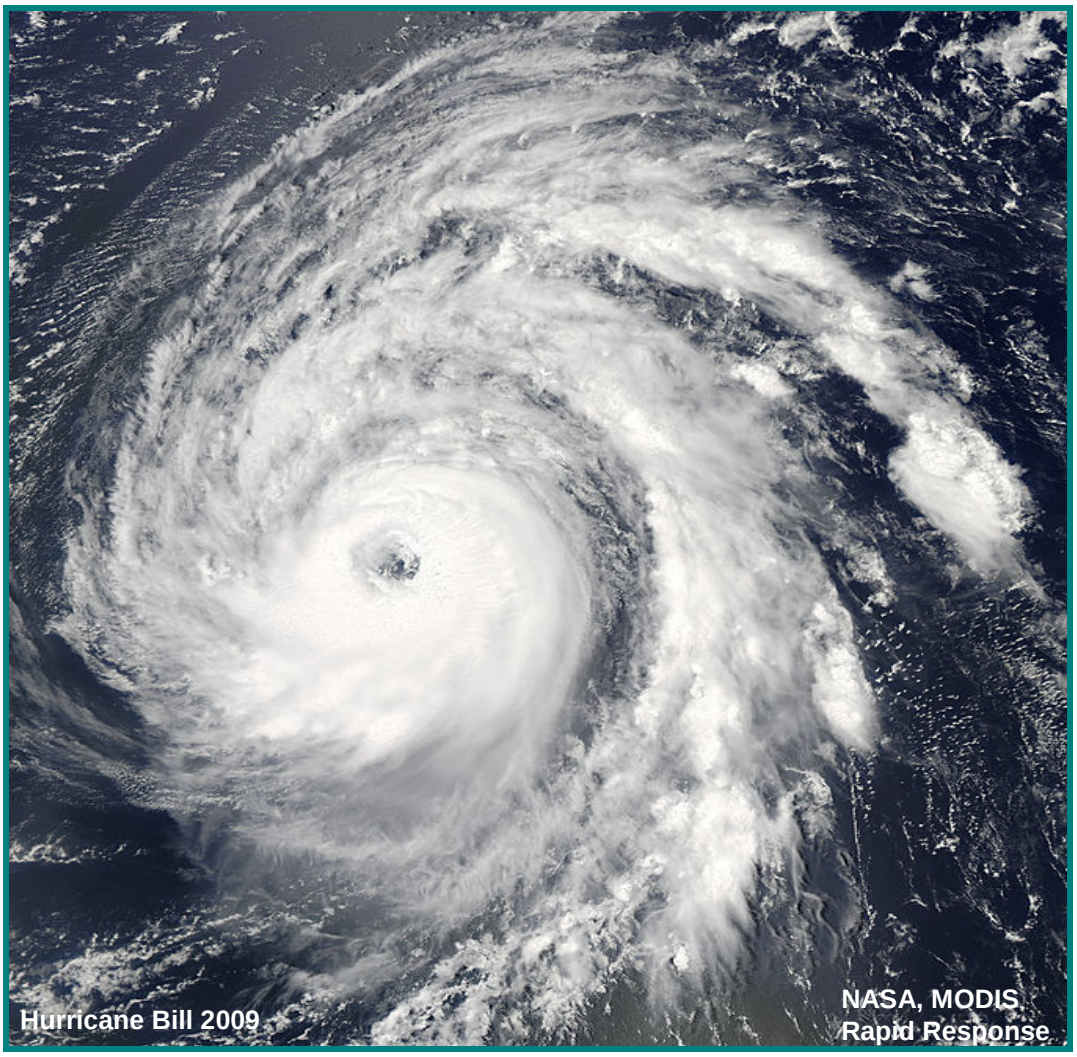
Florida Commission on Hurricane Loss Projection Methodology



Professional Team Report
2009 Standards

EQECAT, Inc.

On-Site Review
February 21-24, 2011

Additional Verification Review
May 17, 2011

On February 21-24, 2011, the Professional Team visited on-site at EQECAT, Inc. in Oakland, California. The following individuals participated in the review:

EQECAT
Branimir Betov, M.S., Senior Software Engineer
Justin Brolley, Ph.D., Hazards Modeler and Research Scientist
Aarti Dinesh, Product Manager
Annes Haseemkunju, Ph.D., Atmospheric Scientist
Petros Keshishian, Ph.D., Principal Engineer
Mahmoud M. Khater, Ph.D., P.E., Senior Vice President, Chief Science and Technology Officer
Omar Khemici, Ph.D., P.E., Vice President, Model Development
John Mangano, Vice President, Meteorologist
David F. Smith, Senior Vice President, Technology Development and Consulting
Paul Vendetti, FCAS, MAAA, Consulting Actuary

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
Donna Sirmons, Staff

The review began with introductions and an overview of the audit process. EQECAT began with a discussion of the following model changes:

- Probabilistic hurricane database regenerated to be consistent with HURDAT as of June 7, 2009, and to additionally include the 2009 hurricane season
- Update to incorporate directionally-varying friction factors
- Update to incorporate effect of inflow angle on boundary layer flow
- Land use/land cover data from the Florida Water Management District 2004-2008 used for resolution of communication, utility, and transportation land use categories
- Update to December 2009 ZIP Code database.

The Professional Team was unable to verify Standards M-2 (Hurricane Parameters and Characteristics), M-4 (Hurricane Windfield Structure), M-5 (Landfall and Over-Land Weakening Methodologies), M-6 (Logical Relationships of Hurricane Characteristics), S-1 (Modeled Results and Goodness-of-Fit), S-5 (Replication of Known Hurricane Losses), S-6 (Comparison of Projected Hurricane Loss Costs), C-1 (Documentation), C-4 (Implementation), and C-5 (Verification) due to a coding error in the inflow angle equation. The documentation of an equation from the scientific literature differed from that implemented in the source code. A re-run of the output ranges is necessitated. Hence Standards A-6 (Logical Relationship to Risk), A-10 (Output Ranges), and A-11 (Probable Maximum Loss) could not be verified. The Professional Team was also unable to verify Standard A-5 (User Inputs) due to handling of defaults for unknown construction type. Consequently, Standards G-1 (Scope of the Computer Model and Its Implementation), G-4 (Independence of Model Components), and G-5 (Editorial Compliance) could not be verified as they require the verification of all other standards. At the exit briefing, modeler options as given in the Report of Activities were reviewed.

The Professional Team reviewed the following corrections to be included in the revised submission:

- Page 13, G-1.2, Hazard Definition section revised to clarify use of NWS-23 in windspeed equation
- Page 22, G-1.4, Vihma and Savijarvi (1991) added to references
- Page 23, G-1.4, Simiu et al. (2007) added to references
- Page 25, G-1.5, revised to include change in sea-to-land transition
- Page 27, G-1.5, corrected Figure 5 due to misallocation of ZIP Codes
- Page 28, G-1.5, corrected Figure 6 due to misallocation of ZIP Codes
- Page 33, G-2.2.B, corrected to include new actuarial consultant, Paul Vendetti
- Page 35, G-2.3.A, updated independent peer review for surface windfield from Friedman to Tuleya
- Page 37, G-2.3.C, revised to replace Dr. Friedman with Professor Tuleya
- Page 52, M-2.1, corrected top range of Rmax
- Page 53, M-2.1 and 2, updated to include Kwon and Cheong (2010) reference
- Page 58, M-3.2, corrected dates of data sources for Radius of Maximum Winds and Translation Speed
- Pages 84-85, V-1.5, revised to provide clarification on vulnerability functions for four to seven story and more than seven story buildings
- Page 90, Form V-1, comment added to specify assumptions
- Page 94, Form V-2, comment added to specify assumptions
- Page 100, A-3.1, Hazard Definition section revised to clarify use of NWS-23 in windspeed equation
- Page 103, A-5, revised to clarify that insurer inputs are clearly identified
- Page 127, A-10.2, revised to include change in sea-to-land transition
- Page 134, Form A-2, Figure 28 legend corrected
- Page 236, S-1.4, revised to identify dataset used for Figure 51
- Page 251, Form S-3, corrected dates of data sources for Radius of Maximum Winds and Translation Speed

Additional Verification Review – May 17, 2011

EQECAT submitted revisions to the original November 15, 2010 model submission under the 2009 Standards on March 28, 2011. The Professional Team completed the additional verification review on May 17, 2011 in Oakland.

