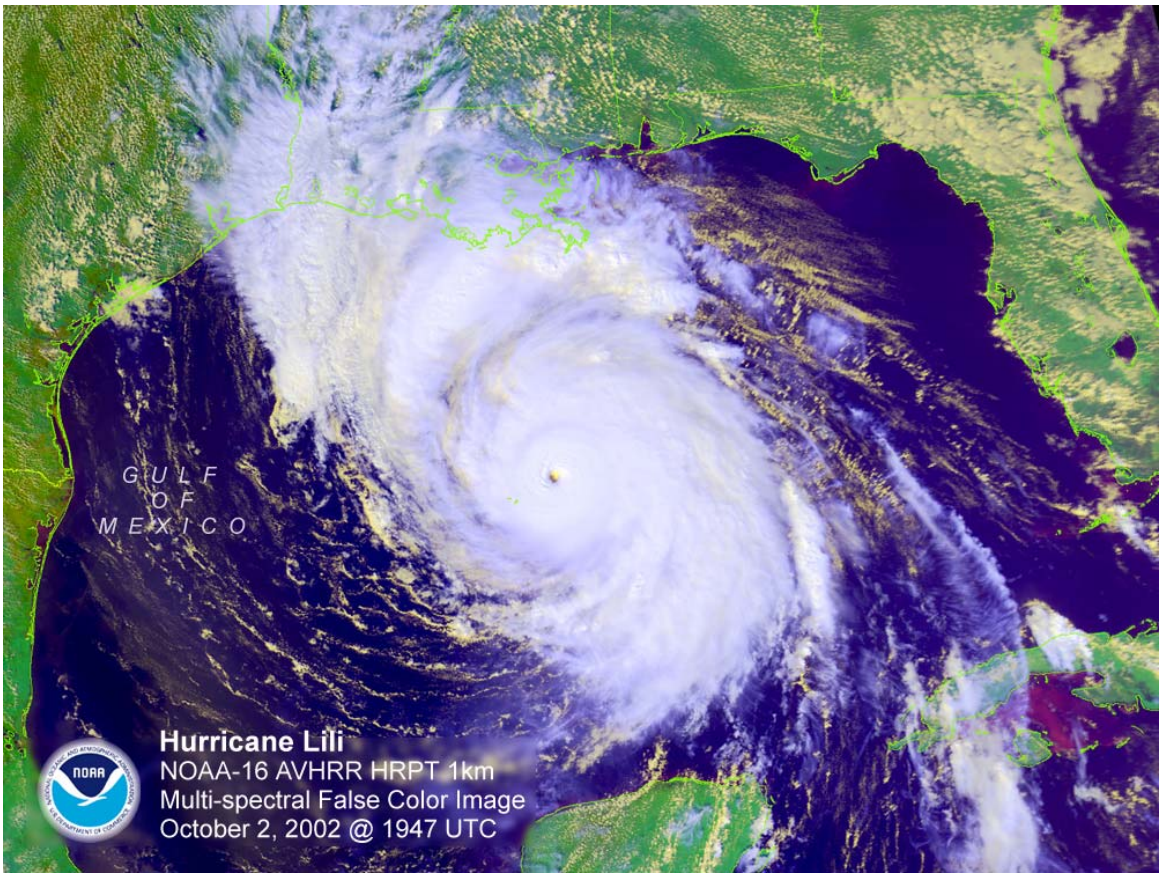
# Florida Commission on Hurricane Loss Projection Methodology




## Professional Team Audit Report
## 2002 Standards

## EQECAT, Inc.

**On-Site Review**
**May 13 & 14, 2003**

On May 13 & 14, 2003, the Professional Team visited on-site at EQECAT, Inc. (EQE) in Oakland, California. The following people participated in the review.

## EQECAT

Shawna S. Ackerman, FCAS, MAAA, Principal and Consulting Actuary – Pinnacle Actuarial Resources, Inc.
James R. (Bob) Bailey, Ph.D., P.E., Technical Manager, Wind Engineering Services
Robert Healy, Senior Vice President
Mahmoud M. Khater, Ph.D., P.E., Senior Vice President, Chief Science and Technology Officer
Omar Khemici, Ph.D., P.E., Group Manager
Thomas I. Larsen, Senior Vice President
Sriram Narasimhan, Engineer
Nilesh Shome, Senior Project Engineer
David F. Smith, Group Manager, Meteorologist

## Professional Team

Mark Johnson, Ph.D., Statistician, Team Leader
Marty Simons, ACAS, Actuary
Paul Fishwick, Ph.D., Computer Scientist
Fred Stolaski, P.E., Structural Engineer
Tom Schroeder, Ph.D., Meteorologist
Nari Balsara, P.E., Structural Engineer observer
Jenni Evans, Ph.D., Meteorologist observer
Donna Sirmons, Staff

The review began with introductions and an overview of the audit process. EQE gave a presentation on the model changes since the February 2002 submission and the effect of those changes on loss costs statewide.

EQE described the change in wind speed calculations for Hurricane Andrew and the impact the modifications to Hurricane Andrew's windfield had on USWIND. EQE made the appropriate changes to the model.

Discussed and reviewed corrections to be made in the submission that will be provided to the Commission prior to the May 29 & 30, 2003 meetings.

- Standard 5.3.5 – range of mitigation credits
- Pages 46 & 47 – include additional personnel
- Page 56 – graphical representation of modeled degradation rates compared to the Kaplan-DeMaria decay rate
- Pages 75, 76 and 77 – remove references to Professional Team report

Verification of Standard 5.3.5 could not be made while on-site owing to the fact that EQE did not provide to the Commission the mitigation measures and their ranges of possible impacts on damage. The Professional Team expects that verification can be made subject to EQE providing the required information which was presented to the Professional Team while on-site. EQE has indicated the required information will be provided to the Commission prior to the May 29 & 30, 2003 meetings. Hence, verification is conditional on the aforementioned material being provided to the Commission on or before May 30, 2003.

# Deficiencies from April 1, 2003 Meeting

1. Form F – provide the missing input values for the quantile variable and indicate what the variable represents.

   *EQE Response:*

   In Form F, we have used the quantile 1 variable to represent what we call "mu", the filling rate (or inland decay) parameter. Note that mu has a dependence on central pressure, so it can vary even if the quantile 1 input is constant. We have provided the corresponding values of mu in the file 2002FormFquantile1_EQECAT.xls.

   **Verified: Yes**

   Professional Team Comments:

   Discussed the filling rate parameter "mu" used by EQE as the quantile variable in Form F. Reviewed coefficient of variations for mu.

2. Module 3, Section V, item 8 (page 97 in your submission) – provide the required information or a written explanation as to why this information would not be presented to the Commission.

   *EQE Response:*

   We have provided the information requested in Module 3, Section V, item 8 in the files 2002FHCFevents_EQECAT.xls and 2002FHCFandrewbyzip_EQECAT.xls.

   **Verified: Yes**

   Professional Team Comments:

   Submission of these files overcomes the stated deficiency.

3. Module 3, Section V, item 9 (page 98 in your submission) – provide the required explanation of how the Expected Annual Hurricane Losses and Return Time were calculated.

   *EQE Response:*

   The following describes how EQECAT calculated each column of the table under Module 3, Section V, item 9 (Distribution of Hurricanes by Size):

a. The table is based on the EQECAT "Reduced Set" of approximately 50,000 stochastic events, of which 26,146 affect the FHCF exposure data provided to us by the Commission. Each of the 26,146 hurricanes has an annual frequency defined in the model, and a modeled result for Personal Residential Zero Deductible statewide loss using the FHCF exposure data. When the 26,146 hurricanes are sorted in descending order of loss, the exceedance frequency for each loss is given by the sum of all hurricane frequencies with losses at or above that level.
b. Each row of the table represents a range of losses. We calculated the average loss for each range as the sum of all losses (from the 26,146 hurricanes) failing within the range divided by the number of such losses (the number of losses is provided in the "No. of storms" column).
c. We calculated the expected annual hurricane loss for each range by summing the produce of loss and annual frequency over all hurricanes with losses failing within the range.
d. We calculated the return time in years for each range by first interpolating the exceedance frequency (see (a) above) to the value corresponding to the average loss for the range (this was done linearly between the adjacent hurricane losses, from among the 26,146 hurricanes). Taking this exceedance frequency to be $\lambda$, we calculated the return time in years as $1/(1 - \exp(-\lambda))$.

**Verified: Yes**

Professional Team Comments:

The deficiency is overcome with the above explanation.

# EQECAT, Inc. – Pre-Visit Letter

The main purpose of the on-site review performed by the Professional Team (Pro Team) of the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM) is to verify that the written and electronic submission conforms to the model producing the output ranges included in the submission to the FCHLPM. It is particularly important to review in detail all information relating to the model, including any information that may be considered proprietary. It is the responsibility of the modeler to provide all information necessary for a complete review of the model. For each reference within the submission that cites "material to be shown to the professional team," it is important that the material is presented to the Pro Team during the on-site review. Material that the modeler intends to present to the FCHLPM should be presented to the Pro Team during the on-site review.

In the course of preparing for the on-site review, the Pro Team has identified some specific areas that it intends to cover while on-site. These items are provided below to assist the modeler in preparing for the on-site review. Some of this material may have been shown or available on a previous visit by the Pro Team.

The goal of the Pro Team is to provide the FCHLPM with a clear and thorough report of the model, subject to non-disclosure conditions. All modifications, adjustments, assumptions, or other criteria that were included in producing the information requested by the FCHLPM 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 Pro Team. Access to critical articles or materials referenced in the submission or during the on-site review should be available on-site for the Pro Team. The Pro Team should be provided access to a phone line that can provide internet access through one of the Pro Team member computers for reference work that may be required while on-site.

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

## 1, General

1.1 Pages 160-161, Standard 5.1.2 – Explain whether any employees are no longer involved in the model due to professional conduct.

1.2 Page 161, Standard 5.1.3 – Describe how Model Revision Policy was used for revisions from prior version to USWIND® Version 5.7 / WORLDCATenterprise™ Version 3.5.

1.3 Page 50, Module 2, Section I, #5 – Describe the Dr. Friedman review mentioned here, including the date of the review. Does it pertain to the model under current review?

1.4 Page 193, Appendix 2 – Has the 1996 review of USWIND been updated? Describe the value of the 1996 review in light of more recent information, findings, standards, and scientific materials.

General items numbered 1.5 through 1.15 below refer to the output ranges.

1.5 Explain any differences in minimum and maximum loss costs for any county where the changes from last year's submission exceed 5%.
1.6 Provide a brief overview of any differences in minimum and maximum loss costs for any county regardless of the magnitude of the difference.
1.7 Explain any significant differences in the relativities between building and contents loss costs from those derived from last year's submission.
1.8 Explain any significant differences in the relativities between mobile homes and other construction types loss costs from those derived from last year's submission.
1.9 Explain any significant differences in the relativities among deductibles from those derived from last year's submission.
1.10 Explain any differences in the relativities between building and additional living expense loss costs from those derived from last year's submission.
1.11 Explain any differences in the relativities between building and appurtenant structure loss costs from those derived from last year's submission.
1.12 Explain the relationship between the loss cost for a $2,500 deductible Personal Residential/Renters/Frame and a 5% deductible Personal Residential/Renters/ Frame loss cost.
1.13 Provide any internal comparisons performed since the prior submission regarding the following:
   a. Model output vs. insurance company data
   b. Model output prior to and after zip code updates
   c. Changes in loss costs brought about by model revisions
   d. Changes in loss costs brought about by other changes.
1.14 Explain the relationship among $0 Deductible Structure, $0 Deductible Contents, $0 Deductible Appurtenant Structure, and $0 Deductible Additional Living Expense.
1.15 Explain the relationship between a 1% Deductible and a 5% Deductible loss cost for Brevard, Dade, and Hamilton counties.

## 2. Meteorology

2.1 Page 25, Module 1, Section I, A #5 – Verify that "miles" in responses 4 and 5 refers to "statute miles."
2.2 Page 25, Module 1, Section I, A #5 – Discuss your choice of a default "profile factor" of 1.
2.3 Page 26, Module 1, Section I, A, #5 – Discuss the data, methods, and assumptions used to derive "gradients to sustained winds" factor.
2.4 Page 28, Module 1, Section I, A, #9 and cover letter – Discuss the modification to the modeled Hurricane Andrew wind field.
2.5 Page 37, Module 1, Section II, B #6 – Discuss the dependence of Radius of Maximum Winds for low central pressures.
2.6 Page 42, Module 1, Section II, C #1 – Discuss the outliers in Table 2.
2.7 Page 56, Module 3, Section I, #7 – Provide comparisons of your decay rate to that of Kaplan DeMaria.

