification by the modeling organization to the Base Hurricane Storm Set will be reviewed.
4. Reasoning and justification underlying any short-term and long-term 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 hurricane frequencies for the four regions of Florida and overall as provided in Form M-1 will be reviewed.
6. Form M-1 will be reviewed for consistency with Form S-1. Changes to the modeling organization's Base Hurricane Storm Set from the previously accepted submission will be reviewed.
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 historical record. In the case of partitioning, modeled probabilities from the partition and its complement will be reviewed and compared with the complete historical record.

**Pre-Visit Letter**

8. M-1, Disclosure 1, page 43: Demonstrate the method for incorporating updates to the Base Hurricane Storm Set used.
11. Form M-1, page 137: Justify the distribution of modeled storms, in particular for By-Passing Hurricanes.
12. Form M-1, page 137: Verify consistency between Form M-1 and Form S-1 (page 208).

**Verified: YES**

**Professional Team Comments:**

Reviewed the procedure for incorporating and validating updates to the Base Hurricane Storm Set.

Discussed counting of stochastic by-passers in Form M-1 designed to be equivalent to NHC reanalysis method (sustained hurricane winds over land). Discussed that definition of by-passers applied elsewhere agrees with Commission definition (Standard A-2).

Discussed updated model version adds two years of starting points and four years of sea surface temperatures (SST) and environmental data (tropopause temperature and wind shear).

Discussed HURDAT re-analysis updates are not considered in the development of the stochastic storm set. Discussed that updates are used in stochastic set comparisons.

Reviewed plots comparing increased windspeeds from 2009 to 2011 due to increased sea surface temperatures. Discussed the decreasing importance of SST with increasing windspeed/return period.

Discussed changes to three historical storms: Great Miami Hurricane (1926), Lake Okeechobee Hurricane (1928), and NoName4 (1947). Reviewed windfield maps for the three revised historical storms.

Reviewed the 6.2% change in statewide loss costs due to the updates to the hurricane event set.

Reviewed Chi-Squared test results for modeled storms by region in Form M-1.

Discussed historical storms in Form M-1 do not include the additional storms listed in Form A-2.

Discussed that no short- or long-term variations are imposed.

Reviewed consistency between Forms M-1 and S-1. Discussed use of 112 years (modeler) compared to 111 years (Report of Activities).

## 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. Prepare graphical depictions of hurricane parameters as used in the model. Describe and justify:
  - a. The data set basis for the fitted distributions,
  - b. The modeled dependencies among correlated parameters in the windfield component and how they are represented,
  - c. The asymmetric nature of hurricanes,
  - d. The fitting methods used and any smoothing techniques employed.
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. All cited scientific literature provided in Standard G-1 will 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. Describe the value(s) of the far-field pressure used in the model and approximate its sensitivity on the average annual zero deductible statewide loss costs.

**Verified: YES**

### Professional Team Comments:

Discussed scaling of 0.8 for developing the relative intensity of historical storms in the model.

Reviewed plot comparing 2009 to 2011 Hurricane Wilma (2005) gust windspeeds.

Reviewed databases and time periods used for hurricane simulations (sources of SST, wind shear, tropopause temperature).

Discussed use of constant far field pressure.

Discussed uncertainty in identifying far field pressure for historical storms and comparisons with NHC databases. Discussed use of constant far field pressure and relative humidity equal to 0.8 in analyses of historical relative intensities used to develop the stochastic intensity model.

### 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 – 130	Extensive
4	131 – 155	Extreme
5	Over 155	Catastrophic

#### Audit

1. Demonstrate that the quality of fit extends beyond the Florida border by showing results for appropriate coastal segments in Alabama, Georgia, and Mississippi.
2. Describe and support the method of selecting stochastic storm tracks.
3. Describe and support the method of selecting storm track strike intervals. If strike locations are on a discrete set, show the landfall points for major metropolitan areas in Florida.
4. Provide any modeling organization specific research performed to develop the functions used for simulating model variables or to develop databases.
5. Form S-3 will be reviewed for the probability distributions and data sources.

**Verified: YES**

**Professional Team Comments:**

Verified no change in the methodology used to generate stochastic storm tracks. Discussed that quality of fits extend outside of Florida.

Discussed that no storm selection imposed for landfalling hurricanes, so no strike intervals used.

Reviewed revised Form S-3 to be consistent with the hurricane parameters provided in revised M-2, Disclosure 1.

## **M-4 Hurricane Windfield Structure**

- A. Windfields generated by the model shall be consistent with observed historical storms affecting Florida.***
- B. 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.***
- C. With respect to multi-story structures, the model windfield shall account for the effects of the vertical variation of winds if not accounted for in the vulnerability functions.***

### **Audit**

1. Provide any modeling organization-specific research performed to develop the windfield functions used in the model. Identify the databases used.
2. Provide any modeling organization-specific research performed to derive the roughness distributions for Florida and adjacent states.
3. The spatial distribution of surface roughness used in the model will be reviewed.
4. Identify other variables in the model that affect over-land surface windspeed estimation.
5. Provide detailed comparisons of the model windfield with Hurricane Charley (2004), Hurricane Jeanne (2004), and Hurricane Wilma (2005).
6. For windfield and/or pressure distributions not previously reviewed, present time-based contour animations (capable of being paused) to demonstrate scientifically reasonable windfield characteristics.
7. The effects of vertical variation of winds as used in the model where applicable will be reviewed.
8. Form M-2 will be reviewed.

