# Florida Commission
# on Hurricane Loss Projection Methodology

## Professional Team Audit Report

# RISK ENGINEERING, INC.

***On-Site Review***
***March 30-April 1, 2000***

***Additional On-Site Review***
***April 26-27, 2000***

On March 30-April 1, 2000, the Professional Team visited on site at Risk Engineering Inc. in Boulder, Colorado for the purposes of an initial assessment of their model followed by a Standard-by-Standard review audit. The following people participated in the review:

**RISK ENGINEERING, Inc.**

Robin McGuire, Ph.D., President
Gabriel Toro, Vice President
Robert Kilcup, Ph.D., P.E., Senior Engineer
Thomas Stone, Project Engineer
John Vlasity, Project Scientist

**PROFESSIONAL TEAM**

Mark Johnson, Statistician, Team Leader
John Pepper, Engineer
Tom Schroeder, Meteorologist
Marty Simons, Actuary
Paul Fishwick, Computer Scientist
Ron Iman, Statistician
Anne Bert, Staff
Cindy Gokel, Staff
Joan Lazar, Staff

The review commenced with a number of presentations by Risk Engineering providing details of their methodology as promised in their original submission. In particular, they presented their basic probabilistic approach for event generation (occurrence model) with special attention to comparisons with the historical record. These extensive presentations provided an opportunity for the Professional Team to address questions in the Modules as well as specific issues related to the subsequent Standards review.

In the course of reviewing Modules 1-3, the Professional Team indicated areas needing extensive supporting material and Risk Engineering indicated that they would attempt to provide this material during the Standards review the following day. The Professional Team report indicates the extent to which this was accomplished. Several inconsistencies with Modules 1-3 were pointed out to Risk Engineering reflecting necessary changes to their model to achieve potential verification by the Professional Team during the Standard verification process. The Professional Team made no suggestions as to how that would be accomplished. The Professional Team expressed concern that some Standards could not be assessed during this visit due to the unavailability of necessary supporting materials.

The Standards review of Sections 1-4 took place on the second day. Risk Engineering was provided a preliminary assessment of each Standard at the end of the day.

On the final day, Paul Fishwick met separately with Tom Stone to discuss computer design issues. The Professional Team then reviewed and verified the computer standards in Section 5. Overnight, Risk Engineering produced materials which led to the ability of the Professional Team to verify additional Standards.

The review at Risk Engineering concluded with an exit interview. The Professional Team provided a preliminary draft of the report that will be provided to the Commission in May. Risk Engineering was given the opportunity to check for any factual errors and to remove any confidential or proprietary information. The Professional Team acknowledged Risk Engineering for their cooperation in the review of the Standards.

## ADDITIONAL VERIFICATION REVIEW

Risk Engineering submitted a letter dated April 19, 2000, to Elsie Crowell, Chair of the FCHLPM. Risk Engineering indicated that that they had "revised their software and documentation to be fully compliant with all Commission standards and requested an additional meeting with the Professional Team to obtain resolution of the outstanding issues." The Chair assembled a subset of the Professional Team, for one additional verification review. The Professional Team conducted this review on April 26-27, 2000, in Boston, MA. Boston was chosen for the review because the Team was already assembled in Boston for the review of another Company. **All Standards were verified with the exception of 5.1.2, 5.2.5, 5.4.1 and 5.4.10.** The following people participated in the review:

### RISK ENGINEERING

Robin McGuire, Ph.D., President
Robert Kilcup, Ph.D., P.E., Senior Engineer
Thomas Stone, Project Engineer

### PROFESSIONAL TEAM

Marty Simons, Actuary, Team Leader
Fred Stolaski, Engineer
Ron Iman, Statistician
Anne Bert, Staff
Cindy Gokel, Staff

# Florida Commission on Hurricane Loss Projection Methodology

# 1999 Standards

## 5.1 General Standards – Mark Johnson, Team 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 it applies to Additional Living Expense (ALE). References to the model shall include its implementation.

*Reference: Module 3, Section III, 1*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Viewed presentation regarding methods for developing lost costs by coverage**

### 5.1.2 Qualifications of Modeler Personnel and/or Independent Experts

Model construction, testing, and evaluation must be performed by modeler personnel and/or independent experts who possess the necessary skills, formal education, or experience to develop hurricane loss projection methodologies, and who must abide by the standards of professional conduct adopted by their profession.

*Reference: Module 2, Section I, B, C, E, F*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **No** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Reviewed five personnel resumes.**
**Two are P.E.'s and three are Ph.D's**

### 5.1.3 Modelers Policy of Model Revision

The modeler shall have developed and implemented a clearly written policy for model revision with respect to methodologies and data. Zip codes used in the model shall be updated at least every 24 months using information originating from the United States Postal Service.

*Reference: Module 1, I.A.9*
*Reference: Module 1, I.A.10*
*Reference: Module 3, Section VI, #1*
*Reference: Module 3, Form A*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **No** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Written policy was reviewed. Zip Codes updated in 1999**.

### 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.

*Reference: Module 1, II, B.13, 15, 16, 17*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

## 5.2 Meteorological Standards - Tom Schroeder

### 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 (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **No** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Model does not generate output relative to these parameters.**

### 5.2.2 Identification of Units of Measure of The Model

All units of measure for model inputs and outputs shall be clearly identified.

*Reference: Module 1, I.C.2*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **No** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Demonstrated through materials provided in submission that inputs and outputs were clearly identified**.