The following individuals participated in the additional verification review:

EQECAT
Branimir Betov, M.S., Senior Software Engineer
Justin Brolley, Ph.D., Hazards Modeler and Research Scientist
Annes Haseemkunju, Ph.D., Atmospheric Scientist
Mahmoud M. Khater, Ph.D., P.E., Senior Vice President, Chief Science and Technology Officer
Omar Khemici, Ph.D., P.E., Vice President, Model Development
John Mangano, Vice President, Meteorologist
David F. Smith, Senior Vice President, Technology Development and Consulting

Professional Team

Jenni Evans, Ph.D., Meteorologist
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. EQECAT confirmed no additional changes were discovered or made since the March 28, 2011 revised submission. EQECAT began with a presentation on the implementation of the inflow angle and the percentage changes in loss costs compared to the initial November 15, 2010 submission. EQECAT then provided an explanation on the incorporation of default structure types for North Florida and South Florida.

The Professional Team reviewed the Computer Standards related to the correction for coding the inflow angle equation and changes implemented to EQECAT's training procedures to mitigate future instances of coding errors. 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 14, 2010 meeting. The deficiencies were corrected by the established time frame and the corrections have been verified.

1. Standard G-1, Disclosure 5 (page 25)
   Updated inflow angle function (Standard M-4, Disclosure 2, page 60) and additional Florida Water Management District 2004-2008 land use and land cover data (Standard M-4, Disclosure 7, page 61) not included in the list of changes to the model.

2. Standard M-2, Disclosure 3 (page 54)
   References not provided for the modeling of the inflow angle.

3. Form S-6 (pages 261-263)
   There are several deficiencies with respect to the completion of Form S-6 and the attendant discussion and analyses:
   a. Confirm that the profile factor was based on the fourth input variable in the input file provided, *"FormS6Input09.xls."* This appears to be the case, but needs to be made explicit.
   b. Far field pressure was not used as an input variable as specified in the input file provided, *"FormS6Input09.xls."*
   c. The correction factor CF (conversion factor for converting the modeled gradient winds to surface winds) was not used as an input variable in the input file provided, *"FormS6Input09.xls."*

d. Standardized regression coefficients summary table and corresponding graph not provided.
e. Expected percentage reduction summary table and corresponding graph not provided.

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 so as 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 clarify points in this letter. The comments are grouped by standards sections. 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 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 an internet connection through one of the Professional Team member computers for reference work that may be required while on-site.

The presentation during the on-site review is recommended to proceed in the following sequence: (1) new, or updated, material related to the model; (2) responses to the pre-visit letter questions and issues; and (3) responses to the audit items for each standard in the Report of Activities.

Be prepared to provide for the Professional Team's review, 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.

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 2006. 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 2010 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.

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

GENERAL STANDARDS – Mark Johnson, Leader

G-1 Scope of the Computer Model and Its Implementation*

*(*Significant Revision)*

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

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. All software located within the model, used to compile data used by the model, used to validate the model, and used to project model loss costs and probable maximum loss levels (1) fall within the scope of the Computer Standards, and (2) will be reviewed interactively (viewed simultaneously by all Professional Team members in conjunction with the review of each standard).

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

Pre-Visit Letter

1. G-1, Disclosure 2, page 14: Provide the basis and how the correlations among individual site losses are modeled in aggregating losses.

2. G-1, Disclosure 5.A, page 25: Provide a summary of the new treatment of inflow angle incorporated in the model.

3. G-1, Disclosure 5.B, page 25: Be prepared to explain the 8.3% increase in the average annual zero deductible statewide loss costs as a result of the probabilistic hurricane database update.

4. G-1, Disclosure 5.B & C, page 25: Provide the percentage difference in average annual zero deductible statewide loss costs and color-coded map by county of the percentage difference resulting from the updated inflow angle function referred to on page 60.

5. G-1, Disclosure 5.C, page 25: Provide a color-coded map by county of the percentage difference in average annual zero deductible statewide loss costs as a result of the ZIP Code database update.

6. G-1, Disclosure 5.C, Figure 4, page 26: Be prepared to explain loss costs changes by county due to the Base Hurricane Storm Set update.

7. G-1, Disclosure 5.C, page 27: Be prepared to explain the large increases (>30%) next to large decreases (<-30%) in Figure 5. For example, counties around Lake Okeechobee.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Reviewed the impact of the updated inflow angle function on loss costs at the county level. Discovered a coding error that needs to be corrected so that description of model matches implementation.

Reviewed the new treatment of inflow angle in the model. The inflow angle is computed as a function of distance from storm center and radius of maximum winds based on Kwon, I.H. and Cheong, H.B. (2010).

Discussed the methodology for calculating and aggregating site loss distributions for each event.

Reviewed the base hurricane storm set update for consistency with HURDAT windspeeds near landfall locations.

Reviewed the ZIP Code database update and its overall and county-wide impacts. Reviewed change in assignment of ZIP Codes from one county to another.

Reviewed revised Figures 5 and 6 (pages 27 and 28) adjusted to assign ZIP Codes to the correct counties. Discussed why the ZIP Codes assigned to different counties did not affect Figure 4, impact of the frequency update.

Reviewed counties impacted mostly by the friction update, the ZIP Code database update, the base storm set update and the combination of the base storm set update with the friction update. Discussed the friction update including the inflow angle, land use land cover, and time stepping changes.

References reviewed:

- Kwon, I.H., and Cheong, H.B. (2010). “Tropical Cyclone Initialization with a Spherical High-Order Filter and an Idealized Three-Dimensional Bogus Vortex,” *Monthly Weather Review*, Vol. 138, No. 4, pp. 1344-1367.
- Simiu, E., Vickery, P., and Kareen, A. (2007). “Relation between Saffir-Simpson Hurricane Scale Wind Speeds and Peak 3-s Gust Speeds over Open Terrain,” *Journal of Structural Engineering*, Vol. 133, No. 7, 1043-1045.
- Vihma, T. and Savijarvi, H. (1991). “On the Effective Roughness Length for Heterogeneous Terrain,” *Quarterly Journal of Royal Meteorological Society*, Vol. 117, pp. 399-407.

- Westerink, J.J., et al. (2008). “A Basin- to Channel-Scale Unstructured Grid Hurricane Storm Surge Model Applied to Southern Louisiana,” *Monthly Weather Review*, Vol. 136, No.3, pp. 833-864.

Additional Verification Review Comments

Reviewed resolution of the inflow angle implementation.

Reviewed changes to the treatment of unknown construction types.