2.8 Page 60, Module 3, Section I, #10 – Explain the 100 year gust wind speed for the zip code on the coast east of Lake Okeechobee which appears to generate a value between 140 and 160 mph in Figure 7.
2.9 Page 99, Module 3, Section V, #9 – Provide a detailed explanation of the numbers produced in Table 17.
2.10 Page 164, Standard 5.2.3 – Provide the input file used in generation of the stochastic storm set.
2.11 Page 165, Standard 5.2.6 – Provide quality of fit of simulated storms and analyses performed relative to historical records for appropriate coastal segments of Alabama, Georgia, and Mississippi.
2.12 Pages 164-165, Standard 5.2.4 – Provide "EQECAT analyses which will be presented to the Commission."
2.13 Page 166, Standard 5.2.8 – Describe the underlying methodology used to produce land friction criteria used in the model.
2.14 Page 166, Standard 5.2.9 – Describe the underlying methodology used to produce overland weakening criteria used in the model.
2.15 Page 167, Standard 5.2.10 – Present contour plots of wind fields (2-dimensional instantaneous) as developed for Form F.

3. Vulnerability

More information and details will need to be provided in order to verify Standard 5.3.1, Standard 5.3.4, and Standard 5.3.5.

3.1 Page 28, Module 1, Section I, A #9 – Discuss the modification to Hurricane Andrew data. Disclose and describe the sources of scientific information used. (Standard 5.3.1)
3.2 Page 32, Module 1, Section I, B #7 – Discuss methods used to adjust vulnerability functions based on user information and how that is stated in the output. (Standard 5.3.5)
3.3 Page 32, Module 1, Section I, C #1.a – If demand surge were included, how is this documented in the output? (Standard 5.3.6)
3.4 Page 34, Module 1, Section II, A #5 – Has any new insurance data been obtained? Have any new field investigations been made? Has any new building stock been added? Has any new data on mobile homes been obtained? (Standard 5.3.1)
3.5 Page 70, Module 3, Section III, #4 & #5 – Expand on this to include descriptions of characteristics, range of modifications, effect of multiple modifications, etc. Describe how user input can affect the model output, how such user input is monitored for reasonableness, and how such user input is disclosed to the recipient of the model output. (Standard 5.3.1)
3.6 Page 75, Module 3, Section IV, #3 – Explain the last sentence in your response.
3.7 Page 169, Standard 5.3.2 – Provide several examples of vulnerability function curves for each type required. Typical examples of regional variation shall be shown.

3.8 Page 169, Standard 5.3.3 – Show in the computer code where peak gust wind speed of 40 mph is used as the starting point of damage being considered.
3.9 Page 169, Standard 5.3.4 – The range of magnitude and direction (positive or negative) of the variations in damage shall be listed in the submittal and validated.
3.10 Page 170, Standard 5.3.4 – Explain how a modification to the vulnerability curves will be done once additional knowledge (such as building code used during design) is available.
3.11 Page 170, Standard 5.3.5 – Provide list of mitigation measures required. Their effect on loss costs must be listed along with the ranges of possible impacts on damage for each mitigation measure listed. (Minimum requirement provided in Standard 5.3.5 and expanded upon on page 159 in the Guidebook.)
3.12 Page 170, Standard 5.3.5 – Provide examples of evaluation of the combined effect of multiple mitigation measures.
3.13 Page 171, Standard 5.3.6 – Verify ALE losses are considered for instances where no building or content losses occur.
3.14 Page 171, Standard 5.3.6 – Are abnormal working conditions considered in determining the time factors to repair/reconstruct the property?
3.15 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.

## 4. Actuarial

4.1 Page 31, Module 1, Section I, B #6 – Provide the reports referenced in the response, “which the user can use to validate the correctness of the data”.
4.2 Page 31, Module 1, Section I, B #7 – Describe the methods used to calculate a quality factor as cited in the response.
4.3 Page 32, Module 1, Section I, C #1.a and Page 174, Standard 5.4.5 – Describe the methods used to calculate demand surge and the methods used to ensure that demand surge is excluded from the loss costs submitted to the FCHLPM.
4.4 Page 32, Module 1, Section I, C #1.b – Describe the methods used to reflect building code and enforcement as cited in your response.
4.5 Page 32, Module 1, Section I, C #1.c – Describe the methods used to account for site specific factors as cited in your response.
4.6 Module 1, Section I, C #1.d – Describe the methods used to incorporate storm and flood damage to the infrastructure in the model outputs.
4.7 Pages 81-85, Module 3, Section IV, #10 & #11 – Define terms that are used.
4.8 Page 86, Module 3, Section V, #1 – Provide supporting documentation available to insurer in support of a rate filing.
4.9 Pages 96-97, Module 3, Section V, #6 & #7 – Provide the range and maps of weighted average loss costs percentage change for all ranges.
4.10 Page 112, Module 3, Section VII, Form C – Provide an explanation of results.
4.11 Page 116, Module 3, Section VII, Form E – Define top event.
4.12 Page 172, Standard 5.4.1 – Describe in detail (with examples) the procedures used to review insurance company claims data and to ensure consistency as

referenced in your responses to this standard. Provide specific description of the methods used to "correct insured values to include under-insurance, if any (e.g., 80% insurance to value clause in many insurance policies)."

4.13 Page 172, Standard 5.4.1 – Describe in detail how inherent hazard mitigation and building code criteria are considered when utilizing insurance company data for creation or validation of model components. Explain how this process is expected to change as mitigation criteria apply to greater percentages of properties in Florida.

4.14 Page 173, Standard 5.4.2 – Describe in detail the modification factors referenced in your response to this standard.

4.15 Page 173, Standard 5.4.4 – Provide the assumptions that relate to insurer input.

4.16 Page 177, Standard 5.4.7 – Describe, in detail, how the data portrayed in Figure S-3 is incorporated in the loss costs produced for the FCHLPM.

4.17 Page 177, Standard 5.4.8 – Provide the "more detailed information" referenced in your response to this standard.

4.18 Page 178, Standard 5.4.9 – Provide the "more detailed information" referenced in your response to this standard.

4.19 Page 180, Standard 5.4.12 – Describe the extension of the hurricane data base referenced in response 1 to this standard. Describe how the revision does not impact upon Florida loss costs.

4.20 Page 180, Standard 5.4.12 – Describe the impacts upon the data contained in the output ranges of the modifications made to the Hurricane Andrew data.

4.21 In all cases where insurance company inputs are used to derive or to verify model output, be prepared to provide the following:

a. Identify insurance company
b. Provide initial insurance company submission for review
c. Provide correspondence between model and insurance company relative to data amendments
d. Provide example of model adjustments for invalid zip code information
e. Provide methods used to remove demand surge from Hurricane Andrew data, if such data is used for modeling or verification.

4.22 Be prepared to explain differences in average annual loss provided in Standard 5.4.11 between this submission and the previous submission.

4.23 Be prepared to describe the impact upon loss costs of any model revisions not specifically referenced above.

4.24 Describe any differences between this submission and the prior submission relative to results displayed on Forms A, B, and C.

4.25 Table 1 below summarizes the percentage changes in maximum wind speed for each of the coverage categories as reported in Form B (2002 relative to 2001) by city. Table 2 provides the same information by hurricane category. The average wind speed has not changed from 2001. Explain the minimal (or zero) changes in max wind speeds. Explain the increases in losses for Ft. Myers given the very minimal changes elsewhere.

**Table 1. Percentage Changes in Form B by City: 2002 Relative to 2001**

| City | Max WS | Total Loss | Cov A Loss | Cov C Loss | Cov D Loss |
|---|---|---|---|---|---|
| Ft. Myers | 0.0 | 4.3 | 3.9 | 5.9 | 4.9 |
| Ft. Pierce | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Jacksonville | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Miami | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| Panama City | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Tampa | 0.0 | 0.9 | 0.8 | 0.9 | 0.9 |
| Average | 0.0 | 0.9 | 0.8 | 1.1 | 1.0 |

**Table 2. Percentage Changes in Form B by Category: 2002 Relative to 2001**

| Category | Max WS | Total Loss | Cov A Loss | Cov C Loss | Cov D Loss |
|---|---|---|---|---|---|
| 1 | 0.0 | 1.0 | 0.9 | 1.3 | 0.9 |
| 2 | 0.0 | 1.0 | 0.9 | 1.6 | 1.1 |
| 3 | 0.0 | 1.1 | 1.0 | 1.4 | 1.3 |
| 4 | 0.0 | 0.8 | 0.7 | 0.8 | 1.0 |
| 5 | 0.0 | 0.6 | 0.5 | 0.6 | 0.7 |
| Average | 0.0 | 0.9 | 0.8 | 1.1 | 1.0 |

## 5. Computer

5.1 During the Computer Software audit, the Pro Team will expect all elements of the code base (i.e., actuarial, engineering, scientific, user interface, database) to be addressed. Please ensure that all personnel involved with designing, writing, and maintaining of this software are available.

5.2 During the overall audit process, the Pro Team may request "code spot checks" to assist in verifying a standard that is related to such code, either in terms of its structure (i.e., syntax) or its execution. During a spot check, it will be necessary to convene the coder or software engineer responsible for this aspect.

5.3 Page 182, Standard 5.5.1 – The Pro Team will verify that "All computer software (i.e., user interface, scientific, engineering, actuarial) relevant to the modeler's submission is consistently documented." It is expected that any and all software that is used in the model will be so documented.

5.4 Page 182, Standard 5.5.3 – Be prepared to show how data and control flow diagrams, and file schema, are documented as specified for this standard.

5.5 Pages 182-183, Standard 5.5.4 – Be prepared to show the hierarchy of sub-components within the detailed control and data flow diagrams, and explicit forward references in each diagram and component, to the source code. Be prepared to show traceability as required in the standard.

5.6 Pages 183-184, Standard 5.5.5 – Be prepared to expand on your response to this standard based upon the standard requirement that the modeler address issues of correctness of the software. It is not clear from the response, whether EQECAT is indicating verification or validation. This standard addresses only

software verification and the issue of code correctness. The two paragraph response under "(2) Testing" points to the process of validation against physical phenomena (meteorology, structural engineering), whereas this standard explicitly requires that the modeler address issues of correctness of the software.

6. Statistical

6.1 Page 122, Module 3, Section VII, Form F – Provide Pro Team with lost cost analysis.

6.2 Pages 185-186, Standards 5.6.1 through 5.6.6 – Explain the reasons why the responses have not been presented to the FCHLPM in the submission. Be prepared to provide detailed responses to each statistical standard to the Pro Team.

6.3 In addition to the FCHLPM required analyses, be prepared to present any internal sensitivity and/or uncertainty analyses performed on your model by internal staff members or by outside consultants.

## 5.1 General Standards – *Mark Johnson, Leader*

### 5.1.1 Scope of the Computer Model and Its Implementation

The computer model shall project loss costs for personal lines residential property from hurricane events, excluding flood and storm surge, except as flood and storm surge apply to Additional Living Expense (ALE). References to the model throughout the Standards shall include its implementation.

If the modeler uses historical data that include losses from flood and storm surge, then the modeler shall disclose the techniques employed to exclude such losses, and those techniques shall be based on accepted scientific methods.

If the modeler uses engineering or other data that include losses from flood and storm surge, then the modeler shall disclose the techniques employed to exclude such losses, and those techniques shall be based on justifiable methods.

*Reference: Module 1, Section I, C.1.d (storm surge and flood damage to the infrastructure)* (page 32)

Audit: This standard concerns the scope of the computer model and its implementation that is expected to project loss costs for personal residential property due to hurricane events. ALE is mentioned explicitly since flood and storm surge can in fact impact ALE. The main intent of the audit is to determine the capabilities of the model and to assess its implementation for purposes of Florida estimated loss costs.

Is there a flood or storm surge component to the model? Is it in the "off" position for the production of Florida output ranges as well as other information supplied in the standards and modules (e.g., 5.4.11 and Form B)?

**Proprietary:** **No**
**Verified:** **Yes**

**Professional Team Comments:**

Verified USWIND model does not include storm surge or flood damage in output range calculations except as it relates to ALE. Reviewed how USWIND handles ALE losses due to damage to the infrastructure.