### **Pre-Visit Letter**

9. M-4, Disclosure 7, page 55: Describe the methods used to update the land use and land cover database and corresponding friction factors.
10. M-4, Disclosure 7, page 55: Relevant references should be included in the response.
13. Form M-2, page 141: Discuss the change in location between actual and open terrain maxima.

**Verified: YES**

**Professional Team Comments:**

Reviewed update to the land use land cover data to 2006 NLCD. Discussed that the overall methodology and NLCD canopy data are unchanged.

Reviewed adjustment calculations for percent tree canopy coverage for developed open space, developed low intensity, and developed medium intensity.

Reviewed methodology for tree canopy coverage and area weighting calculations.

Reviewed the +1.1% change in statewide loss costs due to the update of the land use land cover data.

Discussed in detail the NLCD classifications and  $z_0$  weights assigned for developed low intensity, developed medium intensity, and developed high intensity. Reviewed in detail aerial displays of the land use land cover for select developed low, medium, and high intensity terrain justifying the  $z_0$  classifications.

Reviewed comparisons of the modeled windfield distribution and windspeeds with observations for Hurricane Charley (2004), Hurricane Jeanne (2004), and Hurricane Wilma (2005).

Reviewed the change in location between actual and open terrain maximum one minute sustained windspeed at 10 meters in Form M-2. Discussed choice of  $z_0$  for Miami region and its possible impact on the location of the maximum winds in actual terrain (in Everglades) in Form M-2.

Discussed that treatment of vertical variation of winds is unchanged and is captured in the vulnerability functions.

Reviewed comparisons of modeled wind time series versus available station observations for the three major events updated: the Great Miami Hurricane (1926), Lake Okeechobee Hurricane (1928), and NoName4 Hurricane (1947). Reviewed revised windfield plots for these storms. This information is to be presented to the Commission during the Trade Secret session.

**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. Describe the variation in over-land decay rates used in the model.
2. Comparisons of the model's weakening rates to weakening rates for historical Florida hurricanes will be reviewed.
3. Transition of winds from over-water to over-land (i.e., landfall) will be reviewed. Provide color-coded snapshot maps of roughness length and spatial distribution of windspeeds over-land and over-water for Hurricane Jeanne (2004), Hurricane Dennis (2005), and Hurricane Andrew (1992) at the closest time after landfall.

**Verified: YES**

**Professional Team Comments:**

Discussed that over-land decay method is unchanged.

Reviewed maps of Hurricane Jeanne (2004) and Hurricane Wilma (2005) depicting windfields near landfall time and the transition of windspeeds from over-water to over-land.

**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 and the modeling organization's sensitivity analyses provide the information used in auditing this standard.
2. Justify the relationship between central pressure and radius of maximum winds.
3. Justify the variation of the asymmetry with the translation speed.

**Verified: YES**

**Professional Team Comments:**

Verified no change in the treatment of hurricane asymmetry from the previous submission.

Reviewed revised Form M-3 to correct wind radii values for 900mb central pressure.

Discussed use of two different subsets of stochastic storms in creating the table and graphs in Form M-3.

## VULNERABILITY STANDARDS – Masoud Zadeh, Leader

### V-1 Derivation of Vulnerability Functions\*

(\*Significant Revision)

- A. Development of the vulnerability functions shall be based on any or a combination of the following: (1) historical data, (2) tests, (3) structural calculations, (4) expert opinion, or (5) site inspections. However, any development of the vulnerability functions based on structural calculations or expert opinion shall be supported by tests, site inspections, and historical data.**
- B. The method of derivation of the 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 properties.**
- D. Building height/number of stories, primary construction material, year of construction, location, and other construction characteristics, as applicable, shall be used in the derivation and application of vulnerability functions.**
- E. Vulnerability functions shall be separately derived for commercial residential building structures, personal residential structures, mobile homes, appurtenant structures, contents, and time element coverages.**
- F. The minimum windspeed that generates damage shall be consistent with fundamental engineering principles.**
- G. Vulnerability functions shall include damage as attributable to windspeed and wind pressure, water infiltration, and missile impact associated with hurricanes. Vulnerability functions shall not include explicit damage to the structure due to flood, storm surge, or wave action.**

### Audit

1. Historical data shall be available in the original form with explanations for any changes made and descriptions of how missing or incorrect data were handled. For historical data used to develop vulnerability functions, demonstrate the goodness-of-fit of the data. Complete reports detailing loading conditions and damage suffered are required for any test data used. Complete structural calculations shall be presented so that a variety of different structure types and construction characteristics may be selected for review. The basis for expert opinion and original site inspection reports shall be available for review.