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 be signatories on Forms G-1 through G-6 as applicable and shall abide by the standards of professional conduct if adopted by 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

8. G-2, Disclosure 2.B, page 33: Response should include new consulting actuary Paul Vendetti. Provide the resumes of new personnel working on the model or acceptability process who were not involved at the time of the previous Professional Team review. Discuss departures of personnel involved in the previous version of the model.

9. G-2, Disclosure 2.D, page 35: Consulting actuary Paul Vendetti should be available for at least two hours during the on-site review. While the full two hours may not be needed, Mr. Vendetti should be prepared to discuss the steps taken to determine that the model meets each of the Actuarial Standards.

Verified: YES

Professional Team Comments:

Reviewed resume of new actuarial consultant, Paul A. Vendetti, FCAS, MAAA.

Reviewed recent independent peer review of the surface windfield by Professor Robert Tuleya on February 16, 2011. Response to disclosure G-2.3.A. revised to replace the independent peer review by Dr. Don Friedman in 1995 with the review completed by Tuleya in 2011.

Discussed personnel changes since the previous submission.

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

Reviewed updated Expert Certification Forms.

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.

Pre-Visit Letter

10. G-3, page 38: Be prepared to review the updated ZIP Code centroids as has been done during previous on-site reviews.

Verified: YES

Professional Team Comments:

Reviewed new versus old centroids throughout Florida and the process of quality assurance. Reviewed changes to vendor supplier of ZIP Code data.

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 M-2, M-4, M-5, M-6, A-5, A-6, A-10, A-11, S-1, S-5, S-6, C-1, C-4 and C-5.

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

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

G-5 Editorial Compliance

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

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 November 1, 2009*.

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: ~~**NO**~~ **YES**

Professional Team Comments:

This standard cannot be verified pending verification of Standards M-2, M-4, M-5, M-6, A-5, A-6, A-10, A-11, S-1, S-5, S-6, C-1, C-4 and C-5.

Reviewed flowchart describing submission form creation.

Editorial items noted by the Professional Team during the on-site reviews were satisfactorily addressed during the audit. The Professional Team has reviewed the submission per Audit item 3, but cannot guarantee that all editorial difficulties were identified. The modeler is responsible for eliminating such errors.

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 June 7, 2009 (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. (Trade Secret List item)

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

11. M-1, Disclosure 2, page 49: Response seems inconsistent with response given on page 68, Form M-1.E, "… other storms have been updated in order to have SSI intensities consistent …"

Verified: YES

Professional Team Comments:

Discussed that landfall frequency and severity distributions for the state of Florida were developed from NHC HURDAT starting at 1900 as of June 7, 2009 with the 2009 hurricane season additionally included. Discussed that any updates to the historical storms implemented by the modeler directly followed the changes in the list accompanying the 2009 Report of Activities, as provided by the Commission.

Reviewed flowchart for calculation of smoothed landfall distribution. Process is unchanged from previous years, but inputs updated consistent with historical database.

Discussed that the model considers only the long-term view of hurricane frequencies and makes no modifications of the historical frequencies as derived from the entire Base Hurricane Storm Set.

Form M-1 was reviewed for (i) consistency between historical and modeled frequencies by region and (ii) consistency between current and previous submission. Discussed how the method for counting "All Florida" landfalls changed between the submissions in response to a clarification of the form instructions in the 2009 Report of Activities (previous years counted every landfall for every storm and current submission reports only one landfall per storm).

Reviewed modeler comparison of individual historical storm changes by landfall location and intensity and check for consistency with historical frequency changes by Saffir Simpson category.

Reviewed modeler comparison of stochastic landfall frequencies by milepost and category between the previous and current submission. Reviewed comparison of these with the historical storm changes.

Compared frequencies reported in Forms M-1 and S-1. Difference in totals is due to rounding.

M-2 Hurricane Parameters and Characteristics*

*(*Significant Revision)*

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, strike probabilities, 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:

   - The data set basis for the fitted distributions,
   - The modeled dependencies among correlated parameters in the windfield component and how they are represented,
   - The asymmetric nature of hurricanes,
   - 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.

Pre-Visit Letter

12. M-2, page 51: Describe how the "EQECAT analyses of meteorological data" are tied to currently accepted scientific literature.

13. M-2, Disclosure 1, page 51: Response does not include central pressure (which is referred to on page 53 in response to disclosure 2).

14. M-2, Disclosure 1, page 52: Be prepared to discuss the range of Radius of Maximum Winds values given here compared to those provided in Form M-3.

15. M-2, Disclosure 3, page 54: Provide references from "recent peer-reviewed articles" in support of the new inflow angle treatment used in the model.

16. M-2, Disclosure 5, page 54: Be prepared to provide the methodology used to directly simulate surface winds.

17. M-2, Disclosure 9, page 55: Hurricane frequency distributions by intensity and segment (based on modeler's segmenting of coastline) are not provided in Form M-1. Be prepared to provide the hurricane frequency distribution for each segment.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

This standard cannot be verified since inflow angle affects depiction of spatial and time variant windfields and the asymmetric nature of hurricanes (audit item 2). Pre-visit Letter #15, treatment of inflow angle, and #16, methodology used to directly simulate surface winds, also await the additional review.

Reviewed application of kernel smoothing to derive distributions of landfall location, track direction and maximum 1-minute sustained winds at landfall. Discussed that there were no changes to the method, but the values are updated consistent with the Base Hurricane Storm Set and the addition of the 2009 season based on information from NHC advisories for the 2009 season.

Discussed that profile factor is the hurricane parameter used to assign the variation of rotational winds by distance from the storm. Discussed that a lognormal distribution of profile factor (varying by milepost) was derived from this historical data. Reviewed KS tests for profile factor distribution fits for "all US" and Florida only datasets.

Discussed that profile factors for more recent historical storm cases are determined from information in the NHC advisories and recent publications. Reviewed approach used for determination of profile factors for recent storms. Viewed plot illustrating their agreement with the existing lognormal distribution used for stochastic storms.

Viewed maps of coastline distributions of median, 5^{th} and 95^{th} percentile values for profile factor. Discussed that the maximum and minimum values in Figure 8 applied to the stochastic set for Florida.

Reviewed a graph of the profile factor versus Rmax data used to set an empirical Rmax-dependent upper bound on profile factor. Discussed implementation of this limit on profile factor to truncate for unrealistically large storms. Discussed that there is no truncation for a minimum profile factor.

Reviewed an asymmetric hurricane windfield plot for a modeled storm with Vmax = 130 mph; Rmax = 25 miles; profile factor = 1.0 (default value for Florida); and vortex motion = 25 mph.

Discussed that the interdependencies among model parameters and the representation of the windfield asymmetry due to storm motion are unchanged from the previous submission.

Verified that the model directly simulates surface winds at landfall, so no conversion factor between the modeled vortex winds and surface winds is used. Discussed choice of 0.9 for gradient to surface wind conversion to pressure at landfall for inland decay calculation.

Reviewed Simiu et al. (2007) and Vihma and Savijarvi (1991). Reviewed their application to the model in conjunction with the code. These are included in a revised reference list under Standard G-1.

Discussed external data sources relevant to model generated windfields. Updated LULC data and its quality control for update to surface roughness were reviewed.

Discussed that maximum 1-minute sustained 10-meter windspeed at landfall is used as input into the wind field model; central pressure is not an input parameter to the model.

Discussed that the far-field pressure used in the model is a constant value and is unchanged from the previous submission.