Documentation reviewed:

- USWIND Output Report – Hurricane Expected Annual Damage and Loss by Zip Code within a County within a State for FHCF exposure database.

### 5.1.2 Qualifications of Modeler Personnel and Independent Experts

Model construction, testing, and evaluation shall be performed by modeler personnel or independent experts who possess the necessary skills, formal education, or experience to develop hurricane loss projection methodologies.

The model or any modifications to an accepted model shall be reviewed by modeler personnel or independent experts in the following professional disciplines, if relevant: structural/wind engineering (licensed Professional Engineer (PE)), statistics (advanced degree), actuarial science (Associate or Fellow of Casualty Actuarial Society or Member of the American Academy of Actuaries), meteorology (advanced degree), and computer science/engineering (advanced degree). These individuals shall abide by the standards of professional conduct adopted by their profession.

*Reference:* *Module 2 #2 (professional credentials),* (page 46)
*#3 (multi-discipline team),* (page 48)
*#5 (independent expert review)* (page 50)

Audit: The Professional Team would like to review the professional vitae of modeler personnel and independent experts responsible for the current model and information on their predecessors, if different than current personnel. For the actuarial personnel, professional status in the appropriate actuarial organization or organizations is usually apparent on the vitae. For other disciplines, the vitae ought to be sufficient to make a determination for this standard, with further commentary possible during the on-site interactions. Background information on individuals providing testimonial letters in the submission must be provided.

Do you have any new personnel (since last year) working on the model? If so, resumés should be available. Were any personnel dismissed for violations of the professional code of conduct? If so, what influence would it have on the model under review?

**Proprietary:** **No**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed the resume of Sriram Narasimhan, Engineer, Ph.D. Candidate, Civil Engineering (May 2004) Rice University, M.S. Civil Engineering 2002 Rice University, M.S. Civil Engineering 1999 Louisiana State University, M.Eng. Coastal Engineering 1994 AIT Bangkok Thailand, B. Eng. Civil Engineering 1993 Osmania University India

No employees have been dismissed due to professional misconduct.

### 5.1.3 Model Revision Policy

The modeler shall have developed and implemented a clearly written policy for model revision with respect to methodologies and data. The modeler shall clearly identify the model version under review. Any revision to any portion of the model that results in a change in any Florida residential hurricane loss cost must be accompanied by a new model version number.

*Reference:* *Module 1, Section I, A.1 (model version number),* (page 11)
*A.9 (model revisions)* (page 28)

Audit: The Professional Team would like to see the process for model revisions (both methodology and data, especially updates from year-to-year with new storms). What safeguards or controls are in place? How does the annual update take place? How is it identified? How are each of the changes mentioned in 5.4.12 consistent with this policy? Citing specific examples gives further strength to the Professional Team assessment (for 1996 storms, we did the following ... and now the updated storm set is in place....). The Professional Team computer expert could then review the current set up.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed EQE's policy for model revision with respect to methodologies and data. Discussed the procedure for incorporating changes to the model and how they follow policy procedure. Looked at specific instances within the computer codes and databases to verify that the policy is indeed implemented.

Documentation Reviewed:

- EQECAT Technology and Software Development Process
- EQECAT Technology Development Features including Development and Refinement of Technical Requirements, Technical Specifications, and Technical Algorithm

### 5.1.4 Independence of Model Components

The meteorology, vulnerability, and actuarial components of the model shall each be demonstrated to be theoretically sound without compensation for potential bias from the other two components. Relationships within the model among the meteorological, vulnerability, and actuarial components shall be demonstrated to be reasonable.

*Reference:* *Module 1, Section II, B.11 (independent functions or variables),* (page 40)
*B.13 (model sensitivity),* (page 40)

*B.14 (sensitivity in output results),* (page 40)
*B.15 (SA & UA performed on model)* (page 41)
*Standard 5.5.3 (Model Architecture and Component Design)* (page 182)
*Standard 5.5.5 (Verification)* (page 183)

Audit: This standard will be considered after the review of meteorology, vulnerability, and actuarial sections. The modeler needs to demonstrate to the Professional Team that their choices of model components adequately portray hurricane phenomena and effects (damage and loss costs). This can be accomplished indirectly via agreement with historical loss costs and attendant tests but also requires an assessment of the theoretical soundness of each component. A model would not be found to meet this standard, if an artificial calibration adjustment had been made to improve the match of historical and model results for a specific storm. What impact do changes in the model from the previous year potentially impact this standard? How can you demonstrate that in fact these changes do not impinge on this standard?

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

The independence of the meteorology, vulnerability, and actuarial components of the model were verified throughout the course of the review.

### 5.1.5 Risk Location

Zip codes used in the model shall be updated at least every 24 months using information originating from the United States Postal Service. The United States Postal Service issue date of the updated information shall be disclosed.

Zip code centroids, when used in the model, shall be based on population data and shall be visually demonstrated to be reasonable.

Zip code information purchased by the modeler shall be verified by the modeler for accuracy and appropriateness.

*Reference:* *Module 1, Section II, A.2 (primary databases)* (page 33)
*Module 3, Section VI, #1 (handling of invalid zip codes)* (page 104)
*Module 3, Section VII, Form A (Zip Code Data Base)* (page 109)

Audit: Aside from disclosure of updates, the Professional Team is likely to ask to view the location of centroids for specific zip codes. Interest in specific zip codes arises in the context of logical relationship to risk or in basic assessments of loss costs. What is the effective (official United States Post

Office) date corresponding to the database of zip codes? What is the date at which the zip codes and their centroids were introduced into the model?

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Discussed EQE's procedure for updating the ZIP Code database. Verified that no update was made to the ZIP Code database this year.

### 5.1.6 Identification of Units of Measure and Conversion Factors

All units of measure for model inputs and outputs shall be clearly identified. All conversion factors used by the model shall be disclosed.

*Reference: Module 1, Section I, C.2 (input variables)* (page 32)

Audit: Are there any units of measure omitted or incorrectly stated?

**Proprietary:** **No**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed USWIND storm editor that identifies the various model inputs and the associated conversion factors.

Discussed EQE's methodology for the gradient to sustained wind speed factor and the basis for the factor.

### 5.1.7 Visual Presentation of Data

Visualizations shall be accompanied by legends and labels for all elements. Individual elements shall be clearly distinguishable, whether presented in original or copy form.

a. For data indexed by latitude and longitude, by county or by zip code, a color contour map and a continuous tone map with superimposed county and zip code boundaries shall be produced.

b. Florida Map Colors: Maps will use two colors, blue and red, along with shades of blue and red, with dark blue and dark red designating the lowest and highest quantities, respectively. The color legend and associated map shall be comprised of an appropriate number of intervals to provide readability.

*Reference: Module 3, Section I, #10 (maps of maximum winds at zip code level)* (page 59)
*Module 3, Section V, #3 (maps of loss costs by zip code),* (page 89)
*#7 (maps of output ranges % change by county)* (page 96)

Audit**:** The modeler will have key maps, charts, and graphs pre-prepared and will have the ability to quickly prepare such maps during an on-site review. All visualizations should be presented in a manner that enables simultaneous viewing by the entire Professional Team.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed color contour maps, graphs, charts, and plots. Visualizations intended for the Commission meet the standard.

## 5.2 Meteorological Standards – *Tom Schroeder, Leader*

### 5.2.1 Units of Measure for Model Output

All model outputs of length, wind speed, and pressure shall be in units of statute miles, statute miles per hour, and millibars, respectively.

**Proprietary:** **No**
**Verified:** **Yes**

**Professional Team Comments:**

Correct units of measure were verified throughout the course of the audit.

### 5.2.2 Damage Function Wind Inputs

Wind inputs to the damage function shall be in units consistent with currently used wind measurement units and/or shall be converted using standard meteorological/engineering conversion factors which are supported by literature and/or documented measurements available to the Commission.

*Reference: Module 3, Section II, #2 (wind speed conversion)* (page 67)
*Standard 5.1.6 (Identification of Units of Measure and Conversion Factors)* (page 162)

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Verified that there was no change to the model from the previous year. Discussed EQE's gust factor.

Documentation reviewed:

- Wind Effects on Structures, Simiu and Scanlan (1996, 3rd edition) as it pertains to wind gust conversions.

### 5.2.3 Official Hurricane Set or Suitable Approved Alternatives

Modelers shall include in their base storm set all hurricanes, including by-passing hurricanes, which produce hurricane force winds in Florida. The storm set, derived from the Tropical Prediction Center/National Hurricane Center (TPC/NHC) document *Tropical Cyclones of the North Atlantic Ocean, 1871-1998,* updated through the 2001 hurricane season and/or the HURDAT (HURricane DATa) data set, is found in the *Report of Activities as of November 1, 2002* under Section VII, Compliance With Standards and Related Information, #4 (Base Storm Set). All proposed alternatives to the characteristics of specific storms in the storm set shall be subject to the approval of the Commission.

*Reference:* *Module 1, Section II, A.1 (deviation from official hurricane set),* (page 33)
*A.2 (primary databases),* (page 33)
*B.7 (parameters for hurricane frequency),* (page 37)
*B.8 (stochastic hurricane generation)* (page 37)
*Module 3, Section I (Hurricane Set)* (page 54)

Audit: The input file used in generation of the stochastic storm set is useful evidence of compliance with this standard. The modeler should be prepared to show the storm set used.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Verified that EQE updated their probabilistic hurricane database to be consistent with the storm set provided by the Commission. The hurricane database was updated to include another year of hurricane activity in the Atlantic Basin and the reclassification of Hurricane Andrew. EQE has extended their storm set to include the entire Atlantic Basin. This had no impact on the Florida.

Reviewed the input file used in generation of the stochastic storm set.

### 5.2.4 Hurricane Characteristics

Methods for depicting all modeled hurricane characteristics including but not limited to wind speed, radial distributions of wind and pressure, minimum central pressure, radius of maximum winds, strike probabilities, and tracks shall be based on information documented by scientific literature or modeler information accepted by the Commission.

*Reference:* *Module 1, Section II, B.1 (wind speeds used for loss estimation),* (page 34)
*B.2 (asymmetric nature of hurricanes),* (page 34)
*B.3 (filling rate function),* (page 35)
*B.4 (land friction),* (page 35)
*B.5 (characteristics used for wind speed estimation),* (page 36)
*B.6 (dependent wind speed variables),* (page 37)
*B.7 (parameters for hurricane frequency),* (page 37)
*B.8 (stochastic hurricane generation)* (page 37)
*Module 3, Section I (Hurricane Set)* (page 54)
*Module 3, Section VII, Form F (Hypothetical Events for SA & UA)* (page 117)
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)

Audit: Prepare graphical depictions (e.g., histograms overlaid with fitted density functions) of storm characteristics as used in the model. The modeler should be prepared to describe the data set basis for the fitted distributions, to describe assessments of correlated characteristics (e.g., central pressure and radius of maximum winds), to describe the fitting methods used and any smoothing techniques employed, and to defend choices of parametric distributions used. The modeler should be prepared to present information on the spatial distribution of hurricane force winds (e.g., the radius of hurricane force winds) associated with both modeled and historical events. Throughout the review of this standard, an assessment of the goodness-of-fit of parametric distributions to historical should be provided, consistent with 5.6.2.

With respect to storm tracks, the stochastic storm set or its equivalent should depict realistic storm tracks. This can be demonstrated through Figure 3 in Module 3, Section 1, for example. Consistency between historical and modeled tracks means: (1) distributions of storm tracks should accurately depict actual storm tracks in Florida; and (2) comparisons are to be based on methods documented in accepted scientific literature or proposed by the modeler and accepted by the Commission.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Verified that there was no change in the model from the previous year. Discussed EQE's approach to Radius of Maximum Winds and the scientific

basis. Reviewed graphical representations of the profile and distributions for the relationship between Rmax and Central Pressure.

Discussed in detail the outliers in Table 2 on page 42 of EQE's submission. Reviewed scatter plot of Hurricane Carla comparing modeled wind speed versus historical observed wind speed.

Discussed EQE's profile factor and the basis for using a default factor of 1. Reviewed graphical representations of the effect of the profile factor and the profile factor formula.

Discussed the modeling hurricane characteristics basis for landfall location, maximum wind speed at landfall, landfall track direction, Rmax, translation speed, and filling rate.