2. Copies of any papers, reports, and studies used in the development of the vulnerability functions shall be available for review. Copies of all public record documents used may be requested for review.
3. Multiple samples of vulnerability functions for building structures, mobile homes, appurtenant structures, contents, and time element coverages shall be available. The magnitude of logical changes among these items for a given windspeed shall be explained and validation materials shall be available.
4. Justify the construction types and characteristics used.
5. Provide validation of the mean vulnerability functions and associated uncertainties.
6. Document and justify all modifications to the vulnerability functions due to building codes and their enforcement. If age of building is used as a surrogate for building code and code enforcement, provide complete supporting information for the number of age groups used as well as the year(s) of construction that separates particular group(s).
7. Provide validation material for the disclosed minimum windspeed. Provide the computer code showing the inclusion of the minimum windspeed at which damage occurs.
8. The effects on building vulnerability from local and regional construction characteristics and building codes will be reviewed.
9. Describe whether and/or how the claim practices of insurance companies are accounted for when claims data for those insurance companies are used to develop or to verify vulnerability functions. 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.
10. Provide the percentage of damage at or above which the model assumes a total loss.
11. Form V-1 will be reviewed.

### **Pre-Visit Letter**

- 14.V-1.B, page 63: Explain how the uncertainties in vulnerability functions are developed, including the form and basis of the probability distributions around the mean damage ratio for a given windspeed level. Provide examples.
- 15.V-1, Disclosure 2, page 65: Describe the breakdown of loss data among building, content, and time element. Provide any new insurance data received and analyzed since 2007.
- 16.V-1, Disclosure 3, page 65: Provide support for Disclosure 3.
- 17.V-1, Disclosure 6, pages 66-67: Explain the basis for 19,040 classes of buildings and how the user decides which classes to be used for a portfolio with a limited number of

information fields. For example, explain how the building classes in the FHCF database are mapped to these 19,040 classes.

18. V-1, Disclosures 8-14, pages 67-68: Disclosures 8 through 14 are new disclosures for V-1. Prepare to discuss in depth.

22. Form V-1, page 149: Describe the process and provide the documentation for all steps to complete Form V-1. Discuss the reasons in Part B why the values for concrete dropped so much, whereas there was little change in wood frame, masonry, and mobile home. Provide comparisons of the corresponding vulnerability functions.

**Verified: YES**

### **Professional Team Comments:**

Reviewed the new vulnerability modeling of high-rise buildings. Loss functions for steel or reinforced concrete frame high-rise buildings were expanded to allow for modeling high-rise buildings of arbitrary height and to account for changes in building codes. Reviewed new modifiers for modeling buildings higher than 80', unit floor location within building, and building code era and building location. This information is to be presented to the Commission during the Trade Secret session.

Reviewed the development of the uncertainties associated with the vulnerability functions.

Reviewed graphical plot of cumulative distribution function of building loss for 8-story buildings.

Discussed quality of insurance loss data available for building, content, and time element losses and recent improvements in the data.

Discussed additional insured loss data received and analyzed in 2010, but not used to develop or modify the vulnerability functions in the model.

Discussed methodology to select vulnerability functions for buildings with unknown construction characteristics.

Discussed the methodology for development of vulnerability functions for commercial residential high-rise properties. Discussed how the model accounts for variation of windspeed with height of buildings in the development of the vulnerability functions. Discussed the high-rise analysis studies completed for the relativities study and their use in development of vulnerability functions for high-rise buildings.

Discussed the methodology for development of appurtenant structures and attached exterior structures vulnerabilities.

Discussed repair versus replacement thresholds assumptions (which may vary by insurer), and their use in the development of the vulnerability functions for high-rise commercial residential buildings.

Discussed validation of modeled losses by construction type and coverage as provided in Form S-4.

Discussed the process for completing Form V-1. Discussed the addition of the height modifier for buildings above 8-stories which reduced losses for concrete structures as evidenced in Form V-2.

Reviewed plot comparing Form V-1 masonry and mobile home losses, supporting the closeness of losses in Part B of Form V-1.

Reviewed the floor-by-floor and height average annual loss factors and calculations. Reviewed shape plots of floor-by-floor factors. Reviewed the corresponding equations and their implementation in the source code.

Reviewed the ratios of the ASCE to SBC building tables used to compute high-rise building factors and discussed the year bands to which they apply.

Reviewed maps of ASCE and SBC design windspeeds for Florida, Gulf Coast and Atlantic Coast states.

Reviewed factors computed for both concrete and steel buildings with Florida Building Code roof cover.

Reviewed breakdown of insurance claims data for personal residential and commercial residential losses into events, companies, and coverages.

**V-2 Derivation of Contents and Time Element Vulnerability Functions\****(\*Significant Revision)*

- A. The relationship between the modeled structure and contents vulnerability functions and historical structure and contents losses shall be reasonable.**
- B. Time element vulnerability function derivations shall consider the estimated time required to repair or replace the property.**
- C. The relationship between the modeled structure and time element vulnerability functions and historical structure and time element losses shall be reasonable.**
- D. 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. To the extent that historical data are used to develop mathematical depictions of contents functions, demonstrate the goodness-of-fit of the data to fitted models.
2. Justify changes from the previously accepted submission in the relativities between loss costs for structures and the corresponding loss costs for contents.
3. Documentation and justification of the following will be reviewed:
  - a. The method of derivation and data on which the time element vulnerability functions are based;
  - b. Validation data specifically applicable to time element coverages;
  - c. Assumptions regarding the coding of time element losses by insurers;
  - d. The effects of demand surge on time element for the 2004 and 2005 hurricane seasons;
  - e. Assumptions regarding the variability of time element losses by size of property;
  - f. Statewide application of time element coverage assumptions;
  - g. Assumptions regarding time element coverage for mobile homes, tenants, and condo unit owners exposure;
  - h. The methods used to incorporate the estimated time required to repair or replace the property;
  - i. The methodology and available validation for determining the extent of infrastructure damage and its effect on time element costs.
4. Justify changes from the previously accepted submission in the relativities between loss costs for structures and the corresponding loss costs for time element.
5. To the extent that historical data are used to develop mathematical depictions of time element functions, demonstrate the goodness-of-fit of the data to fitted models.