Reviewed modeler analysis of stochastic landfall frequencies by milepost and category between the previous and current submission. Reviewed comparison of these with the historical storm changes.

Differences between Table 3 on page 236 and Table 3 on page 266 of previous submission were due to changes to the treatment of friction (including the LULC update) and to the inflow angle adjustment incorporated into the current submission. Revised Table 3 will be provided with the upcoming inflow angle revision.

Discussed that EQECAT's analyses of meteorological data agrees with description in revised Form S-3.

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

Reviewed the effects of inflow angle and the impacts on the effective roughness length on windspeed and wind distribution. Reviewed schematics of the inflow angle effect for an idealized storm making landfall in the Florida panhandle, the east coast, and the southwest coast of Florida.

Reviewed the contribution of the inflow angle to the location of maximum winds relative to forward speed. All else equal, inflow angle shifts the location of the maximum winds from the right front towards the right rear of the storm center location. This can result in the storm center crossing the coast and beginning to decay before the maximum wind region reaches the coast. The delay in maximum winds reaching the coast allows time for extra filling thus reducing loss costs.

M-3 Hurricane Probabilities*

*(*Significant Revision)*

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

B. Modeled hurricane landfall strike probabilities 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 strike probabilities 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.

Pre-Visit Letter

18. M-3, Disclosure 1, page 57: Provide a summary list of all assumptions used in creating the hurricane characteristics databases.

19. M-3, Disclosure 2, page 58: Provide the time period used for the "HRD surface analysis" and list of storms analyzed. Provide a reference for this analysis.

Verified: YES

Professional Team Comments:

Verified continuity of fits for landfall frequencies and profile factors distributions for Florida and adjacent states.

Discussed that the only assumption applied in deriving the stochastic distributions is that the period 1900-2009 is representative of the long-term hurricane climatology in Florida and adjacent states.

Discussed that "HRD surface analyses" were only used for recent storm analyses, not for distribution development. Page 58 will be revised for year ranges and to remove reference to "HRD surface analyses" for distribution development. Form S-3 will be corrected for year ranges in agreement with those in revised page 58.

M-4 Hurricane Windfield Structure*

*(*Significant Revision)*

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 Katrina (2005), 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. (Trade Secret List item)

8. Form M-2 will be reviewed.

Pre-Visit Letter

20. M-4, page 59: Describe how the latest submission addresses Dr. Willoughby's concerns expressed at the June 3, 2009 model review meeting and given below.

    "I'm a lot concerned with the way you represent a profile of the 10-meter wind. There's a lot of dynamics going on in the boundary layer. To the extent that the parametric profiles that all of the models use were validated, they were validated with radial wind profiles. So there's a lot of detail that's being sort of

summed up in the few simple relations and one can easily imagine their complexities are significant to damage that you're not simulating has been pointed out with other modelers. The state-of-the-art is very much a moving target for learning a lot more about how hurricanes are put together and at some point the shelf life of this formulation is going to expire and it's out there. One would like to see some changes next year. The issue is that the science has advanced a lot. There are published references. There's a lot of dynamics that you can put in for relatively small cost and complexity and we would really like to see it moving that way. We'd like to see the industry as a whole get interested in improved parameterized wind profiles. I really am concerned about the way they have formulated the radial wind profile and the fact that they apply a profile that's designed for gradient winds to 10-meter winds."

21. M-4, Disclosure 2, page 60: Be prepared to justify continued use of the radial wind profile.

22. M-4, Disclosure 3, page 60: Be prepared to provide data in support of the new treatment of inflow angle in the model.

23. M-4, Disclosure 7, page 61: Be prepared to discuss the method for incorporating information from the new Florida Water Management District LULC data into the treatment of roughness length.

24. M-4, Disclosure 8, page 61: Provide the "recent meteorological references." Be prepared to describe the implementation in the model of the "16 directional effective roughness lengths using currently accepted methods."

25. M-4, Disclosure 9, page 62: Be prepared to provide a revised Figure 9 of Hurricane Wilma (2005) displaying all counties with modeled winds exceeding 40 mph.

26. M-4, Disclosure 12, page 63: Be prepared to provide a more complete explanation of the sources of the spatial variation of winds (including the "notable difference") based on updates to the model.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

This standard cannot be verified since inflow angle coding error means that the Professional Team cannot verify that the model is consistent with historic hurricanes (A). It also affects audit items (1) windfield functions in the model and (4) other variables – inflow angle – since it affects over-land surface windspeed estimation by impacting the choice of upstream roughness applied for friction (which also affects gust factor). These two issues mean that audit item (5) cannot be assessed since the model windfields for these storms cannot be reviewed and audit item (8) cannot be reviewed because Form M-2 will change. Answers to Pre-visit Letter items 22, 25 and 26 cannot be reviewed until inflow angle changes are completed.

Modeler responded to Dr. Willoughby's statement from the previous model review in 2009. Discussed that EQE has made considerable modifications to the modeled winds at a site since the previous submission. Discussed that these changes were made to provide an updated boundary layer transition between land use/land cover features including sea-to-land transitions.

Model changes to windfield calculations include:
- inclusion of wind direction and inflow angle, and
- introduction of a directionally-dependent land friction adjustment at a site to account for the effects of upwind land use/land cover features on the surface roughness.
Verified that previous method for windspeed reduction in coastal zones has been superseded by these updates.

Reviewed revised Figure 17 box plots and resolved differences from previous submission. Reviewed scatter plots, box plots, residual plots for Hurricane Charley (2004), Hurricane Katrina (2005) and Hurricane Wilma (2005).

Reviewed flow chart and reference papers for derivation of site-specific winds. Reviewed code modules for each equation (see Standard M-4).

Discussed that data for 27 US landfall events found in Table 13.1 were used to find a profile factor for a standardized "average" radial wind profile. Modeler discussed that the profile factor formulation used has the flexibility to fit wind profiles to actual events.

Reviewed straightforward modeler analyses comparing the EQECAT Generalized Standard Profile Equation for function of radial variation of rotational winds with a variety of well known windfield distributions.

Discussed variation of profile factor to get "best fit" for historical storms and eyeballed examples of these to compare similar fits for the Holland and Willoughby profiles.

Reviewed plots of HRD surface wind analyses (H*Wind) for Hurricane Frances (2004), Hurricane Jeanne (2004) and Hurricane Katrina (2005) just before landfall in Florida.

Reviewed a detailed description of the new methodology for assigning 16 directionally-dependent friction factors at each site. Technique for development of friction factors by sector was based on weightings described in Westerink et al. (2008) and an averaging approach described by Vihma and Savijarvi (1991).

Reviewed flow chart and reference papers for derivation of site-specific winds. Reviewed final mathematical formulation implemented in the model.

Reviewed application of resulting directional roughness factors to convert between over-water 1-minute 10-meter windspeed to over-land wind gust appropriate for local land use and land cover following Simiu et al. (2007).

Input roughness lengths were derived from the 30-meter resolution NLCD2001 dataset supplemented for airport runways, interstates, etc. using selected classes from the FWMD data (Transportation, Communications, Utilities). Reviewed modeler analyses to

determine that the FWMD data provide an improved roughness length assignment over the NLCD2001 for these classes for examples of Miami International Airport, Key West International Airport and Naval Air Station (NLCD alone and then overlaid with FWMD).

Reviewed codes for calculation of minimum pressure at landfall and pressure decay over land.