### 5.2.5 Landfall Intensity

Models shall use maximum one-minute sustained 10-meter wind speed when defining hurricane landfall intensity. This applies both to the base storm set adopted in 5.2.3 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 wind speed shall be within the range of wind speeds (in statute miles per hour) categorized by the Saffir-Simpson scale.

**Saffir-Simpson Hurricane Scale (for displayed parameters):**
A scale from 1 to 5 that measures hurricane intensity.

| Category | Winds (mph) | Central Pressure (MB) | Damage |
|---|---|---|---|
| 1 | 74 - 95 | $\geq$ 980 | Minimal |
| 2 | 96 - 110 | 965 - 979 | Moderate |
| 3 | 111 - 130 | 945 - 964 | Extensive |
| 4 | 131 - 155 | 920 - 944 | Extreme |
| 5 | Over 155 | < 920 | Catastrophic |

*Reference:* *Module 3, Section I, #1 (definition of event),* (page 54)
*#2 (upper limit of wind speeds produced),* (page 54)
*#3 (multiple landfalls),* (page 55)
*#11 (frequency and annual occurrence rates),* (page 61)
*#12 (number of events, relative frequency and annual occurrence rate by category)* (page 64)

*Module 3, Section VII, Form B (30 Hypothetical Events)*
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)
*Standard 5.6.3 (Uncertainty Characterization)* (page 185)

Audit: The modeler should be prepared to describe and to support category 3-5 storms with respect to intensity and wind speed. In particular, defend the goodness-of-fit of historical versus modeled frequencies (by intensity), providing confidence intervals where appropriate.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Verified no change from previous year in the model and that wind speeds developed for historical hurricanes are consistent with observed values.

### 5.2.6 Hurricane Probabilities

Modeled hurricane probabilities shall reasonably match the historical record through 2001 for category 1 to 5 hurricanes, shall be consistent with those observed for each geographical area of Florida, and shall be displayed in vertical bar graphs. "Consistent" means: (1) spatial distributions of modeled hurricane probabilities shall accurately depict vulnerable coastlines in Florida and the states of Alabama, Georgia, and Mississippi; and (2) probabilities are compared with observed hurricane frequency using methods documented in accepted scientific literature or proposed by the modeler and accepted by the Commission.

*Reference:* *Module 1, Section I, B.2 (handling of beach/coastal areas)* (page 29)
*Module 1, Section II, A.1 (historical database for wind speeds and frequency),* (page 33)
*B.7 (parameters for hurricane frequency),* (page 37)
*B.8 (stochastic hurricane generation)* (page 37)
*Module 3, Section I (Hurricane Set)* (page 54)
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)
*Standard 5.6.3 (Uncertainty Characterization)* (page 185)

Audit: The modeler should be prepared to describe and to support the method of selecting stochastic storm tracks and angle of landfall. The modeler should be prepared to describe and to 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. Assess the goodness-of-fit of modeled to historical frequencies for the four sections of the state and overall. The modeler should be prepared to demonstrate that the quality of fit extends beyond the Florida border by showing results for appropriate coastal segments

in Alabama, Georgia, and Mississippi. Explain any significant discrepancies. In particular, defend the goodness-of-fit of historical versus modeled frequencies (by intensity), providing confidence intervals where appropriate.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed graphical representation of the annual frequency for Florida and continuous states for simulated storms versus historical storms.

### 5.2.7 Hurricane Probability Distributions

Modeled probability distributions for hurricane intensity, eye diameter, forward speed, radii for maximum winds, and radii for hurricane force winds shall be consistent with historical hurricanes in the Atlantic basin as documented in accepted scientific literature available to the Commission.

*Reference:* *Module 1, Section I, A.2 (probability distributions)* (page 11)
*Module 1, Section II, B.1 (wind speeds used for loss estimation),* (page 34)
*B.7 (parameters for hurricane frequency),* (page 37)
*B.8 (stochastic hurricane generation)* (page 37)
*Module 3, Section 1, #2 (upper limit of wind speeds produced),* (page 54)
*#5 (hurricane tracks),* (page 55)
*#9 (radius of hurricane force winds, Rmax and FFP by CP),* (page 57)
*#11 (frequency and annual occurrence rates),* (page 61)
*#12 (number of events, relative frequency and annual occurrence rate by category)* (page 64)
*Module 3, Section VII, Form F (Hypothetical Events for SA & UA)* (page 117)
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)
*Standard 5.6.3 (Uncertainty Characterization)* (page 185)

Audit: The modeler should be prepared to disclose the goodness-of-fit of parametric distributions to historical hurricane characteristics.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Verified that there was no change from previous submission. Material reviewed is indicated in Standard 5.6.1.

### 5.2.8 Land Friction

Land friction shall be used in the model to reduce wind speeds over land, shall be based on scientific methods, and shall provide realistic wind speed transitions between adjacent zip codes, counties, and territories. The magnitude of friction coefficients shall be consistent with accepted scientific literature, consistent with geographic surface roughness, and shall be implemented with appropriate geographic information system data.

*Reference:* *Module 1, Section II, B.4 (land friction),* (page 35)
*B.5 (characteristics used for wind speed estimation)* (page 36)
*Module 3, Section I (Hurricane Set)* (page 54)
*Module 3, Section VII, Form F (Hypothetical Events for SA & UA)* (page 117)

Audit: The modeler should be prepared to describe the handling of land friction. Maps by zip codes are required.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Discussed USWIND use of land friction and the basis for its formulation. The basis is the USGS Land Use/Land Cover database (1993).

Reviewed land friction coefficient factors and color-coded ZIP Code maps reflecting the friction factors. Discussed the uncertainty associated with the friction parameter.

### 5.2.9 Hurricane Overland Weakening Rate

The hurricane overland weakening rate methodology used by the model shall be provided to the Commission and shall be shown to be (1) reasonable as observed in comparison to historical records, and (2) documented in accepted scientific literature or in modeler information accepted by the Commission.

*Reference:* *Module 1, Section II, B.3 (filling rate function)* (page 35)
*Module 3, Section I (Hurricane Set)* (page 54)
*Module 3, Section VII, Form F (Hypothetical Events for SA & UA)* (page 117)

Audit: The modeler should be prepared to compare the model's weakening rates to historical Florida storms and to weakening rates documented in scientific literature.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Discussed the methodology used for the USWIND filling rate. Reviewed graphical comparisons showing the consistency with the Kaplan-DeMaria filling rate analysis.

Discussed the "mu" decay rate variable and reviewed the associated formula.

### 5.2.10 Temporal and Spatial Wind Field Characteristics

The time variant wind field, including the radial distribution of wind speeds, shall be demonstrated to be consistent with accepted scientific principles, such as:

1. The radius of maximum winds shall reflect specified hurricane characteristics.
2. The magnitude of the asymmetry shall increase as translational speed increases, all other factors held constant.
3. The wind speed shall decrease with increasing surface roughness (friction), all other factors held constant.

*Reference: Module 3, Section I, #6 (decay rates),* (page 55)
*#9 (radius of hurricane force winds, Rmax and FFP by CP)* (page 57)
*Module 3, Section II (Hurricane Wind Field)* (page 67)
*Module 3, Section VII, Form B (30 Hypothetical Events),*
*Form C (One Hypothetical Event),* (page 112)
*Form F (Hypothetical Events for SA & UA)* (page 117)

Audit: Forms B, C, and F provide the information used in auditing this standard. Contour plots of the wind field from Form F are desired. If prepared, they should be presented to the Professional Team on-site and be consistent with the sensitivity and uncertainty analyses for wind speed.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed wind speed contour plots produced during the Form F analysis at time step intervals. The Professional Team selected storm sample 38 for further investigation. Reviewed contour plots of wind fields, graphical representations of the wind speed profile for Cat 1, Cat 3, and Cat 5 hurricanes at time step intervals (addressing radius of maximum winds).

Reviewed EQE's asymmetry factor in wind speed through contour plots adapted from the Form F data that were prepared while we were on-site. Verified that asymmetry increased as translational speed increased.

## 5.3 Vulnerability Standards – *Fred Stolaski, Leader*

### 5.3.1 Derivation of Vulnerability Functions

Development of the vulnerability functions is to be based on one or more of the following: (1) historical data; (2) tests; (3) structural calculations; (4) expert opinion. Any development of the vulnerability functions based on structural calculations and/or expert opinion shall be supported by tests and historical data to the extent such data are available.

The derivation of the vulnerability functions shall be described and demonstrated to be theoretically sound.

Any modification factors/functions to the vulnerability functions or structural characteristics and their corresponding effects shall be disclosed and shall be clearly defined and their theoretical soundness demonstrated.

*Reference:* *Module 1, Section I, A.7 (categories of vulnerability functions),* (page 26)
*A.8 (documents/research used in development of vulnerability functions),* (27)
*C.1.a (socio-economic effects)* (page 32)
*Module 1, Section II, A.5 (claims data used in development of vulnerability functions)* (page 34)
*Module 3, Section III (Vulnerability Functions-Damage Estimates)* (page 68)
*Module 3, Section IV, #3 (appurtenant structures vulnerability function),* (75)
*#4 (mobile home vulnerability function),* (page 75)
*#5 (contents vulnerability function),* (page 75)
*#6 (ALE vulnerability function)* (page 76)
*Standard 5.4.1 (Underwriting Assumptions)* (page 172)
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)

Audit: 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, be prepared to demonstrate the goodness-of-fit of the data to fitted models per 5.6.2. 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 building types and construction characteristics may be selected for review. The basis for expert opinion and original site inspection reports shall be available.

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.

All modifications to the vulnerability functions shall be individually listed with the direction (either positive or negative) and the range of magnitude of the change indicated. Any variation in the change over the range of wind speeds shall be identified.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Verified that no change was made to the vulnerability functions. Reviewed insurance claims data and sources, engineering surveys, and EQE post-disaster field investigations.

Documentation reviewed:

- Vulnerability Functions for Estimating Wind Damage to Building, James R. McDonald, Ph.D., P.E. and Kishor C. Mehta, Ph.D., P.E.
- Memo from James R. McDonald re: Vulnerability Functions for Both Structural Damage to the Manufactured Home and Damage to Contents
- After 10 Years, Hurricane Andrew Gains Strength, NOAA Press Release, August 21, 2002
- Vulnerability Assessment of Harris County to Hurricane Winds, June 2000

### 5.3.2 Required Vulnerability Functions

Vulnerability functions shall separately compute damages for building structures, mobile homes, appurtenant structures, contents, and additional living expense.

*Reference:* *Module 1, Section I, A.7 (categories of vulnerability functions),* (page 26)
*Module 3, Section III (Vulnerability Functions-Damage Estimates)* (page 68)
*Module 3, Section IV, #3 (appurtenant structures vulnerability function),* (75)
*#4 (mobile home vulnerability function),* (page 75)
*#5 (contents vulnerability function),* (page 75)
*#6 (ALE vulnerability function)* (page 76)
*Module 3, Section V, #2 (loss cost relationships by type of coverage and type of construction),* (page 87)
*#4 (output ranges)* (page 125)
*Module 3, Section VII, Form B (30 Hypothetical Events),*
*Form C (One Hypothetical Event),* (page 112)
*Form D (Loss Costs),*
*Form F (Hypothetical Events for SA & UA)* (page 117)

Audit: Multiple samples of vulnerability functions for building structures, mobile homes, appurtenant structures, contents, and additional living expense shall be available to the Professional Team. The magnitude of logical changes among these items for a given wind speed shall be explained and validation materials shall be available.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Discussed in detail the origination of the vulnerability functions. Verified EQE uses actual insurance claims data in the development and validation of USWIND vulnerability functions.

Reviewed examples of several vulnerability function curves showing the variation of wind speed damage ratio for building types and associated features – timber, unreinforced masonry, mobile homes, contents, ALE.

Documentation reviewed:

- Hurricane Luis, September 4-8, 1995 – Report of Reconnaissance Survey, September 11-16, 1995

### 5.3.3 Wind Speeds Causing Damage

Damage associated with a declared hurricane event shall include damage incurred for wind speeds above and below the hurricane threshold of 74 mph. The minimum wind speed that generates damage shall be specified.

*Reference:* *Module 1, Section II, B.1 (wind speeds used for loss estimation)* (page 34)
*Module 3, Section III (Vulnerability Functions-Damage Estimates)* (page 68)
*Module 3, Section VII, Form F (Hypothetical Events for SA & UA)* (page 117)

Audit: The disclosed minimum wind speed shall be reasonable with validation material available. The computer code showing the inclusion of the minimum wind speed at which damage occurs shall be verified.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed the computer code and verified that the damage cut-off sustained wind speed is 40 mph. No change was made in the model.