**Pre-Visit Letter**

19.V-2, pages 70-72: Discuss in depth and provide supporting documentation.

20.V-2, Disclosure 2, page 71: Discuss how the model allows for impact of damage to the infrastructures to time element loss.

**Verified: YES**

**Professional Team Comments:**

Discussed the methodology for development of contents and ALE vulnerabilities.

Discussed that the model allows for ALE losses to be incurred due to indirect causes such as damage to the infrastructure.

Reviewed relationship of contents losses to building losses for wood frame, masonry, and mobile home.

Reviewed relationship of ALE losses to building losses for wood frame, masonry, and mobile home.

Reviewed building loss cumulative distribution functions.

Reviewed calculation for expected insured loss.

Reviewed plot of contents and ALE ratios to building ratios for Hurricane Charley (2004).

Reviewed scatter plot of contents losses as a function of building damage for frame, masonry, and mobile home.

Reviewed scatter plot of ALE losses as a function of building damage for frame, masonry, and mobile home.

### **V-3 Mitigation Measures**

**A. Modeling of mitigation measures to improve a structure's wind resistance and the corresponding effects on vulnerability shall be theoretically sound and consistent with fundamental engineering principles. These measures shall include fixtures or construction techniques that enhance the performance of the structure 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.**

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

#### **Audit**

1. Form V-2 and Form V-3 (Trade Secret item) provide the information used in auditing this standard.
2. Individual mitigation measures as well as their effect on damage due to use of multiple mitigation measures will be reviewed. Any variation in the change over the range of windspeeds for individual and multiple mitigation measures will be reviewed.
3. Mitigation measures used by the model that are not listed as required in this standard will be disclosed and shown to be theoretically sound and reasonable.

#### **Pre-Visit Letter**

21. V-3, page 73: Discuss the changes and the basis for the changes in modifiers.

**Verified: YES**

#### **Professional Team Comments:**

Reviewed the process for completing Forms V-2 and V-3.

Reviewed a revised Form V-2 initially generated during the audit. ARA provided an explanation for the error in completing Form V-2 that was submitted in November 2012. Discussed mitigation measures in the model that produce the results given in Forms V-2 and V-3.

Discussed the fluctuation of hip roof damage percentage changes for frame and masonry structures as windspeed increased.

Reviewed revised Form V-3 and confirmed consistency with the revised Form V-2.

Reviewed the changes to mid- and high-rise modifiers.

Reviewed the changes in revised Form V-2 relative to the previously accepted Form V-2.

**ACTUARIAL STANDARDS – Marty Simons, Leader****A-1 Modeling Input Data**

- A. When used in the modeling process or for verification purposes, adjustments, edits, inclusions, or deletions to insurance company input data used by the modeling organization shall be based upon accepted actuarial, underwriting, and statistical procedures.*
- B. All modifications, adjustments, assumptions, inputs and/or 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 shall include methods to assure accuracy of insurance data. 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.

**Verified: YES**

**Professional Team Comments:**

Verified that the model does not take into account flood or storm surge other than the effects of storm surge damage on the infrastructure.

**A-2 Event Definition\****(\*Significant Revision)*

- A. 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.**
- B. Time element loss costs shall reflect losses due to infrastructure damage caused by a hurricane.**

**Audit**

1. The model will be reviewed to determine that the definition of an event 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 (if so, how) the model takes into account flood or hurricane storm surge.

**Verified: YES****Professional Team Comments:**

Verified no change in the definition of an event or the handling of by-passing storms in the model.

Discussed hurricane definition with the modeler and with consulting actuary, Matthew Chamberlain.

**A-3 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 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.***
- F. The methods, data, and assumptions used in the estimation of demand surge shall be actuarially sound.***

**Audit**

1. Describe 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.
2. The method of inclusion of secondary uncertainty in the probable maximum loss levels will be examined.
3. Provide the data and methods used to incorporate individual aspects of demand surge on personal and commercial residential coverages, inclusive of the effects from building material costs, labor costs, contents costs, repair time, etc.
4. All referenced literature will be reviewed to determine applicability.

**Verified: YES**

**Professional Team Comments:**

Verified modeled loss costs do not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margin, and the model does not make a prospective provision for economic inflation.

Verified no change in the previously accepted methodology for producing probable maximum loss estimates.

Verified that model is capable of producing loss costs and probable maximum loss costs at a geocode (latitude/longitude) level.

Reviewed the revisions to the demand surge component of the financial model. Discussed the new methodology where losses by coverage with demand surge are capped at the policy limits. Reviewed the -0.6% change in statewide loss costs due to the changes in modeling demand surge.

Discussed with Matthew Chamberlain, actuarial consultant, his review of the Actuarial disclosures and forms, and his review of modeler's demand surge procedures. Discussed the scope of his review.