Reviewed code for calculation of friction effect leading to over-land winds at a site based on differential roughness length distribution based on wind direction.

Reviewed windfield animations for Hurricanes Dennis (2005) and Andrew (1992) demonstrating the application of differential roughness on directionally-varying winds over land and the logical transition of winds from over-water to over-land and back to over-water.

Reviewed code for application of inflow angle adjustment to rotational winds. Coding error was detected in inflow angle equation necessitating re-run of output ranges and PML.

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

Reviewed windfield exhibits for model simulations of historic hurricanes. Reviewed maps of modeled windspeeds and individual observations for Hurricane Charley (2004), Hurricane Katrina (2005) and Hurricane Wilma (2005). Reviewed scatter plots, box plots and residual plots for Hurricane Charley (2004), Hurricane Katrina (2005) and Hurricane Wilma (2005). Compared all exhibits with the counterparts in the initial November 15, 2010 submission.

Reviewed a revised Table 3 in Standard S-1 for agreement between historical observations and model simulations of historical storm windfields.

Reviewed revised Form M-2. Discussed expected changes due to inflow angle based on dominant storm direction at landfall for locations around the state. Discussed spatial distribution of winds and the change in location for the strongest winds for 100-yr and 250-yr return periods. Discussed that small changes in the top and second storm windspeeds between the previous and current submissions are due to the inflow angle and sea-to-land transition and result in the changed “top storm” locations.

M-5 Landfall and Over-Land Weakening Methodologies*

*(*Significant Revision)*

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 Dennis (2005) and Hurricane Andrew (1992) at the closest time after landfall. (Trade Secret List item)

Pre-Visit Letter

27. M-5, Disclosure 3, page 66: Be prepared to describe the method for determining the new directional friction factors used in the model.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Inflow angle affects the transition of winds from over-water to over-land (B) through the choice of upstream friction factor. Audit item #3 cannot be reviewed until the spatial windspeed distributions for Hurricanes Dennis (2005) and Andrew (1992) are revised consistent with the revised inflow angle.

Verified that the modeled decay rate formulation is unchanged. Reviewed method for determining minimum pressure from maximum windspeed at landfall taking into account storm motion.

Discussed application of profile factor formulation of windfield as the starting point for developing site-specific winds.

Reviewed windfield animations for Hurricanes Dennis (2005) and Andrew (1992) demonstrating the application of differential roughness on directionally-varying winds over land and the logical transition of winds from over-water to over-land and back to over-water.

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

Reviewed time-step color contour animations of spatial distributions of roughness length and of windspeeds over-land and over-water for Hurricane Andrew (1992) and Hurricane Dennis (2005). Compared exhibits for both the initial November 15, 2010 submission and the revised March 28, 2011 with the inflow angle implemented correctly. In both cases, the effect of the inflow angle implementation often resulted in a change in the upstream direction used for roughness length and so changed the windspeed at a chosen location.

Discussed that any small water mass upstream will cause a lowering of roughness length. Reviewed comparison of windspeed maps for Hurricane Katrina (2005) at landfall for the previous and current submission. Observed an increase in the hurricane wind region to the left of the storm at landfall in the barrier islands for inflow angle implementation.

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.

Pre-Visit Letter

28. M-6, Disclosure 3, page 67: Be prepared to demonstrate the consistency of the modeled wind radii (Form M-3) with observations.

29. Form M-3.C, page 77: Be prepared to discuss the radii limits depicted in Figure 17.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Inflow angle impacts Standard M-6 based on evaluation of the spatially varying windfield.

Discussed the difference between the boxplot in Form M-3 between the current and previous submission given that the relationship between central pressure and radius of maximum winds is unchanged. Differences result from weighting ranges in each boxplot by storms used in the current stochastic storm set. Viewed exhibit illustrating this explanation.

Compared ranges of 40 mph radius in Form M-3 with maximum and minimum profile factor wind profiles in Figure 8. Viewed examples illustrating the impact of motion in changing outer wind radii values to agree with table in Form M-3 assuming 15 mph forward speed.

Compared maximum Rmax for stochastic storm of 69 miles with maximum observed value.

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

Reviewed color contour animations of spatial distributions of windspeeds at landfall for Hurricane Andrew (1992) and Hurricane Dennis (2005). Reviewed asymmetry due to storm motion and due to landfall.

VULNERABILITY STANDARDS – Masoud Zadeh, Leader

V-1 Derivation of Vulnerability Functions*

*(*Significant Revision)*

A. Development of the vulnerability functions is to be based on a combination of the following: (1) historical data, (2) tests, (3) structural calculations, (4) expert opinion, or (5) site inspections. 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 associated uncertainties shall be theoretically sound.

C. Building height, construction type, and construction characteristics shall be used in the derivation and application of vulnerability functions.

D. In the derivation and application of vulnerability functions, assumptions concerning building code revisions and building code enforcement shall be justified.

E. Vulnerability functions shall be separately derived for building structures, mobile homes, appurtenant structures, contents, and time element coverages.

F. The minimum windspeed that generates damage shall be reasonable.

G. Vulnerability functions shall include damage due to hurricane hazards such as windspeed and wind pressure, water infiltration, and missile impact. Vulnerability functions shall not include explicit damage 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. To the extent that historical data are used to develop vulnerability functions, demonstrate the goodness-of-fit of the data to fitted models. 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. Form V-1 will be reviewed.

Information available on-site only:

- McDonald-Mehta Engineers (1993). *Vulnerability Functions for Estimating Wind Damage to Buildings*, for EQE Engineering and Design, Texas Tech University, Lubbock, TX.

Pre-Visit Letter

30. V-1.A, page 80: Be prepared to provide comparisons of model wood frame and masonry vulnerability functions with 2004 and 2005 hurricane loss data.

31. V-1.B, page 81: In response to the new language in the standard, describe how the uncertainties associated with vulnerability functions were developed.

32. V-1.C, page 81: In response to the new language in the standard, describe how the model accounts for variation of windspeed with height of buildings in the development of vulnerability functions. Provide plots of vulnerability functions and their uncertainty for 1-3, 4-7, and 8 or more story reinforced concrete constructions.

33. V-1.D, page 81: Be prepared to provide assumptions and justification regarding the impact of building code revisions and enforcement on vulnerability functions.

34. V-1, Disclosure 1, page 83: Provide an example application of the vulnerability development process (Figure 19) and explain how insurance data is used for both developing and validating vulnerability functions.

35. V-1, Disclosure 3, page 83: Describe the inspections performed after hurricanes of 2004, 2005, and 2008 and how these inspections impacted the model vulnerability functions.

36. V-1, Disclosure 5, page 84: Compare vulnerability functions for four to seven story buildings and more than seven story buildings.

37. Form V-1, page 91: Account for differences between this year's submission and the previous submission.

Verified: YES

Professional Team Comments:

Reviewed and discussed building classifications used for commercial residential properties.

Reviewed vulnerability functions for high-rise, mid-rise and low-rise structures. Reviewed plots of the high-rise, mid-rise, and low-rise vulnerability functions and their uncertainty for reinforced concrete constructions with strong cladding.

Discussed the basis for the development of the commercial residential vulnerability functions.

Reviewed plot of vulnerability functions for high-rise concrete structures with weak, average, and strong cladding. Discussed assumptions used to justify making no changes to the existing vulnerability functions.

Reviewed plot of vulnerability functions for high-rise heavy steel structures with weak, average, and strong cladding.

Discussed how year built is handled.