### 5.3.4 Construction Characteristics

In the derivation and application of vulnerability functions assumptions concerning construction type, construction characteristics, new building codes, and revisions to existing building codes shall be demonstrated to be reasonable and appropriate.

*Reference:* *Module 1, Section I, A.7 (categories of vulnerability functions),* (page 26)
*B.7 (vulnerability modifications range of impacts on loss costs),* (page 32)
*C.1.b (building code and enforcement),* (page 32)
*C.1.c (construction characteristics)* (page 32)
*Module 1, Section II, A.3 (damageability assumptions)* (page 34)
*Module 3, Section III (Vulnerability Functions-Damage Estimates)* (page 68)
*Module 3, Section IV, #4 (mobile home vulnerability function),* (page 75)
*Module 3, Section VII, Form D (Loss Costs),*
*Form F (Hypothetical Events for SA & UA)* (page 117)

Audit: Construction types and characteristics used shall be listed and include validation of the range of magnitude and direction of the variations in damage. Any variation in differences, such as less damage to obviously stronger structures (masonry verses frame), shall be fully explained.

All modifications to the vulnerability functions due to a new building code or revisions to the existing building code shall be documented and include the range of magnitude and direction of any changes. Any variation in the change over the range of wind speeds shall be identified.

These modifications shall fully comply with 5.3.1.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Discussed the methodology used by USWIND for handling changes in building codes and how building code enforcement is considered. Modifications due to construction types and building codes are included in the mitigation measures covered in Standard 5.3.5.

### 5.3.5 Mitigation Measures

Modeling of mitigation measures to improve a building's wind resistance and the corresponding effects on vulnerability shall be disclosed and demonstrated to be theoretically sound. These measures shall include, but not be limited to, 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.

The percentage changes in the statewide, zero deductible personal residential non-mitigated loss costs that would be produced in the output ranges due to each mitigation measure shall be individually and specifically provided to the Commission, including ranges of possible impacts on damage for each mitigation measure listed.

Methods for estimating the effects of mitigation measures shall be shown to be reasonable both individually and in combination.

*Reference:* *Module 1, Section I, A.6 (mitigation factors)* (page 26)
*Module 3, Section III, #5 (hazard mitigation)* (page 70)

Audit: The comprehensive and detailed listings of items that are required or should be considered ensures consistency and completeness among all modelers in presenting the necessary disclosures and demonstrations of theoretical soundness.

Total effect on damage due to use of multiple mitigation measures shall be documented and shown to be reasonable.

**Proprietary:** **Yes**
**Verified:** **Conditional Verification**

**Professional Team Comments:**

Presentation was provided giving an overview of USWIND secondary structural modifiers including:

- basic methodology of vulnerability functions
- mean, lower, and upper bounds of curves for default structure types
- inputs of known structural features
- adjustment of mean value
- process involved in calculating loss costs
- process for determining the effects of mitigation features including multiple features.

Reviewed revised vulnerability curves reflecting additional structural information. Discussed the input structural features and their grouping into 5 categories:

1. Roofing system
2. Wall system
3. Anchorage system
4. Opening protection
5. General

Discussed EQE's scoring of mitigation features for credits, the methodology used in developing the mitigation features scoring, who makes the final decisions, how it is implemented in the computer code, and how USWIND accounts for multiple features. Discussed in detail how the scoring is applied for interactions between the 5 different groups.

Documentation Reviewed:

- Score Summary by each mitigation feature
- Score Comparisons
- Examples of different mitigation features applied under each category
- Summary of individual test cases of mitigation features for different building classes (QF and EAD's)
- Vulnerability Assessment of Harris County to Hurricane Winds, June 2000
- Formal Engineering of Residential Buildings, Joseph E. Minor, P.E., F.ASCE, *Journal of Architectural Engineering, Vol. 8, No. 2, June 1, 2002.*
- Performance of Roofing Systems in Hurricane Hugo, James R. McDonald, Thomas L. Smith
- Roof Wind Damage Mitigation: Lessons from Hugo, Thomas Lee Smith, James R. McDonald
- Roofing Design that Avoids Glass Breakage During High Winds, James M. Gregory, et al.
- A Simple Window Glass Design Chart, Joseph E. Minor, H. Scott Norville
- Behavior and Strength of Laminated Glass, H. Scott Norville, et al.
- Laminated Glass Units Under Uniform Lateral Pressure, R.A. Behr, et al.
- Performance of Roofing Systems in Wind Storms, Joseph E. Minor
- Wind-Induced Loads on Metal Edge Flashings, J.R. McDonald, et al.
- Damage Assessment of Hurricane Andrew in Louisiana, Marc L. Levitan, et al.
- Preliminary Design Guidelines for Wind-Resistant Roofs on Essential Facilities, Thomas Lee Smith, James R. McDonald
- Industry Perspective: Impact Resistance Standards, IBHS Document
- The Influence of a Parapet on Local Pressure Fluctuations, H. Sockel, R. Taucher
- Pressure Fluctuations on Flat Roofs and Parapets, Ahsan Kareem and P.C. Lu
- Roof Corner Wind Loads and Parapet Configurations, A. Baskaran and T. Stathopoulos
- Load Reduction on Flat Roofs, P.A. Blackmore
- Wind Pressure on Block-Type Buildings, C. Kramer, H.J. Gerhardt and S. Scherer
- Overview of Hurricane Andrew in South Florida, Ronald A. Cook
- Assessment of Building Damage Sustained During Hurricane Iniki, Michael K.H. Yee and Arthur N.L. Chiu
- Damage to Engineered Structures at Homestead AFB, Maurice R. Harlan
- Causes of Roof Damage and Roof Failure Modes: Insights Provided by Hurricane Andrew, Thomas Lee Smith
- A Survey of Building Performance in Hurricane Iniki and Typhoon Omar, James W. Sheffield

- Effectiveness of Storm Shutters in Hurricane Damage Prevention, Raja R.A. Issa, et al.
- Failure of Residential Building Envelopes as a Result of Hurricane Andrew in Dade County, Florida, Clifford Oliver and Chris Hanson
- Wind Engineering as Related to Tropical Cyclones, Leighton Cochran
- Hurricane Shutters Homepage, NOAA/AOML
- Structural Vulnerability Assessment for St. Kitts and Nevis, Elmes and Associates
- Performance of Manufactured Housing in Louisiana during Hurricane Andrew, Marc. L. Levitan, et al.
- Performance of Plywood and OSB Sheathing during Hurricanes Andrew and Iniki, Edward L. Keith
- Hurricane Andrew – The Ultimate Curtain Wall Test, James Hayes Larkin
- Performance of Commercial Masonry Structures in Hurricane Andrew, Geoffrey W. Blaney
- Failures and Failure Mechanisms for Exterior Walls, Gene S. Sanders
- Wind Resistance of Conventional Light-Frame Buildings, Ronald W. Wolfe, et al.
- Design and Construction Deficiencies and Building Code Adherence, Mohammed S. Khan and Wimal Suaris
- Valuable Information from Wind-Caused Damage in Hurricane Frederic, K.C. Mehta, et al.
- Better Building Codes Cut Property Loss, Harvey G. Ryland
- Some Effects of Roof Shapes on Housing Wind Loads, Kumamaru, et al.
- Skylights for Residences, Consumer Energy Information
- Buy Skylights, www.Buyskylights.com
- The Strange Life of Hurricane Gilbert, September 11-19, 1988, Dale Perry, et al.
- Hurricane Georges, FEMA
- Concrete Walls Protect Best Against Wind-Blown Debris, Business News Magazine
- Roof Connections in Houses: Key to Wind Resistance, Harrold W. Conner, et al.
- Lessons Learned from Analyzing Tornado Damage, Timothy Marshall
- Hurricane Damage to Residential Structures: Risk and Mitigation, John K. Ayscue
- Hurricane Georges in the Gulf Coast, Building on Success - Observations, Recommendations, and Technical Guidance, FEMA
- Building Performance: Hurricane Iniki in Hawaii, Observations, Recommendations, and Technical Guide, FEMA
- Midwest Tornadoes of May 3, 1999, FEMA – Building Performance Assessment Report
- Building Performance, Hurricane Andrew in Florida, Observations, Recommendations, and Technical Guide, FEMA
- Researching the Answers, ARA Report 0792, March 8, 2002 – Analysis of Costs and Loss Reduction Benefits of Windborne Debris Protection – North Carolina Coast Exposure C Locations

### 5.3.6 Additional Living Expenses (ALE)

In the estimation of Additional Living Expenses (ALE), the model shall consider hurricane damage including storm surge damage to the infrastructure.

The ALE vulnerability function shall consider the time it will take to repair/reconstruct the home.

*Reference:* *Module 1, Section I, C.1.d (storm surge and flood damage to the infrastructure)* (page 32)
*Module 3, Section IV, #6 (ALE vulnerability function)* (page 76)
*Module 3, Section V, #4 (output ranges)* (page 125)
*Module 3, Section VII, Form B (30 Hypothetical Events), Form D (Loss Costs), Form F (Hypothetical Events for SA & UA)* (page 117)
*Standard 5.4.9 (ALE)* (page 178)

Audit: The methodology and available validation for determining the extent of infrastructure damage and its effect on undamaged properties shall be made available to the Professional Team.

Documentation and calculations used to determine the time to repair/reconstruct the property shall be shown. Use of expert opinion or other modifications shall be explained.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Verified no change in the model. Discussed EQE's handling of damage to the infrastructure. ALE losses are evaluated using vulnerability functions derived from insurance claims data.

Reviewed USWIND Output Report showing Total Insured Value (TIV) by site for a single portfolio with number of buildings, loss to the buildings, contents, total property, and ALE. All loss costs were $0 except for ALE.

## 5.4 Actuarial Standards – *Marty Simons, Leader*

### 5.4.1 Underwriting Assumptions

When used in the modeling process or for verification purposes, adjustments, edits, inclusions, or deletions to insurance company input data used by the modeler shall be based on accepted actuarial, underwriting, and statistical procedures. The methods used shall be documented in writing.

For damage 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, and (4) relevant underwriting practices underlying those losses shall be identified and demonstrated to be reasonable and appropriate.

*Reference:* *Module 1, Section I, B.4 (annual aggregate loss distributions)* (page 30)
*Module 1, Section II, A.3 (damageability assumptions),* (page 34)
*A.4 (other assumptions),* (page 34)
*A.5 (claims data used in development of vulnerability functions)* (page 34)
*Module 3, Section IV (Insurance Functions-Company Loss Estimates)* (72)
*Standard 5.3.4 (Construction and Codes)* (page 169)
*Standard 5.6.1 (Use of Historical Data)* (page 185)
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)

Audit: Quality assurance procedures will include methods to assure accuracy of input insurance data prior to code execution. Compliance with this standard shall be readily demonstrated through rules and documented procedures.

Be prepared to disclose 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." Be prepared to disclose the methods used to delineate among the insurer claim practices in the use of historical claims data to verify model outputs.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Discussed in detail the procedures to generate the vulnerability functions, the steps taken if inconsistencies are found in insurance claims data, and the validation procedures and results. Reviewed field descriptions processed in the natural hazards file on the percentage relationship of the amount of building

insurance to the actual building value and how these relationships are used in the model.

### 5.4.2 Actuarial Modifications

All actuarial modifications made to the model shall be disclosed to the Commission and based on accepted engineering and actuarial criteria.

*Reference: Module 1, Section I, A.6 (actuarial functions modification factors),* (page 26)
*A.10 (modifications available for model user),* (page 29)
*B.7 (actuarial modifications range of impacts on loss costs),* (page 32)
*C.1.b (building code and enforcement),* (page 32)
*C.1.c (construction characteristics)* (page 32)
*Module 3, Section III, #3 (building code enforcement),* (page 69)
*#4 (quality of construction type, materials and workmanship),* (page 70)
*#5 (hazard mitigation)* (page 70)
*Module 3, Section V, #4 (output ranges)* (page 125)
*Module 3, Section VII, Form D (Loss Costs),*
*Form F (Hypothetical Events for SA & UA)* (page 117)
*Standard 5.3.4 (Construction and Codes)* (page 169)

Audit: Be prepared to disclose adjustments made to account for future impacts on loss costs brought about by revisions due to building code changes or revised mold claim procedures. If loss costs are not adjusted following a revision in Florida building codes or for revised mold claim procedures, be prepared to provide the actuarial criteria indicating no adjustment is appropriate based on expected future insurance company claim payments.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed details on the modification factors for damage to the building and contents and how loss cost adjustments are included in the model.