**A-4 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. Describe the process used to determine the accuracy of the insurance-to-value criteria in data used to develop or validate the model results.
2. To the extent that historical data are used to develop mathematical depictions of deductibles and policy limits, demonstrate the goodness-of-fit of the data to fitted models.
3. To the extent that historical data are used to validate the model results, the treatment of the effects of deductibles, policy limits, and coinsurance in the data will be reviewed.
4. Justify changes from the previously accepted submission in the relativities among corresponding deductible amounts for the same coverage.

**Verified: YES**

**Professional Team Comments:**

Verified no change in the process for calculating and applying deductibles and policy limits from the previously accepted submission.

**A-5 Coverages**

- A. The methods used in the development of contents loss costs shall be actuarially sound.***
- B. The methods used in the development of time element coverage loss costs shall be actuarially sound.***

**Audit**

The methods used to produce contents and time element loss costs will be reviewed.

**Verified: YES**

**Professional Team Comments:**

Verified no change in the process and calculations used to develop contents and time element loss costs from the previous submission.

**A-6 Loss Output\****(\*Significant Revision)*

- 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 quality of building codes and enforcement increases, all other factors held constant.**
- G. Loss costs shall decrease as deductibles increase, all other factors held constant.**
- H. The relationship of loss costs for individual coverages, (e.g., structures and appurtenant structures, contents, and time element) shall be consistent with the coverages provided.**
- I. Output ranges shall be logical for the type of risk being modeled and deviations supported.**
- J. 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 mobile home risk exposure,**
  - 3. inland counties versus coastal counties, and**
  - 4. northern counties versus southern counties.**

## A-6 Loss Output (Continued)

***K. For loss cost and probable maximum loss level estimates derived from or validated with historical insured hurricane losses, the assumptions in the derivations concerning (1) construction characteristics, (2) policy provisions, (3) coinsurance, (4) contractual provisions, and (5) relevant underwriting practices underlying those losses, as well as any actuarial modifications, shall be appropriate based on the type of risk being modeled.***

### Audit

1. Provide the data and methods used for probable maximum loss levels for Form A-8.
2. All referenced literature will be reviewed 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. Forms A-1, A-2, A-3, A-6, and A-7 will be used to assess coverage relationships.
6. The total personal and commercial residential insured losses provided in Forms A-2 and A-3 will be reviewed individually for total personal residential and total commercial residential insured losses.
7. Forms A-4 and A-5 will be reviewed, including geographical representations of the data when applicable.
8. Justify all changes in loss costs from the previously accepted submission.
9. Form A-4 will be reviewed to ensure appropriate differentials among deductibles, coverage, and construction types.
10. Anomalies in the output range data will be reviewed and shall be justified.

### Pre-Visit Letter

23. Provide detailed results for Monroe County at the ZIP Code level for all Actuarial forms.
24. Form A-6: Describe the process and provide the documentation for all steps to complete Form A-6. Describe the steps taken to ensure sensibility of the results.

25. Form A-7, pages 198-203: Describe the process and provide the documentation for all steps to complete Form A-7. Describe the steps taken to ensure sensibility of the results.

26. Form A-8, pages 205 and 207: References to Form A-9 should be to Form A-8.

**Verified:    NO    YES**

**Professional Team Comments:**

Form A-4 was not completed using specified deductibles as documented in the output range instructions.

Reviewed ARA mapping of FHCF ZIP Codes for the entire state of Florida in detail and discovered several ZIP Codes were unnecessarily remapped. Due to this error, Forms A-2, A-3, A-4, A-5, and A-8 will need to be regenerated with the correct ZIP Code allocations.

Reviewed Forms A-1, A-2, A-3, A-4, A-5, A-7, and A-8 as submitted and A-6 on site.

Reviewed the change in interpretation of the industry exposure “additional risk characteristics” fields in the 2007 FHCF exposure data where the weakest value and the unknown values are coded with the same indicator. Reviewed the four factors revised to treat each as weak rather than previously treated as unknown: structure opening protection, roof shape, roof-wall connection, and roof-deck attachment. Reviewed the 2.8% decrease in statewide loss costs due to the change in handling the “additional risk characteristics” fields in the exposure data.

Discussed change in loss costs differences from the November to the January resubmission for Suwannee and St. Lucie counties due to additional ZIP Codes in both counties and the coding of ZIP Codes that cross county lines. Reviewed comparison of ARA ZIP Codes to FHCF ZIP Codes.

Reviewed differences between Form A-3 (2011 Standards) with the previous submission Form A-5 (2009 Standards) for various ZIP Codes of interest. Differences attributed to ZIP Code centroid movements and changes in surface roughness due to new land use land cover database.

Reviewed differences between Form A-1 and Form A-4 for frame, masonry, and mobile home due to mixture of known and unknown structure classification differences in the forms.

Discussed \$0 deductible results in Form A-4 for Calhoun and neighboring counties.

Reviewed specific Form A-6 results for varying building strengths and building codes. Discussed methodology for classifying year built, roof type and age.

Reviewed Monroe County ZIP Codes included in the model and ARA mapping of FHCF Monroe County ZIP Codes not in the ARA list of ZIP Codes.

Reviewed process and steps taken for completing Forms A-6 and A-7.