Discussed how building code enforcement is used. Reviewed the age groups for mobile homes and all other structures.

Reviewed plot and underlying data comparing the claim rates from Hurricane Andrew (1992) for fire resistive structures and all structures compared to the vulnerability functions for concrete structures with strong and weak cladding.

Reviewed the additional living expense vulnerability function.

Discussed the use of 10-meter windspeed for damage assessment for all building heights. Discussed that variability of windspeed with height of building is addressed in the vulnerability functions.

Discussed the site inspections performed after Hurricane Charley (2004), Hurricane Frances (2004), Hurricane Jeanne (2004), Hurricane Ivan (2004), Hurricane Katrina

(2005), Hurricane Rita (2005), and Hurricane Ike (2008). Verified no adjustments were made to the vulnerability functions based on the site inspections.

Discussed the differences in Form V-1 from the previous submission related to the addition of the reference concrete structure to the form. Verified no change in roughness factor used for the form from previously accepted submission. Page 90 was revised accordingly.

Reviewed plots of the four vulnerability functions used to estimate the damage in Form V-1.

Discussed the composition of unknown construction. Discussed the need to use Florida specific composition for unknown construction.

Reviewed plot of contents vulnerability functions for high-rise concrete and heavy-steel structures.

Reviewed plot comparing contents damage variation by cladding for high-rise concrete structures.

Discussed basis for using personal residential ALE vulnerability function for commercial residential.

Reviewed ALE mean and COV plots.

Discussed reason for variation of COV curve for high & mid-rise and low rise vulnerability functions.

Reviewed plot of building and contents vulnerability functions with average cladding for reinforced masonry, tied down mobile home, unreinforced masonry, untied down mobile home, and wood frame structures.

Reviewed and discussed percentage of claims in Hurricane Hugo (1989) and Hurricane Andrew (1992) with windspeed less than 40 mph.

Reviewed and discussed comparisons of claims data for hurricanes of 2004 and 2005 for masonry and wood frame with EQECAT model corresponding vulnerability functions.

Documentation reviewed:

- J. McDonald and K. Mehta (1993). *Vulnerability Functions for Estimating Wind Damage to Buildings*, for EQE Engineering and Design, Texas Tech University, Lubbock, TX. Verified no update to this document.
- Vulnerability Functions Volume I
- Vulnerability Functions Volume II

V-2 Mitigation Measures

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

- ***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 shall be empirically justified both individually and in combination.

Audit

1. Forms V-2 and V-3 (Trade Secret List 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

38. Form V-2, page 94: Account for differences between this year's submission and the previous submission. Provide an explanation of variation of impact of mitigation across windspeeds and between the two classes of construction (e.g., for rated shingles, straps and door and skylight covers).

Verified: YES

Professional Team Comments:

Discussed differences from previous year submission being due to the updates of the location of ZIP Code centroids which included the Form V-2 ZIP Code 33921 and associated change in roughness factor. Page 94 was revised accordingly.

Verified that there is no change in mitigation measures and associated mitigation factors since last previously accepted model.

Verified that mitigation measures and factors used for both personal and commercial residential properties are the same.

Discussed that not all mitigation measures are applicable to all building classes.

Documentation reviewed:

- 2003 EQECAT Report, “Secondary Structural Modifiers: Features and Model Description,” July 28, 2003.

ACTUARIAL STANDARDS – Marty Simons, Leader

A-1 Modeled Loss Costs and Probable Maximum Loss Levels*

*(*Significant Revision)*

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

Audit

1. The model will be reviewed to determine that the definition of an event in the model is consistent with Standard A-1.

2. The model will be reviewed to determine that by-passing storms and their effects are considered in a manner that is consistent with Standard A-1.

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:

Discussed that modeled losses do not include storm surge and flood damage other than the implicit effects of storm surge damage on the infrastructure. Discussed that there was no explicit adjustment for storm surge damage to infrastructure.

A-2 Underwriting Assumptions*

*(*Significant Revision)*

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. 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) claim payment practices, (4) coinsurance, (5) contractual provisions, and (6) relevant underwriting practices underlying those losses, as well as any actuarial modifications, shall be appropriate.

Audit

1. Demonstrate how the claim practices of insurance companies are accounted for when claims data for those insurance companies are used to develop or to verify model calculations. For example, 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.

2. Provide the percentage of loss at or above which the model assumes a total loss.

Pre-Visit Letter

39. A-2, Disclosure 1, page 97: Provide examples of communications with insurers to account for "unknown" data items.

40. A-2, Disclosure 4, page 97: Be prepared to provide additional information regarding the effects of contractual obligations on the claim payment process.

Verified: YES

Professional Team Comments:

Discussed with Paul Vendetti his review of the process for analyzing claims data, communications with insurers and the use of the claims data for validation.

Reviewed the methodology used, and examples of, communications with insurers to determine the structure type to use in a portfolio where the structure type is given as unknown.

Discussed the claim practices of insurers as they relate to the model. Discussed the impact of public adjusters on claims paid and the effects of contractual obligations on commercial residential model calculations.

Reviewed claims data from the 2004 and 2005 storms.

A-3 Loss Cost Projections and Probable Maximum Loss Levels*

*(*Significant Revision)*

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 at a geocode (latitude-longitude) level of resolution.

Audit

1. Describe how the model handles expenses, risk load, investment income, premium reserves, taxes, assessments, profit margin, and economic inflation.

Verified: YES

Professional Team Comments:

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

A-4 Demand Surge*

*(*Significant Revision)*

A. Demand surge shall be included in the model's calculation of loss costs and probable maximum loss levels using relevant data.

B. The methods, data, and assumptions used in the estimation of demand surge shall be actuarially sound.

Audit

1. 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.

2. All referenced literature will be reviewed to determine applicability.

Verified: YES

Professional Team Comments:

Discussed with Paul Vendetti his review of the demand surge methodology.

Verified no change in the accepted methodology for demand surge calculations from the previous submission.

A-5 User Inputs

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.

Pre-Visit Letter

41. A-5, page 103: Provide a more detailed response to the standard. The use of the term "shall be" is not sufficient.

42. A-5, Disclosure 4, page 111: Provide examples of the process described.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

This standard cannot be verified until amended default for unknown construction in Florida is reviewed.

Reviewed process for validation of insurer data.

Reviewed default values assigned to missing data.

Discussed the insurer input reports used to verify the input data.

Documentation reviewed:

- WORLDCATenterprise Data Reference Manual, 14 January 2009

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

Reviewed the change in treatment of unknown construction type and the personal residential default structure types by North and South region.

A-6 Logical Relationship to Risk*

*(*Significant Revision)*

A. 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.

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

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

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

E. Loss costs cannot increase as the quality of building codes and enforcement increases, all other factors held constant.

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

G. 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.

Audit

1. Graphical representations of loss costs by ZIP Code and county will be reviewed.
2. Color-coded maps depicting the effects of land friction on loss costs by ZIP Code will be reviewed.
3. 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-4, and A-5 will be used to assess coverage relationships.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

This standard cannot be verified until after coding change to inflow angle.

Reviewed roughness length map averaged over all wind directions.

Reviewed map of the effects of surface roughness on damage.

Reviewed results provided in Forms A-3, A-4, and A-5.

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

Reviewed further specific examples after correction to inflow angle implementation. Revisions consistent with explanations given.

Reviewed revised Form A-2 results compared to the initial November 15, 2010 submission.