### 5.4.3 Loss Cost Projections

Loss cost projections produced by hurricane loss projection models shall not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margin. Hurricane loss projection models shall not make a prospective provision for economic inflation.

*Reference: Module 1, Section I, B.4 (annual aggregate loss distributions),* (page 30)

*C.1.a (socio-economic effects)* (page 32)
*Module 3, Section III, #2 (socio-economic effects)* (page 68)
*Module 3, Section V (Average Annual Loss Functions-Loss Costs)* (page 86)
*Module 3, Section VII (Baseline Tests)* (page 106)

**Proprietary:** **No**
**Verified:** **Yes**

**Professional Team Comments:**

Verified no change in the model from the previous year. Model is based on insurer loss data.

Documentation reviewed:

- Actuarial Standard of Practice No. 38 – USWIND and USQUAKE Models, August 2001

### 5.4.4 Insurer Inputs

The modeler shall disclose any assumptions, fixed and/or variable, that relate to insurer input. Such assumptions shall be demonstrated to be actuarially sound. Assumptions that can vary by specific insurer shall be disclosed in a model output report. Fixed assumptions, that do not vary, need to be disclosed to the Commission.

*Reference:* *Module 1, Section I, A.10 (modifications available for model user),* (page29)
*B.4 (annual aggregate loss distributions)* (page 30)
*Module 1, Section II, A.3 (damageability assumptions),* (page 34)
*A.4 (other assumptions)* (page 34)
*Module 3, Section III, #2 (socio-economic effects),* (page 68)
*#3 (building code enforcement),* (page 69)
*#4 (quality of construction type, materials and workmanship),* (page 70)
*#5 (hazard mitigation)* (page 70)
*Module 3, Section IV (Insurance Functions-Company Loss Estimates)* (72)
*Module 3, Section V, #4 (output ranges),* (page 125)
*#9 (distribution of hurricanes by size)* (page 98)
*Module 3, Section VII, Form B (30 Hypothetical Events),*
*Form C (One Hypothetical Event),* (page 112)
*Form D (Loss Costs),*
*Form E (PML),* (page 116)
*Form F (Hypothetical Events for SA & UA)* (page 117)
*Standard 5.4.11 (Comparison of Estimated Hurricane Loss Costs)* (page 179)
*Standard 5.4.12 (Output Ranges)* (page 180)

Audit: Potential areas for assumptions may include, but are not limited to, the following:

1. Insurance to Value. Hurricane loss projection models may make assumptions as to the relationship of the amount of insurance to the replacement cost, repair cost, or actual cash value of property. This relationship, called insurance to value, can vary by insurer and can further vary over time.
2. Demographic Assumptions. Hurricane loss projection models may also include assumptions made by insurers using the model. These may include the percentage of houses in a zip code having a particular roof type, cladding, or other structural characteristic. Other assumptions may be more subjective such as maintenance or state of repair.
3. Appurtenant Structures. The model should take into account the prevalence of appurtenant structures by geographic area. In many geographic areas there are relatively few appurtenant structures. Insurers, however, provide an amount of insurance for these structures anyway. Also, change in limits for appurtenant structures may not result in a commensurate change in expected losses because the existing limits may already exceed the value of these structures.
4. Contents. A change in contents limits may not result in a commensurate change in losses because the existing limits may already exceed the value of the contents.
5. Additional Living Expenses. A change in additional living expenses limits may not result in a commensurate change in losses because the existing limits may already exceed the largest likely loss.
6. Insurer Exposures By Zip Code. Some modelers rely on exposure data by zip code provided by insurers in preparation of a rate filing. In such cases, the modeler will validate all zip code information received from insurance company clients to assure that valid zip codes are used.

All items included in the input and output forms submitted to the Commission shall be clearly labeled and clearly defined.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Verified no change in the model from previous year. Reviewed definitions for all model input terms. Discussed insurance company data used to verify model output.

Documentation reviewed:

- File Layout and Import Manual, Version 5

### 5.4.5 Demand Surge

Loss cost projections shall not explicitly include demand surge. Any adjustment to the model or historical data to remove implicit demand surge, shall be disclosed and demonstrated to be reasonable.

*Reference:*
- *Module 1, Section I, C.1.a (socio-economic effects)* (page 32)
- *Module 1, Section II, A.3 (demand surge)* (page 34)
- *Module 3, Section III, #2 (socio-economic effects)* (page 68)
- *Module 3, Section V, #8 (Hurricane Andrew loss costs)* (page 97)
- *Module 3, Section VII (Baseline Tests)* (page 106)

Audit: Demonstrate how the presence of demand surge has been incorporated in any analysis where Hurricane Andrew losses are used for development or verification of the model or its output. Demonstrate how demand surge is incorporated in any other data used in the development or verification of the model.

**Proprietary:** **Some Proprietary**
**Verified:** **Yes**

**Professional Team Comments:**

Verified that loss cost projections produced by USWIND do not explicitly include demand surge. Demand surge is an option that is turned off during the FCHLPM loss cost calculations. If demand surge option is used, this is specifically noted on the output report.

Discussed in detail EQE's methodology for calculating demand surge including:
- definition of demand surge
- formulation (reviewed calculation formula)
- consideration of catastrophe inflation and indexing (reviewed calculation formulas)
- validation procedures and checks.

### 5.4.6 Logical Relation to Risk

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.

1. Loss costs produced by the model shall be positive and non-zero for all zip codes.
2. Modelers shall produce color-coded maps for the purpose of comparing loss costs by five-digit zip code within each county and on a statewide basis.
3. Loss costs cannot increase as friction or roughness increase, all other factors held constant.

4. Loss costs cannot increase as the quality of construction type, materials and workmanship increases, all other factors held constant.
5. Loss costs cannot increase with the presence of fixtures or construction techniques designed for hazard mitigation, all other factors held constant.
6. Loss costs shall decrease as deductibles increase, all other factors held constant.
7. Loss costs cannot increase as the quality of building codes and enforcement increases, all other factors held constant.
8. The relationship of loss costs for individual coverages (A, B, C, D) shall be consistent with the coverages provided.

The above tests are intended to apply in general. There may be certain anomalies that are insignificant or are explainable by special circumstances. This standard applies separately to each coverage.

*Reference:* *Module 1, Section 1, A.6 (actuarial functions modification factors),* (page 26)
*B.1 (consistent loss costs produced),* (page 29)
*B.3 (deductibles, policy limits, replacement costs, insurance-to-value)* (page 30)
*C.1.b (building code and enforcement),* (page 32)
*C.1.c (construction characteristics)* (page 32)
*Module 3, Section III, #3 (building code enforcement),* (page 69)
*#4 (quality of construction type, materials and workmanship),* (page 70)
*#5 (hazard mitigation)* (page 70)
*Module 3, Section V, #2 (loss cost relationships by type of coverage and type of construction),* (page 87)
*#4 (output ranges),* (page 125)
*#5 (explanation of differences in output ranges from prior year),* (page 93)
*#9 (distribution of hurricanes by size)* (page 98)
*Module 3, Section VII (Baseline Tests)* (page 106)
*Standard 5.1.7 (Visual Presentation of Data)* (page 163)
*Standard 5.2.8 (Land Friction)* (page 166)
*Standard 5.3.4 (Construction and Codes)* (page 169)
*Standard 5.3.5 (Mitigation Measures)* (page 171)
*Standard 5.4.7 (Deductibles and Policy Limits)* (page 175)

Audit:
A. Prepare graphic representation of loss costs by zip code. Provide statewide, by region, and major population centers.
B. For land friction, provide a color-coded map by zip code of friction for Florida and identify low, average, and high loss costs. Be prepared to call up loss costs for selected zip codes in Florida.
C. Form B will be used to assess coverage relationships.

**Proprietary:** **Some Proprietary**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed color-coded maps comparing loss costs by ZIP Code within each county and on a statewide basis, scatter plots showing the relationship among appurtenant structures, contents, and ALE for Form D loss costs.

### 5.4.7 Deductibles and Policy Limits

The model shall provide a mathematical representation of the distribution of losses to reflect the effects of deductibles and policy limits, and the modeler shall demonstrate its actuarial soundness.

The relationship among the modeled deductible loss costs shall be shown to be reasonable. Differences in these relationships from those previously found acceptable, if applicable, shall be explained and shown to be reasonable. If applicable, changes in the methods used to reflect the effects of policy limits shall be disclosed.

*Reference:* *Module 1, Section I, B.3 (deductibles, policy limits, replacement costs, insurance-to-value)* (page 30)
*Module 3, Section IV, #1 (variety of damage produced by a given wind speed),* (page 70)
*#2 (insurer loss calculation),* (page 72)
*#8 (property value and replacement cost calculations)* (page 78)
*Module 3, Section V, #3 (maps of loss costs by zip code),* (page 89)
*#4 (output ranges),* (page 125)
*#9 (distribution of hurricanes by size)* (page 98)
*Module 3, Section VII, Form D (Loss Costs)*
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)

Audit: The company actuary will be asked to attest to the actuarial soundness of the procedure. To the extent that historical data are used to develop mathematical depictions of contents functions, be prepared to demonstrate the goodness-of-fit of the data to fitted models as per 5.6.2. Be prepared to discuss and justify changes from the prior submission in the relativities among corresponding deductible amounts for the same coverage.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Discussed the numeric data in the plot shown in Figure S-3 on page 177 of the submission. It does not have to apply to the FCHLPM loss cost analysis performed.

### 5.4.8 Contents

The model shall provide a separate mathematical representation of contents loss costs, and the modeler shall demonstrate its actuarial soundness.

The relationship between the modeled building and contents loss costs shall be shown to be reasonable. If applicable, differences and the reasons for those differences from prior submissions in the relativities between loss costs for the building and the corresponding loss costs for contents shall be explained and shown to be reasonable.

*Reference:* *Module 1, Section I, B.6 (distinction for different policy types)* (page 31)
*Module 3, Section IV, #5 (contents vulnerability function),* (page 75)
*#7 (depreciation assumptions)* (page 77)
*Module 3, Section V, #2 (loss cost relationships by type of coverage and type of construction),* (page 87)
*#4 (output ranges)* (page 125)
*Module 3, Section VII, Form B (30 Hypothetical Events),*
*Form C (One Hypothetical Event),* (page 112)
*Form D (Loss Costs)*
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)

Audit: The company actuary will be asked to attest to the actuarial soundness of the procedure. To the extent that historical data are used to develop mathematical depictions of contents functions, be prepared to demonstrate the goodness-of-fit of the data to fitted models as per 5.6.2. Be prepared to discuss and justify changes from the prior submission in the relativities between loss costs for buildings and the corresponding loss costs for contents.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed portfolio profile reports used for validating data including:

- Total Insured Value by Line of Business
- Total Insured Value by Coverage
- Total Insured Value by Account
- Total Insured Value by Geographical Location (county, state, etc.)
- Profile
- Policy Count by Line of Business
- Deductible Profile

### 5.4.9 Additional Living Expenses (ALE)

The model shall provide a separate mathematical representation of Additional Living Expense (ALE) loss costs, and the modeler shall demonstrate its actuarial soundness.

The relationship between the modeled building and ALE loss costs shall be shown to be reasonable. If applicable, differences and the reasons for those differences from prior submissions in the relativities between loss costs for the building and the corresponding loss costs for ALE shall be explained and shown to be reasonable.

The modeler shall disclose the methods used in the model to incorporate ALE losses from damage to the infrastructure and the methods shall be shown to be reasonable.

*Reference:* *Module 1, Section 1, C.1.d (storm surge and flood damage to the infrastructure)* (page 32)
*Module 3, Section IV, #6 (ALE vulnerability function)* (page 76)
*Module 3, Section V, #4 (output ranges)* (page 125)
*Module 3, Section VII, Form B (30 Hypothetical Events), Form C (One Hypothetical Event), Form D (Loss Costs)* (page 112)
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)

Audit: The company actuary will be asked to attest to the actuarial soundness of the procedure. Also, be prepared to document, discuss, and justify the following during the on-site review:

A. The method of derivation and data on which the ALE vulnerability function is based;
B. Validation data specifically applicable to ALE;
C. Assumptions regarding the coding of ALE losses by insurers;
D. For Hurricane Andrew, be prepared to quantify and discuss the effects of demand surge on ALE;
E. Assumptions regarding the variability of ALE by size of property;
F. Statewide application of ALE assumptions;
G. Assumptions regarding ALE for mobile homes, tenants, and condominium exposure;
H. Logical relation to contents, especially contents versus ALE for condominiums; and
I. ALE resulting from damage to the infrastructure.