Discussed with Matthew Chamberlain, actuarial consultant, his review and emphasis on the logical relationship to risk and loss costs results.

Reviewed results in Form A-2. Discussed large changes due to revised windfields for the Great Miami Hurricane (1926), Lake Okeechobee Hurricane (1928), and NoName4 (1947) storms. Reviewed maps of winds produced for these storms based on the old (2009) and new (2012) hurricane parameters used.

Reviewed plot of percentage changes in modeled historical losses from the previous submission.

Discussed with the modeler that establishing a logical relation to risk must carefully consider that "all other variables are held constant" for certain relationships.

Reviewed map of Calhoun and Jackson County commercial residential loss costs by ZIP Code.

### **\*\*\*Additional Verification Review Comments\*\*\***

Reviewed revised Forms A-4 and A-5 using the specified (notional) deductibles instead of the deductibles given in the FHCF 2007 exposure data file.

Reviewed differences between the initial and revised Form A-4, including the specified deductibles and the ZIP Code re-mappings.

Reviewed process for preparing the revised Output Ranges (Form A-4) with specified deductibles.

**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, S-2, and S-3 will be reviewed. Provide justification for the distributions selected including, for example, citations to published literature or analyses of specific historical data.
2. The modeling organization's characterization of uncertainty for windspeed, damage estimates, annual loss, and loss costs will be reviewed.

**Pre-Visit Letter**

27. Form S-2, page 209: Explain how a majority of the years have no landfalling hurricanes in Florida yet the median losses are non-zero.

Verified:    **NO**    **YES**

**Professional Team Comments:**

Reviewed ARA mapping of FHCF ZIP Codes for the entire state of Florida in detail and discovered several ZIP Codes were unnecessarily remapped. Due to this error, Form S-2 will need to be regenerated with the correct ZIP Code allocations.

Discussed by-passing events occur in years where there are no Florida landfalls.

Discussed updates to datasets used in hurricane model. Form S-3 updated.

Reviewed goodness-of-fit tests for frequencies of storms by categories.

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

Reviewed revised Form S-2 using the actual deductibles provided in the FHCF 2007 exposure data set instead of \$0 deductible.

## **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 have taken appropriate action.*

### **Audit**

1. The modeling organization's sensitivity analysis will be reviewed in detail. Statistical techniques used to perform sensitivity analysis shall be explicitly stated. The results of the sensitivity analysis displayed in graphical format (e.g., contour plots with temporal animation) will be reviewed.
2. Form S-6 will be reviewed, if applicable.

**Verified: YES**

### **Professional Team Comments:**

Verified no changes in model methodology from the previous submission and no new sensitivity tests were required or performed.

### **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 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 shall be explicitly stated. The results of the uncertainty analysis displayed in graphical format (e.g., contour plots with temporal animation) will be reviewed.
2. Form S-6 will be reviewed, if applicable.

**Verified: YES**

#### **Professional Team Comments:**

Verified no changes in model methodology from the previous submission and no new uncertainty tests were required or performed.

## **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. Provide a graph assessing the accuracy associated with a low impact area such as Nassau County. We would expect that if the contribution error in an area such as Nassau County is small, the error in the other areas would be small as well. Assess where appropriate, the contribution of simulation uncertainty via confidence intervals.

**Verified: YES**

### **Professional Team Comments:**

Confirmed that 300,000 simulated years meets the standard through consideration of the standard errors.

## S-5 Replication of Known Hurricane Losses\*

(\*Significant Revision)

***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 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 expected 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 property used in each hurricane to address:
    - (1) Personal versus commercial
    - (2) Residential structures
    - (3) Mobile homes
    - (4) Commercial residential
    - (5) Condominiums
    - (6) Structures only
    - (7) Contents only,
  - i. The inclusion of demand surge, storm surge, loss adjustment expenses, or law and ordinance coverage in the actual losses or the modeled losses.
2. The following documentation will be reviewed:
  - a. Publicly available documentation referenced in the submission,
  - 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,
  - d. User input sheets 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 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**

28. Form S-4, page 217: Explain why frame is so superior to engineered which in turn is superior to masonry.

**Verified: YES**

### **Professional Team Comments:**

Reviewed comparisons in Form S-4 and their changes from the previous submission.

Discussed that locations and structural characteristics vary within each construction class and agree with the patterns observed in the loss data.

Reviewed validation comparisons in Form S-4 of total losses by construction type and by coverage for Hurricane Andrew. A previously overlooked error in a modeled loss has been corrected since the initial submission.

Discussed demand surge was not included in the validation studies.

## 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 will be reviewed for consistency with Standard G-1, Disclosure 5.
2. Justify the following:
  - 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,
  - e. Exposure assumptions.

### Pre-Visit Letter

29. Form S-5, page 218: Explain opposite directions in percentage change from the previously accepted submission.

Verified:    **NO**    **YES**

### Professional Team Comments:

Reviewed ARA mapping of FHCF ZIP Codes for the entire state of Florida in detail and discovered several ZIP Codes were unnecessarily remapped. Due to this error, Form S-5 will need to be regenerated with the correct ZIP Code allocations.

Reviewed initial Form S-5 for consistency with overall submission and determined that the submission results were reasonable in light of model updates and changes to major hurricane characteristics in the historical storm set.