A-7 Deductibles, Policy Limits, and Coinsurance*

*(*Significant Revision)*

A. The methods used in the development of mathematical distributions to reflect the effects of deductibles, policy limits, and coinsurance 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.

D. The effects of coinsurance on commercial residential loss costs produced by the model shall be actuarially sound.

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.

1. To the extent that historical data are used to develop mathematical depictions of deductibles, policy limit, and coinsurance functions, demonstrate the goodness-of-fit of the data to fitted models.

2. Justify changes from the previously accepted submission in the relativities among corresponding deductible amounts for the same coverage.

Verified: YES

Professional Team Comments:

Discussed how coinsurance is defined and the effect of coinsurance on commercial residential loss costs.

Discussed methodology for calculating and applying annual deductibles.

A-8 Contents*

*(*Significant Revision)*

A. The methods used in the development of contents loss costs shall be actuarially sound.

B. The relationship between the modeled structure and contents loss costs shall be reasonable, based on the relationship between historical structure and contents losses.

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.

Pre-Visit Letter

43. A-8, Disclosure 1, page 123: Provide a description of the process used to select the "hypothetical storms" referenced in the second paragraph.

Verified: YES

Professional Team Comments:

Verified no changes made in the model relative to content losses from the previous submission.

Discussed the storms used to produce Figure 25 illustrating the relationship between building and contents losses.

A-9 Time Element Coverage*

*(*Significant Revision)*

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

B. Time element loss cost derivations shall consider the estimated time required to repair or replace the property.

C. The relationship between the modeled structure and time element loss costs shall be reasonable, based on the relationship between historical structure and time element losses.

D. Time element loss costs produced by the model shall appropriately consider time element claims arising from indirect loss.

Audit

1. 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 Hurricane Andrew (1992) and 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.

2. 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

44. A-9.D, page 124: Provide a complete description of the process referenced.

Verified: YES

Professional Team Comments:

Verified no changes made in the model relative to time element losses from the previous submission.

Discussed calculation of time element costs as a function of building damage, content damage, and occupancy.

Reviewed plot of claims validation to the time element vulnerability function.

A-10 Output Ranges*

*(*Significant Revision)*

A. Output ranges shall be logical and any deviations supported.

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

1. masonry construction versus frame construction,

2. personal residential risk exposure versus mobile home risk exposure,

3. in general, inland counties versus coastal counties, and

4. in general, northern counties versus southern counties.

Audit

1. Forms A-6, A-7, and A-8 will be reviewed. The sample output range report produced by the model for commercial residential loss costs will be reviewed.

2. Justify all changes from the previously accepted submission using the 2007 Florida Hurricane Catastrophe Fund aggregate personal residential exposure data.

3. Output ranges will be reviewed to ensure appropriate differentials among deductibles, coverage, and construction types.

4. Anomalies in the output range data will be reviewed and shall be justified.

Pre-Visit Letter

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

This standard cannot be verified due to the inflow angle equation coding error. A re-run of the output ranges is necessitated.

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

Reviewed revised Form A-6.

Reviewed percentage changes in loss costs with the implementation of the inflow angle compared to the November 15, 2010 initial submission in revised Forms A-7 and A-8.

Reviewed specific examples for selected regions and policy types.

A-11 Probable Maximum Loss*

*(*Significant Revision)*

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

Audit

1. Provide the data and methods used for probable maximum loss levels for Form A-9. (Trade Secret List item)

2. All referenced literature will be reviewed to determine applicability.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

This standard cannot be verified due to the inflow angle equation coding error. Revised PML calculations necessitated.

Reviewed methodology for calculating probable maximum loss estimates.

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

Reviewed revised Form A-9 after correction to inflow angle implementation. Revisions consistent with explanations given.

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 agreement using currently accepted scientific and statistical methods in the appropriate disciplines.

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 characterization of uncertainty for windspeed, damage estimates, annual loss, and loss costs will be reviewed.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

This standard cannot be verified due to the coding error in the inflow angle equation.

Reviewed goodness-of-fit tests for the profile factor distribution and for number of landfalls.

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

Reviewed revised windspeed comparisons. Other revisions consistent with explanations given for inflow angle.

Reviewed a revised Table 3 in Standard S-1 for agreement between historical observations and model simulations of historical storm windfields.

Reviewed revised Forms S-2 and S-3. Reviewed comparisons between the initial November 15, 2010 submission and the revised March 28, 2011 submission results.

S-2 Sensitivity Analysis for Model Output*

*(*Significant Revision due to requirement of Form S-6)*

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.

Pre-Visit Letter

45. Form S-6, pages 262-263: Be prepared to explain the local peak mean loss costs at approximately 30 miles inland.

Verified: YES

Professional Team Comments:

Reviewed the results from Form S-6. Loss cost summary results were reproduced by the Professional Team. Windspeed results were reviewed from both a statistical and meteorological perspective.

Discussed the local peak in mean loss costs at approximately 30 miles inland due to low roughness lengths of Florida wetlands experiencing the leading edge of the eyewall during and just after landfall for many of the storms.

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

Reviewed revised Form S-6. Reviewed comparisons between the initial November 15, 2010 submission and the revised March 28, 2011 submission results.

S-3 Uncertainty Analysis for Model Output*

*(*Significant Revision due to requirement of Form S-6)*

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.

Verified: YES

Professional Team Comments:

Reviewed the results from Form S-6. Windspeed results were reasonable from both a statistical and meteorological perspective.

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

Reviewed revised Form S-6. Reviewed comparisons between the initial November 15, 2010 submission and the revised March 28, 2011 submission results.

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:

Discussed no need to adjust the simulation sampling plan.

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.

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.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

This standard cannot be verified due to the coding error in the inflow angle equation.

Reviewed underlying commercial residential claims data for Figure 58.

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

Reviewed revised windspeed comparisons. Revisions were consistent with explanations given for inflow angle.

Reviewed revised Form S-4 results compared to the initial November 15, 2010 submission.

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, and
   e. Exposure assumptions.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

This standard cannot be verified due to the coding error in the inflow angle equation.

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

Reviewed revised windspeed comparisons. Revisions were consistent with explanations given for inflow angle.

Reviewed revised Form S-5 results compared to the initial November 15, 2010 submission.

COMPUTER STANDARDS – Paul Fishwick, Leader

C-1 Documentation

A. The modeling organization shall maintain a primary document binder, containing a complete set of documents specifying the model structure, detailed software description, and functionality. Development of each section shall be indicative of accepted software engineering practices.

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

C. 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.

D. 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 fully documented sections for each Computer Standard.

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.

Information to be presented to the Professional Team:

- C-1.A, B & D page 264 – EQECAT maintains all such documentation, and will have it available to the professional team during the on-site visit.

Pre-Visit Letter

28. C-1.C, page 264: Be prepared to relate the table of contents with the response to Standard G-1, Disclosure 5 by demonstrating individual table item compliance with Computer Standards C-1 through C-7.

Verified: ~~NO~~ YES

Professional Team Comments:

A coding error was discovered by the Professional Team early in the audit relative to the inflow angle equation. The documentation of an equation from the scientific literature differed from that implemented in the source code.

Discussed with the modeler the corrective measures that will be implemented to avoid such issues in the future.

Documentation and source code consistency will be reviewed after implementation of the revised inflow angle.

Reviewed the electronic primary document binder containing locations for finding all project-based documentation and source code related to EQECAT Florida Hurricane Model 2011.

Verified that the model submitted corresponds to WORLDCATenterprise version 3.16.