To the extent that historical data are used to develop mathematical depictions of ALE functions, be prepared to demonstrate the goodness-of-fit of the data to fitted models as per 5.6.2.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed details on the USWIND method for calculating damage to ALE.

Reviewed graphical representations of Form D loss costs for building loss, appurtenant structure loss, contents, and ALE.

Reviewed methods used to include ALE due to infrastructure damage.

### 5.4.10 Replication of Known Hurricane Losses

The model shall be shown to reasonably replicate incurred losses on a sufficient body of past hurricane events, including the most current data available to the modeler. This standard applies separately to personal residential and mobile homes to the extent data are available. Personal residential experience may be used to replicate building-only and contents-only losses. The modeler shall demonstrate that the replications were produced on an objective body of loss data by county or an appropriate level of geographic detail.

*Reference:* *Module 1, Section II, A.5 (claims data used in development of vulnerability functions),* (page 34)
*C.3 (damage estimates validation tests)* (page 43)
*Module 3, Section IV, #9 (validation comparisons of actual exposures and loss to modeled exposures and loss)* (page 78)
*Module 3, Section V, #2 (loss costs relationships by type of coverage and type of construction),* (page 87)
*#8 (Hurricane Andrew loss costs)* (page 97)
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)
*Standard 5.6.3 (Uncertainty Characterization)* (page 185)

Audit: A. Provide the following for each insurer and hurricane:

1. The version of the model used to calculate modeled losses for each storm provided;
2. For each storm, a general description of the data and its source;
3. A disclosure of any material mismatch of exposure and loss data problems, or other material consideration. For each storm, the date of the exposures used for modeling and the date of the hurricane;
4. An explanation of differences in the actual and modeled storm parameters;
5. A listing of the departures, if any, in the wind field applied to a particular hurricane for the purpose of validation and the wind field used in the model under consideration;
6. The type of property used in each storm to address:
   a. Personal versus commercial
   b. Residential structures
   c. Mobile homes

d. Condominiums
e. Buildings only
f. Contents only

7. For each example, the inclusion of demand surge, storm surge, loss adjustment expenses, or law and ordinance coverage in the actual losses, or the modeled losses.

B. Have the following documentation available for on-site review:

1. Provide a copy of the publicly available documentation that you plan to provide to the Commission;
2. A listing of all data sources excluded from validation and the reasons for excluding the data from review by the Commission (if any);
3. An analysis that identifies and explains anomalies observed in the validation data;
4. For Hurricane Andrew, be prepared to quantify and discuss the effects of demand surge; and
5. User input sheets for each insurer and hurricane detailing specific assumptions made with regard to exposed property.

C. Use confidence intervals per 5.6.3 to gauge the comparison between historical and modeled losses.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

No new insurance company validation data. Validations previously reviewed in detail.

### 5.4.11 Comparison of Estimated Hurricane Loss Costs

The model shall provide the annual average zero deductible statewide loss costs produced using the list of hurricanes in 5.2.3 historical hurricanes in Florida based on the 1998 Florida Hurricane Catastrophe Fund's (FHCF) aggregate personal residential exposure data, as of November 1, 1999. These will be compared to the statewide loss costs produced by the model on an average industry basis. The difference, due to uncertainty, between historical and modeled annual average statewide loss costs shall be demonstrated to be statistically reasonable.

*Reference:* *Module 1, Section II, C.2 (expected loss estimates validation tests),* (page 42)
*C.3 (damage estimates validation tests)* (page 43)
*Module 3, Section I, #7 (decay rate compared to Kaplan-DeMaria),* (page 56)
*#11 (frequency and annual occurrence rates)* (page 61)

*Module 3, Section V, #2 (loss cost relationships by type of coverage and type of construction),* (page 87)
*#4 (output ranges),* (page 125)
*#5 (explanation of differences in output ranges from prior year),* (page 93)
*#9 (distribution of hurricanes by size)* (page 98)
*Standard 5.6.2 (Comparison of Historical and Modeled Results)* (page 185)
*Standard 5.6.3 (Uncertainty Characterization)* (page 185)

Audit: Be prepared to discuss and justify the following during the on-site review:

A. Meteorological parameters;
B. The effect of by-passing storms;
C. The effect of actual storms that have two landfalls impacting Florida;
D. The departures, if any, from the wind field, vulnerability functions, or insurance functions applied to the actual hurricanes for the purposes of this test and those used in the model under consideration;
E. Exposure assumptions;
F. Identify and explain any unusual results;
G. Use confidence intervals per 5.6.3 to gauge the comparison between historical and modeled losses;
H. The zero deductible statewide loss for each hurricane in the Official Storm Set; and
I. The zero deductible loss by zip code for Hurricane Andrew.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed differences from prior submission and these differences were shown to be statistically insignificant.

### 5.4.12 Output Ranges

Any model previously found acceptable by the Commission shall provide an explanation suitable to the Commission concerning the differences in the updated output ranges. Differences between the prior year submission and the current submission shall be explained in the submission including, but not limited to:

1. Differences and the reasons for those differences from the prior submission of greater than ten percent in the weighted average loss costs for any county shall be specifically listed and explained in the modeler's submission to the Commission. The submission shall include a specific listing of each affected county.

2. Differences and the reasons for those differences from the prior submission of ten percent or less in the weighted average loss costs for any county shall be explained in the aggregate in the modeler's submission to the Commission.

*Reference:* *Module 1, Section I, B.2 (resolution used for output ranges)* (page 29)
*Module 3, Section V, #4 (output ranges),* (page 125)
*#5 (explanation of differences in output ranges from prior year),* (page 93)
*#6 (output ranges % change by county),* (page 96)
*#7 (maps of output ranges % change by county)* (page 96)

Audit: Be prepared to discuss and justify the following during the on-site review:

1. Changes from the prior submission of greater than ten percent in weighted average loss costs for any county.
2. Changes from the prior submission of ten percent or less in weighted average loss costs for any county.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed color-coded maps by county of changes in the loss costs from previous year. Discussed changes that were greater than 5%. Verified that the update to the storm set was the only source of change to the loss costs.

Discussed the differences in relativities among building type, contents, mobile homes, deductibles, ALE, and appurtenant structures. Verified that there were no significant changes.

Discussed in detail the relationship between the loss cost for a $2500 deductible and a 5% deductible for all policy types.

Discussed the relationship between a $0 deductible structure and a $0 deductible appurtenant structure loss cost.

Reviewed color-coded maps of the percentage change in weighted average loss costs by county for masonry, wood frame, mobile home, renters wood frame, and wood frame condo.

The Professional Team informed EQE that the Commission will be updating the FHCF exposure database provided next year, and they will be required to run both the old and new exposure data sets.

## 5.5 Computer Standards – *Paul Fishwick, Leader*

### 5.5.1 Primary Document Binder

A primary document binder, in either electronic or physical form, shall be created, and shall contain fully documented sections for each subsequent Computer Standard. Development of each section shall be indicative of accepted software engineering practices. All computer software (i.e., user interface, scientific, engineering, actuarial) relevant to the modeler's submission must be consistently documented.

*Reference:* *Module 1, Section I (General Description of the Model)* (page 11)
*Module 1, Section II (Specific Description of the Model)* (page 33)

Audit: The Professional Team will audit all aspects of the submission. Modeler personnel, or their designated proxies, responsible for each aspect of the software (i.e. user interface, quality assurance, engineering, actuarial) shall be present at the break-out meeting when the computer standards are being audited.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed the primary document binder and the master list of reference documents. The binder is unchanged from last year.

### 5.5.2 Requirements

The modeler shall document all requirements specifications of the software, such as interface, human factors, functionality, documentation, data, human and material resources, security, and quality assurance.

*Reference:* *Module 1, Section I (General Description of the Model)* (page 11)
*Module 1, Section II (Specific Description of the Model)* (page 33)
*Module 3, Section VI, #2 (computer code tampering)* (page 105)

Audit: The Professional Team will ask modelers for the requirements specifications documentation and review onsite.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed the following documentation on all requirements specifications for the software:

- USWIND Requirement Specification, Revision 1, August 25, 1994
- Design Specification EQECAT Additional Reports, February 1, 1999
- Design Specification EQECAT Additional Reports, Revision 2, June 30, 1999

Lotus Notes Database with the following documents:

- Treaty Underwriter Module Hardware/Software Requirements, Revision 2, November 7, 2000
- Treaty Underwriter Module Software Requirements Specifications (SRS) Volume 1 of 3, Preliminary Draft, September 7, 2000
- Treaty Underwriter Module Software Requirements Specifications (SRS) Volume 2 of 3, Preliminary Draft, September 7, 2000
- Treaty Underwriter Module Software Requirements Specifications (SRS) Volume 3 of 3, Preliminary Draft, September 12, 2000
- Treaty Underwriter Module Product Requirements Document, Revision 1.0.8, March 6, 2000
- WORLDCAT Enterprise Version 2.0 Product Requirements Document, Revision 1.0.0, September 20, 2000

### 5.5.3 Model Architecture and Component Design

The modeler shall document detailed control and data flow diagrams, interface specifications, and a schema for all data files along with field type definitions. Each network diagram shall contain components (including referenced sub-component diagrams), arcs, and labels. A model component custodian shall be identified and documented.

*Reference:* *Module 1, Section I (General Description of the Model)* (page 11)
*Module 1, Section II (Specific Description of the Model)* (page 33)

Audit: All codes will be designed in diagrams that depict the flow of data and control. Other synonyms for "component" are module, function, plug-in, or object. In all cases, a component has a clear input/output interface. The idea of interacting components with flows extending from one component to another came about in systems theory and engineering and was extended to software engineering. While the standards do not dictate programming paradigm, they require that the top-level design of the code is in an aggregate form that references common components such as STORMS, WIND FIELD, DAMAGE, and COST.

All model component custodians or their designated proxies must be available at the time of audit.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed the model custodian responsibility cross-listing for code, documentation, and data. Reviewed the following documentation on all design levels of the software, including software components and interfaces, data files, and database elements.

- EQECAT Catastrophe Management Output Reports Definitions, Revision 2, November 30, 1994
- EQECAT Catastrophe Management System, Version 3, GUI Design Specification, Revision 5, February 21, 1996
- EQECAT Natural Hazard Applications, Version 5, System Analysis and Data Flow Diagrams, Revision 2, December 1, 1998
- EQECAT Natural Hazard Applications, Version 5, System Design and Implementation, Revision 4, April 16, 2000
- EQECAT Natural Hazard Applications, Version 5, Interface Control Document, Revision 9, September 22, 2000
- EQECAT Data Directory Help File on CD-ROM
- Design Specification EQECAT Additional Reports, February 1, 1999
- Design Specification EQECAT Additional Reports, Revision 2, June 30, 1999
- EQECAT User Manual
- EQECAT Reference Guide
- EQECAT File Layout & Import Manual
- QA Test Procedure
- (Lotus Notes) Application Programmers Interface (API) for the EQE TUM Analysis Engine Broker, Revision 0, August 11, 2000
- (Lotus Notes) Treaty Underwriter Module Data Dictionary Modifications, Revision 0, September 27, 2000

### 5.5.4 Implementation

The software shall be traceable from the flow diagrams and their components down to the code level. All documentation, including document binder identification, shall be indicated in the relevant component. The highest design level components shall incrementally be translated into a larger number of components until the code level is reached.

*Reference:* *Module 1, Section I (General Description of the Model)* (page 11)
*Module 1, Section II (Specific Description of the Model)* (page 33)

Audit: Each of the components in 5.5.3 is refined into subcomponents, and at the end of the component "tree" there are blocks of code. All documentation and

binder identifications will be referenced within this tree. This creates a traceable design from aggregate components down to the code level.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

1. Reviewed the underlying model algorithm implementation, technical assumptions, and the procedures used for updating the system data.

2. Performed code spot checks
   2a. Verification of minimum 40 mph wind speed for damage calculation
   2b. Verified method for quantifying construction categories used in mitigation code.