### \*\*\*Additional Verification Review Comments\*\*\*

Verified changes in Form S-5 were non-significant to 3 decimal points after re-running the form with the correct ZIP Code allocations.

**COMPUTER STANDARDS – Paul Fishwick, Leader****C-1 Documentation\****(\*Significant Revision)*

- 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 binder, containing or referencing a complete set of documentation specifying the model structure, detailed software description, and functionality. Development of the documentation shall be indicative of accepted software engineering practices.**
- C. All computer software (i.e., user interface, scientific, engineering, actuarial, data preparation, and validation) relevant to the submission 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 submission 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 binder, in either electronic or physical form, and its maintenance process will be reviewed. The binder shall contain or reference full documentation of the software.
2. All documentation shall be easily accessible from a central location.
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) shall be present when the Computer Standards are being audited. Internal users of the software will be interviewed.
5. Provide verification that documentation is created separately from and is maintained consistently with the source code.
6. The tables specified in C-1.C that contain the items listed in Standard G-1, Disclosure 5 will be reviewed. The tables shall contain the item number in the first column. The remaining five

columns shall contain specific document or file references for affected components or data relating to the following Computer Standards: C-2, C-3, C-4, C-5, and C-6.

7. Trace the model changes specified in Standard G-1, Disclosure 5 through all Computer Standards.

### **Pre-Visit Letter**

30.C-1.B, page 107: Relate the primary binder table of contents with the response to Standard G-1, Disclosure 5 (pages 24-25) by demonstrating individual table item compliance with Computer Standards C-1 through C-7.

**Verified: YES**

### **Professional Team Comments:**

Reviewed the table of model changes from the previously accepted model, as required by Standard C-1, Audit 6.

Verified that the table required by Standard C-1, Audit 6 reflects major and minor changes to the model, as well as references to the associated documentation.

Reviewed the HurLoss Risk Analysis Suite, Primary Document Binder updated during the audit to reflect current procedures.

Reviewed HurLoss Binder 3-B for the land use land cover  $z_0$  mapping.

Reviewed HurLoss Binder 3-D for indexing the building code era.

Discussed with the modeler that the documentation needed to be updated so that documentation reflected the correct model year. Verified that the modeler updated this documentation.

## C-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. Provide confirmation that a complete set of requirements for each software component, as well as for each database or data file accessed by a component, has been maintained and documented.

### Pre-Visit Letter

- 31.C-2, page 108: Provide requirements documentation that specifically relates to each model change identified in Standard G-1, Disclosure 5 (pages 24-25).

**Verified: YES**

### Professional Team Comments:

Reviewed the requirements documentation related to the model changes as specified in Standard G-1, Disclosure 5.

Reviewed HurLoss 6.0 Florida Model Requirements document.

Reviewed revised requirements documentation to include current process for updating the ZIP Code centroid database.

Discussed the update of NLCD land use land cover (LULC) data from NLCD 2001 to NLCD 2006.

Reviewed requirements documentation for land use land cover z<sub>0</sub> mapping.

Reviewed a revised HurLoss 6.0 UI DB Requirements Implementation Test document updated during the audit to reflect current procedures and to add labels and legends for clarification.

Reviewed updated requirements for using the census block centroids within each ZIP Code.

Reviewed updated dataflow diagram for web-based model analysis requests.

### C-3 Model Architecture and Component Design

*The modeling organization shall maintain and document (1) detailed control and data flow diagrams and interface specifications for each software component, and (2) schema definitions for each database and data file. 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 flow diagrams, 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 diagram including components, sub-component diagrams, arcs, and labels.
2. A model component custodian, or designated proxy, shall be available for the review of each component.

#### Pre-Visit Letter

32.C-3, page 109: Provide a full description of the significant architectural and design changes as indicated in Standard G-1, Disclosure 5 (pages 24-25).

**Verified: YES**

#### Professional Team Comments:

Reviewed the new web-based user interface, MS SQL database for input and output of data, and parallel processing architecture used by HurLoss 6.0.

Reviewed verification tests using Forms A-1 and A-4 with identical model results using the standalone single-processor console application and the web-based multi-processor application.

Reviewed the revised data flow charts for the requirements.

Reviewed the roughness ( $z_0$ ) calculation flowchart.

## **C-4 Implementation**

- A. The modeling organization shall maintain a complete procedure of coding guidelines consistent with accepted software engineering practices.**
- B. The modeling organization shall maintain a complete procedure used in creating, deriving, or procuring and verifying databases or data files accessed by components.**
- C. All components shall be traceable, through explicit component identification in the flow diagrams, down to the code level.**
- D. The modeling organization shall maintain a table of all software components affecting loss costs, 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, Disclosure 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.**

## **Audit**

- 1. The interfaces and the coupling assumptions will be reviewed.
- 2. Provide the documented coding guidelines and confirm that these guidelines are uniformly implemented.
- 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 shall be available and 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 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 C-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 examined for sufficiency, consistency, and explanatory quality.

**Verified:    NO    YES**

**Professional Team Comments:**

This standard cannot be verified pending verification of Standards G-3, A-6, S-1, and S-6.

Reviewed the modeler's updates to Standard C-4.D, and noted that there were no comment line metric data associated with the database query code. Reviewed on-site updates to this data for the database code.