Discussed process for documentation of code. Verified that documentation is created separately from the source code.

Reviewed table defining document and file references relating to Standards C-2, C-3, C-4, C-5, and C-6.

Reviewed Master List of Referenced Documents in the Primary Document Binder revised during the audit to include locations of the root document repositories.

Revised documentation for development of friction factors was provided during the audit.

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

Reviewed documentation relating to the inflow angle calculation in the Florida Hurricane Model 2011a revision (March 28, 2011) to the original November 15, 2010 submission.

Reviewed the corrective measures for quality control to mitigate future problems in translating equations to source code.

C-2 Requirements*

*(*Significant Revision)*

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.

Information to be presented to the Professional Team:

- C-2, page 265 – EQECAT maintains such requirements and documentation, and will have it available to the professional team during the on-site visit.
- C-2.1, page 265 – EQECAT maintains a set of documents describing the specifications and product requirements for user interfaces, database schema, client customizations, security considerations, user manuals, and references. The above documentation will be available to the professional team during the on-site visit.

Pre-Visit Letter

29. C-2, page 265: Be prepared to provide requirements documentation that specifically relates to each model change identified in Standard G-1, Disclosure 5.

Verified: YES

Professional Team Comments:

Reviewed requirements documentation relating to ZIP Code and storm update changes.

Verified that no requirements were specified for the update to the inflow angle in calculating the location windspeed. Verified that requirements were updated during the audit to correct this error.

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.

Information to be presented to the Professional Team:

- C-3, page 266 – The design levels of the software have been documented, including software components and interfaces, data files, and database elements. This documentation will be shown to the professional team during the on-site visit.

Verified: YES

Professional Team Comments:

Verified no changes in the overall model architecture and component design.

Reviewed the flowchart for storm frequency generation.

Reviewed detailed flowchart defining the procedure for the calculation of site-specific over-land windspeed, which included the equation for inflow angle, application of motion asymmetry, and application of friction and gust factors.

Reviewed a flowchart defining the steps in the calculation of windspeed by distance from the storm (using profile factor).

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, and
    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.

Information to be presented to the Professional Team:

- C-4.D, page 267 – This table will be available for review by the professional team.
- C-4.E, page 267 – This underlying model including algorithm implementation and technical assumptions along with the procedures used for updating the system data will be available for review by the professional team during the on-site visit. The [overall system design] information is available for on-site review.
- C-4.F, page 268 – This list will be available for review by the professional team.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Implementation and equation/source code correspondence will be reviewed after the future code change of inflow angle.

Reviewed the documented inflow angle equation and its incorrect coding.

Verified procedures used to create, derive, and procure data files used within the model.

Reviewed equations for calculating windspeed at a site with translational and rotational vector wind components.

Reviewed the equation and corresponding implementation of the weighting parameter implementation for calculating weighted pixel land roughness values.

Discussed the process of implementing equations and data in the source code.

Reviewed the coding guidelines.

Discussed the process used in creating and verifying the ZIP Code database.

Reviewed the table of software components containing lines of code and comments as prescribed in Standard C-4.D.

Verified that the modeler did not produce the required lists specified in Standard C-4.F. Reviewed an updated list produced during the audit.

Reviewed the source code used to calculate storm filling over land.

Reviewed the source code from asymmetric moving storm winds at landfall to modeled wind at a site.

Verified that, with the exception of inflow angle, each flowchart component of the windspeed calculation was correctly implemented in the code. Equations in flowchart were traced to code and variable mappings were reviewed.

Discussed the initial difficulty during the audit in relating equations and variables in 1) Simiu et al. (2007) and 2) Simiu and Scanlan (1996) with equivalent representations in the source code. Reviewed later in the audit, revised equation documentation cross-referencing equations and variables in 1) Simiu et al. (2007) and 2) Simiu and Scanlan (1996) with the source code.

Verified the addition of descriptive comments for the 1-minute over-water to over-land wind conversion source code.

Reviewed the code implementation of the secondary structural modifiers relative to the following: year of construction, structure category (mobile home vs. other structures), and wind borne debris ZIP Code identification.

Verified the inclusion of a minimum windspeed at which damage occurs in the code implementation.

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

Verified the code change made to resolve the problem in the inflow angle implementation.

Verified the change in the source file number relative to the inflow angle update.

Reviewed an update to the equation table required in Standard C-4.F.

C-5 Verification

A. General

For each component, the modeling organization shall maintain procedures for verification, such as code inspections, reviews, calculation crosschecks, and walkthroughs, sufficient to demonstrate code correctness. Verification procedures shall include tests performed by modeling organization personnel other than the original component developers.

B. Component Testing

1. The modeling organization shall use testing software to assist in documenting and analyzing all components.

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

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

4. Aggregation tests shall be performed and documented to ensure the correctness of all model components. Sufficient testing shall be performed to ensure that all components have been executed at least once.

C. Data Testing

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

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

Audit

1. The components will be reviewed for containment of sufficient logical assertions, exception-handling mechanisms, and flag-triggered output statements to test the correct values for key variables that might be subject to modification.

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

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

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

5. The response to Disclosure 1 will be reviewed.

Pre-Visit Letter

30. C-5, page 269: Be prepared to provide complete and thorough verification procedures and output from the model changes identified in Standard G-1, Disclosure 5.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Tests performed to ensure correct implementation of the requirements will be reviewed after the change to the inflow angle equation is completed.

Reviewed methods for unit, aggregation, and regression testing.

Reviewed the software used for testing.

Verified that exception handling mechanisms are used within the source code.

Discussed the unit testing suite covering all classes used to calculate loss costs in Florida.

Reviewed flowchart defining the processes used for manual and automatic verification.

Verified that two executions of the model with no changes in input data parameters, code, and seeds of random number generators produce the same loss costs and probable maximum loss levels.

Verified that the modeler uses an ISO 9000 quality management process as part of their operations. Discussed revision to include additional steps suggested by modeler to improve process for implementation and verification of new code.

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

Reviewed maps used to verify the effects of inflow angle on modeled windspeeds.

Discussed, and re-reviewed, the two updates in the EQECAT Technical Development Process. These updates are designed to improve the quality control process involved in algorithm development.

Reviewed animations to compare windfields from the 2011 and 2011a versions of the model.

Reviewed unit testing procedures implemented to test the inflow angle change.

Reviewed the training procedure used to verify that employees have read the ISO 9000 and 14000 quality control procedures. Verified that the revised Software Development Process is an integral part of this training procedure.

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.

Information to be presented to the Professional Team:

- C-6.C, page 271 – EQECAT's policies and procedures for model revision will be made available to the professional team during the on-site visit.
- C-6.1, page 271 – EQECAT has a series of ISO procedures regarding the maintenance of code, data, and documentation, and these will be made available to the professional team.

Pre-Visit Letter

31. C-6.D, page 271: Be prepared to provide the model version history leading up to the version identified in the submission.

Verified: YES

Professional Team Comments:

Reviewed the policy for model revision, expressed in a flowchart.

Reviewed the tracking and versioning software used.

Verified the prior model version, and that there are no model versions since the initial submission for this year.

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

Reviewed the process used in creating the Florida Hurricane Model 2011a version.

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.

Information to be presented to the Professional Team:

- C-7, page 273 – These procedures will be made available to the professional team during the on-site visit.

Verified: YES

Professional Team Comments:

Reviewed the written policy for security procedures.

Reviewed the new, more stringent, approach to security implemented since the review of the previous model.