3. Documentation reviewed:
   - USWIND Requirement Specification, Revision 1, August 25, 1994
   - EQECAT Natural Hazard Applications, Version 5, System Design and Implementation, Revision 4, April 16, 2000
   - EQECAT Catastrophe Management System, Version 3, GUI Design Specification, Revision 5, February 21, 1996
   - EQECAT Natural Hazard Applications, Version 5, Interface Control Document, Revision 9, September 22, 2000
   - (Lotus Notes) WORLDCAT Enterprise Installation Guide, Revision 2, May 17, 2001

### 5.5.5 Verification

1. General

The modeler shall employ and document procedures employed, such as code inspections, reviews, calculation crosschecks, and walkthroughs, sufficient to demonstrate code correctness. The code shall contain 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. Testing

Tests shall be documented for each software component, independent of all other components, to ensure that each component provides the correct response to inputs. The test specifications, procedures, and results shall also be documented to establish that the integration of all components produces model behavior that functions correctly.

*Reference:* *Module 1, Section I (General Description of the Model)* (page 11)
*Module 1, Section II (Specific Description of the Model)* (page 33)
*Standard 5.1.4 (Independence of Model Components)* (page 161)
*Standard 5.6.4 (Sensitivity Analysis for Model Output)* (page 185)
*Standard 5.6.5 (Uncertainty Analysis for Model Output)* (page 186)

Audit: Some compilers will contain the ability to declare logical assertions. For those compilers without this capability, one can create "if-statements" with the appropriate flag. Assertions as to "what should be true" at specific points in the code aids in producing correct code.

To test the whole, unit testing is required on each of the parts. When each part is verified as working on an independent basis, then the parts can be combined together to create the final program. Tests should be run by varying component inputs to ensure correct output. To the extent that component inputs are varied according to sensitivity and uncertainty analyses, provide this material to the Professional Team for review.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed the model's testing procedures and software to verify that the software results are consistent with the intended simulation approach and the algorithms employed.

Reviewed the following documentation:

- Technical Reference, USWIND Version 4.0 to 5.x, December 1997 – April 2001
- Technical Reference, Damage to Loss Calculation, USWIND and USQUAKE Version 4.0 to 5.x, December 1997 – April 2001
- QA Test Procedure
- Test Runs, Test Plan and Summary of Results
- Test Runs, QA Verification of Scenario Wind Speed
- Test Runs, QA Verification for Wind Speed and Damage Calculations
- Test Runs, QA Verification for Scenario Damage Calculation
- Test Runs, QA Verification for Scenario Gross Loss Calculation
- Test Runs, QA Verification for Scenario Net Loss Calculation
- Test Runs, QA Verification for Gross to Net Calculation
- Test Runs, QA Verification for Probabilistic Gross Loss Calculation
- Test Runs, QA Verification for Probabilistic Net Calculation
- (Lotus Notes) Tum Technical Test Plan R.4
- EQECAT Automated Build Process
    - Test Documentation for Test Cases, WP-POL-00, Primary Underwriter Module Policy Test Case, Florida Wind

- Test Documentation for Test Cases, WP-SS-00, Primary Underwriter Module Single Site Test Case, Florida Hurricane

### 5.5.6 Model Maintenance and Revision

The modeler shall specify all policies and procedures used to maintain the code, data, and documentation. For each component in the system decomposition, the modeler shall list the installation date under configuration control, the current version number, and the date of the most recent change(s). The modeler shall use tracking software to identify all errors, as well as modifications to the code, data, and documentation.

*Reference:* *Module 1, Section I (General Description of the Model)* (page 11)
*Module 1, Section II (Specific Description of the Model)* (page 33)

Audit: Software maintenance includes a written and implemented policy for backup procedures. There are numerous software applications that aid the programming in source revision and control. Even if there are very few programmers, such an approach is necessary to track changes and ensure a quality software engineering process.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed the following methods and documentation for software maintenance and revision:

- QA Test Procedure
- SourceSafe
- EQECAT Build Machine/Process

### 5.5.7 User Documentation

The modeler shall have complete user documentation including all recent updates.

*Reference:* *Module 1, Section I (General Description of the Model)* (page 11)
*Module 1, Section II (Specific Description of the Model)* (page 33)

Audit: The Professional Team will talk to users of the software, including those familiar with the code as well as those who use the code without any knowledge of its components or their internal interfaces.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed the following user documentation:

- EQECAT User Manual
- EQECAT Reference Guide
- EQECAT File Layout & Import Manual
- EQECAT Data Dictionary Help File

## 5.6 Statistical Standards – *Mark Johnson, Leader*

### 5.6.1 Use of Historical Data

The use of historical data in developing the model shall be demonstrated to be reasonable using rigorous methods published in the scientific literature.

*Reference: Module 1, Section II, B.12 (statistical techniques used for probability distribution estimates)* (page 40)
*Module 3, Section I, #8 (source of historical data set)* (page 56)

Audit: Although the chi-square goodness-of-fit test is a commonly used procedure, there are more powerful (rigorous) tests available. Either the Kolmogorov-Smirnov (with relevant adjustments for parameter estimation) or Cramer-von Mises tests should be applied using a reasonable significance level. The Commission does not consider the chi-square goodness-of-fit test to be a rigorous methodology for demonstrating the reasonableness of models of historical data.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed the probability distributions for input variables including lognormal distributions for forward speed and Rmax. The goodness-of-fit was demonstrated through results of chi-square and Kolmogorov-Smirnov tests. Reviewed graphical comparisons confirming the agreement between the modeled distributions of various parameters with the underlying historical data.

### 5.6.2 Comparison of Historical and Modeled Results

The modeler shall demonstrate the agreement between historical and modeled results using accepted scientific and statistical methods.

*Reference: Module 1, Section II, A.1 (deviation from official hurricane set),* (page 33)

*B.7 (parameters for hurricane frequency),* (page 37)
*C.1 (wind speed validation tests),* (page 41)
*C.3 (damage estimates validation tests),* (page 43)
*C.5 (other validation tests),* (page 44)
*C.6 (validation tests documentation)* (page 44)
*Module 3, Section I, #12 (number of events, relative frequency and annual occurrence rate by category),* (page 64)
*#13 (probability of hurricanes by year)* (page 66)
*Module 3, Section III, #3 (building code enforcement),* (page 69)
*#4 (quality of construction type, materials and workmanship),* (page 70)
*#5 (hazard mitigation)* (page 70)
*Module 3, Section IV, #3 (appurtenant structures vulnerability function),* (page 75)
*#4 (mobile home vulnerability function),* (page 75)
*#5 (contents vulnerability function),* (page 75)
*#6 (ALE vulnerability function)* (page 76)

Audit: Examples include hurricane frequencies, tracks, intensities and physical damage.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Verified no change in the model from previous year. Reviewed probability distributions and goodness-of-fit results through chi-square and Kolmogorov-Smirnov tests. Statistical analysis in 5.4.11 reviewed. Reviewed comparison of modeled insured losses versus Property Claims Services reported losses for numerous hurricanes.

Reviewed comparisons of empirical CDFs of historical loss and simulated loss.

### 5.6.3 Uncertainty Characterization

The modeler shall provide an assessment of uncertainty using confidence intervals or other accepted scientific characterizations of uncertainty.

*Reference: Module 1, Section II, B.9 (confidence intervals produced)* (page 37)

Audit: Note that confidence limits could be used for distribution parameter limits and prediction limits could be used for situations in which future values are envisaged.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed graphical representations of loss exceedance curves pertaining to frequency of storms by return period and annual exceedance probabilities.

Reviewed examples of variation in Rmax, CP, and Vt for Dade County.

Reviewed uncertainty in damage estimation on modeling and physical properties, suggested COV, and the modeling uncertainty.

Reviewed uncertainty analysis on the estimation of loss calculated from three different vulnerability functions.

As the changes to the model did not impact most of the statistical underpinnings of the model, the bulk of material reviewed (5.6.1 – 5.6.3) had been reviewed previously.

### 5.6.4 Sensitivity Analysis for Model Output

The modeler shall demonstrate that the model has been assessed with respect to sensitivity of temporal and spatial outputs to the simultaneous variation of input variables using accepted scientific and statistical methods. Statistical techniques used to perform sensitivity analysis shall be explicitly stated and the results of the analysis shall be presented in graphical format.

*Reference:* *Module 1, Section I, A.5 (critical variables determined from SA)* (page 24)
*Module 1, Section II, B.13 (model sensitivity),* (page 40)
*B.14 (sensitivity in output results),* (page 40)
*B.15 (SA & UA performed on model)* (page 41)
*Module 3, Section VII, Form F (Hypothetical Events for SA & UA)*(page 117)
*Standard 5.2.10 (Temporal and Spatial Wind Field Characteristics)*(page 167)

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Reviewed the sensitivity study conducted on the Form F data conducted by EQE. Reviewed other sensitivity analyses performed on Rmax, Vt, filling rate, friction, and gust factor.

### 5.6.5 Uncertainty Analysis for Model Output

The modeler shall demonstrate that the temporal and spatial outputs of the model have been subjected to an uncertainty analysis using accepted scientific and statistical methods. The analysis shall identify and quantify the extent that input variables impact the uncertainty in model output as the input variables are simultaneously varied. Statistical techniques used to perform uncertainty analysis shall be explicitly stated and results of the analysis shall be presented in graphical format.

*Reference:* *Module 1, Section I, A.5 (assessment of uncertainty in loss costs produced by variables)* (page 24)
*Module 1, Section II, B.9 (confidence intervals produced),* (page 37)
*B.13 (model sensitivity),* (page 40)
*B.14 (sensitivity in output results),* (page 40)
*B.15 (SA & UA performed on model)* (page 41)
*Module 3, Section VII, Form F (Hypothetical Events for SA & UA)* (page 117)
*Standard 5.2.10 (Temporal and Spatial Wind Field Characteristics)* (page 167)

Audit: Although some modelers may use parameters as synonyms for input variables, the latter terminology is preferred here.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Uncertainty analyses of EQE were presented to the Professional Team during the on-site review. In particular, reviewed EQE's uncertainty analysis for wind model parameters.

Reviewed EQE's uncertainty analysis of Form F.

### 5.6.6 County Level Aggregation

At the county level of aggregation, the contribution to the error in loss costs estimates induced by the sampling process shall be demonstrated to be negligible using accepted scientific and statistical methods.

*Reference:* *Module 1, Section II, C.2 (expected loss estimates validation tests)* (page 42)
*Module 3, Section V, #4 (output ranges),* (page 125)
*#5 (explanation of differences in output ranges from prior year),* (page 93)
*#6 (output ranges % change by county)* (page 96)
*#7 (maps of output ranges % change by county)* (page 96)
*Module 3, Section VII, Form D (Loss Costs)*
*Standard 5.6.3 (Uncertainty Characterization)* (page 185)

Audit: Provide a graph assessing the accuracy associated with low impact areas such as Nassau County. Assess where appropriate, the contribution of simulation uncertainty via confidence intervals per 5.6.3.

**Proprietary:** **Yes**
**Verified:** **Yes**

**Professional Team Comments:**

Method of stochastic storm generation ensures that this standard is verified.

## Modules Verification:

Module 2

Discussed Dr. Friedman's 1995 review of the meteorological component of USWIND focusing on the basic wind field methodology. Although certain inputs to the model have changed since the review, the basis of the model has not changed, therefore the review is considered relevant.

Discussed the 1996 review of USWIND by Mr. Peter Kelly and Dr. Lixin Zeng. The review remains relevant for the reasons cited in the previous paragraph.

Form A

Reviewed change in Form A results due to a change in the model input portfolio for duplicate ZIP Codes.

Form B

Discussed changes in the model input file resulting in a change in four counties due to ZIP Code changes in the input file. Reviewed differences in counties and verified the changes were a result of ZIP Code centroid movements in the input file. Changes from prior year were adequately explained.

Form C

EQE provided an explanation of how the Form C results were generated. No change from last year.

Form D

Verified that the results of the revised Form D are reasonable. ZIP Code duplication as noted in Form A were accommodated.

Form E

Verified that the results of the revised Form D are reasonable. EQE provided an explanation for the top event row being blank. Discussed the reasoning for the reduced set of storms in lieu of the full set of stochastic storms.

Form F

A graphical analysis was performed on the sensitivity and uncertainty aspects of the form F results. Wind and loss cost contours were generated.