Discussed with the modeler a need to create a cross-reference equation variable table as required by Standard C-4.F. Reviewed a cross-reference equation variable table created on-site. In particular, reviewed documentation of environmental variables (sea surface temperature, wind shear, tropopause temperature) updated in the model.

Reviewed Access database for assigning the  $z_0$  score in the land use/land cover calculation.

Reviewed the Visual Basic code calculating surface roughness ( $z_0$ ) for "developed, open space" and "developed, low intensity" to reclassify each Florida county. This code is referenced in the  $z_0$  calculation flowchart.

Reviewed the Visual Basic code calculating the secondary modifier factors for high-rise buildings based on building height.

Reviewed source code for applying building location and design code adjustment factors.

Reviewed the matrix table of software components containing lines of code and comments as prescribed in Standard C-4.D. Reviewed examples demonstrating an adequate number of comments in database query-based scripts.

Reviewed a diagram illustrating the data structure and layout for the Cumulative Distribution Function (CDF) for building loss.

Verified the correct offset within a data table for referencing the previous building code era.

Verified that the number of comment lines reflected accepted software engineering practice for several provided source code examples.

Reviewed the modeler's use of copy and paste during the process of filling out various submission forms such as A-6 and A-7, in particular.

Reviewed procedure for creating Forms V-2 and V-3 and associated data files generated from the model output for form completion.

Reviewed table of variable names given in the source code for the building height factors in the equations for high-rise building vulnerability.

### **\*\*\*Additional Verification Review Comments\*\*\***

Reviewed the HurLoss ZIP Code mapping algorithm.

Reviewed the semi-automated implementation procedure with Geographic Information Systems (GIS) software to load the latitude/longitude of older ZIP Codes to fit the 2012 ZIP Code polygons.

Reviewed the procedure for using specified (notional) deductibles rather than the \$0 deductible or actual deductibles in the 2007 FHCF exposure data set.

Verified after resolution of outstanding issues with Standards G-3, A-6, S-1 and S-6.

**C-5 Verification\****(\*Significant Revision)***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. Crosschecking procedures and results for verifying equations 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.

### Pre-Visit Letter

33.C-5, page 112: Provide complete and thorough verification procedures and output from the model changes identified in Standard G-1, Disclosure 5 (pages 24-25).

Verified:    **NO**    **YES**

### Professional Team Comments:

This standard cannot be verified pending verification of Standards G-3, A-6, S-1, and S-6.

Discussed code walkthrough and crosschecking procedures for verifying revisions to the model.

Discussed code walk-through and cross-checking verification procedures for building height and floor of interest factors equations.

Reviewed an Access database to ensure correspondence of the data entries in the database with the modeler documented Z.score table showing the LULC class-to-roughness ( $z_0$ ) mapping.

Discussed that the software enhancement update includes a web-based user interface, SQL server database installation for storing input and output data within a multi-processor architecture.

Discussed with the modeler the zero percent change from the previously accepted model based on major change #1 identified in Standard G-1, Disclosure 5.

Discussed with the modeler that tests would need to be executed in more detail via regression tests to document a zero-percent change from the previously accepted model. Verified subsequent tests that satisfied this requirement.

Reviewed verification test procedures for HurLoss 6.0 web UI, database, and parallel processing.

### \*\*\*Additional Verification Review Comments\*\*\*

Reviewed the visual verification procedure used by the modeler to insure correct implementation of the ZIP Code mapping algorithm.

Reviewed verification of the use of specified deductibles versus actual deductible provided in the 2007 FHCF exposure data set.

Verified after resolution of outstanding issues with Standards G-3, A-6, S-1 and S-6.

## **C-6 Model Maintenance and Revision**

- A. The modeling organization shall maintain a clearly written policy for model 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 shall result in a new model version number.***
- C. The modeling organization shall use tracking software to identify 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 maintain the code, data, and documentation will be reviewed. For each component in the system decomposition, provide the installation date under configuration control, the current version number, and the date of the most recent change(s).
2. The policy for model revision will be reviewed.
3. The tracking software will be reviewed.
4. The list of all model revisions as specified in C-6.D will be reviewed.

### **Pre-Visit Letter**

- 34.C-6.D, page 114: Provide the model version history over the past 5 years, leading up to the version identified in the submission.

**Verified: YES**

### **Professional Team Comments:**

Reviewed the model version history over the past five years, leading up to the version identified in this year's model submission.

Reviewed the current policy for model revision, and the revised policy where the modeler added a detailed procedure for ensuring the correct correspondence among source code, slides, and documentation.

Discussed the use of Microsoft Visual SourceSafe and Microsoft Team Foundation Server to track all changes to the software and documentation.

Verified that the current model version is consistent with the policy for model revision.

Discussed current procedures for tracking updates to small, medium, and large databases.

Reviewed source control check-out procedures for the model updates through Visual SourceSafe.

## C-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 procedures and methods used to ensure the security of code, data, and documentation will be reviewed. Specify all security procedures.
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:

Verified no change from the previous submission with regard to security and backup procedures.

Discussed the modeler's confidence that there have been no security breaches to the model software.

Discussed with the modeler the general level of increased security, with the use of whitelisting web links (i.e., URLs).

Discussed with the modeler their increase in security based on cyberattacks at the corporate level.