### 5.2.3 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, II.2*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.2.4 Official Hurricane Set or Suitable Approved Alternatives

Modelers shall include in their base storm set all hurricanes, including by-passing hurricanes, which produce minimal hurricane force winds or higher in Florida. Storm set modifications will be taken from the Tropical Prediction Center/National Hurricane Center (TPC/NHC) document *Tropical Cyclones of the North Atlantic Ocean, 1871-1995* with the most recent updates available. All proposed alternatives shall be subject to the approval of the Commission.

*Reference: Module 1, II.B. 8-9*
*Reference: Module 3, Section I*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **No** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.2.5 Hurricane Characteristics

Methods for depicting all modeled hurricane characteristics (e.g., wind speed, minimum central pressure, radius of hurricane force winds, strike probabilities, and tracks) shall be based on information documented by scientific literature or modeler information accepted by the Commission.

*Reference: Module 1, II.B.1-10*
*Reference: Module 3, Section I*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **No** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Methods of initiating storms are not documented by scientific literature.**

**Viewed presentation of proprietary information by modeler and was deemed to be reasonable. This proprietary methodology has not been published in open scientific literature.**

### 5.2.6 Landfall Intensity

Models shall use as intensity criteria maximum one-minute sustained 10-meter wind speed when defining hurricane landfall intensity. This applies both to the meteorological storm set used to develop landfall strike probabilities as a function of coastal location and to the modeled winds in each hurricane which causes damage. If historical records include minimum central pressure but do not include wind speed, then minimum central pressure will be used to define hurricane intensity. The associated maximum one-minute sustained 10-meter windspeed must be within the range of wind speeds (in statute miles per hour) categorized by the Saffir-Simpson scale for observed minimum pressure.

**Saffir-Simpson Hurricane Scale:**

A scale from 1 to 5 that measures hurricane intensity.

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

*Reference: Module 1, II.B.5*
*Reference: Module 3, Section I. 1, 2, 3*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **No** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Information in letter dated March 20, 2000 was suitably modified while Professional Team was on site.**

### 5.2.7 Hurricane Probabilities

Modeled hurricane probabilities for category 1-5 hurricanes shall be consistent with those observed for each geographical area of Florida. "Consistent" means: (1) spatial distributions of modeled hurricane probabilities must accurately depict vulnerable coastlines in Florida; and (2) probabilities are fit to observed hurricane frequency using methods documented in accepted scientific literature or proposed by the modeler and accepted by the Commission.

*Reference: Module 1, I.B.2*
*Reference: Module 1, II.B.8*
*Reference: Module 3, Section I*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone**<br>**Gabriel Toro** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.2.8 Hurricane Probability Distributions

Modeled probability distributions for hurricane strength, 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, II.B.1, 5, 8, 9*
*Reference: Module 3, Section 1.2, 8*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Proprietary Documentation Reviewed:**

**Research Report: Theory of Probability Weighted Moments by J.R.M. Hosking, IBM Research Division, .T. J. Watson Research Center, Yorkstown Heights, NY, October 1, 1986 Reissued with corrections: April 3, 1989**

### 5.2.9 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, II.B.4*
*Reference: Module 3, Section I*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone**<br>**John Vlasity**<br>**Gabriel Toro** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Reviewed the submission with regard to land friction. Relationship to NWS 23 discussed. Proprietary data base reviewed.**

**Looked at maps of zip code types for purposes of assessing wind speed transitions.**

### 5.2.10 Hurricane Overland Weakening Rate

The hurricane overland weakening rate used by the model shall be no less than and no greater than the observed extremes in historical records for Florida. The mean wind speed must be within twenty percent (20%) of the Kaplan/DeMaria decay value or an alternative acceptable to the Commission.

*Reference:* *Module 1, II.B. 3,10*
*Reference:* *Module 3, Section I*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Viewed proprietary graphical presentation.**

## 5.3 Vulnerability Standards – John Pepper

### 5.3.1 Vulnerability Functions

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

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.

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

Damage associated with a declared hurricane event shall include damage incurred for wind speeds above and below the hurricane threshold of 74 m.p.h. The assumptions used in determining sub-hurricane force induced damage shall be identified and demonstrated to be reasonable and appropriate. The minimum wind speed that generates damage shall be specified.

*Reference: Module 1, I.A.8*
*Reference: Module 3, Section III*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | | |

**Pro Team Comments:**

**Vulnerability function is replaceable by user. User adjustments are flagged as "not accepted" by the FCHLPM.**

**Development of the vulnerability functions was based on structural calculations and expert opinion. They were supported by field observations and historical data.**

### 5.3.2 Construction Characteristics

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

*Reference: Module 1, I.A.7*
*Reference: Module 3, Section III*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **No** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Masonry, wood frame and mobile home construction types used. Tie down and straps not considered in any construction type**.

### 5.3.3 Modification Factors

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

*Reference: Module 3, Section III, 3, 4*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Modification factors to the basic vulnerability functions were disclosed by the modeler and are allowed by the model, but the outputs are flagged as "not accepted" by the FCHLPM.**

### 5.3.4 Additional Living Expenses

In the estimation of Additional Living Expenses (ALE), the model shall include only factors that are hurricane related and theoretically sound. Storm surge/wave damage to the infrastructure shall be included.

The Additional Living Expense vulnerability function shall consider the time it takes to repair/reconstruct the home.

*Reference: Module 3, Section IV, 5*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Viewed presentation regarding methods for developing ALE.**

## 5.4 Actuarial Standards – Marty Simons

### 5.4.1 Underwriting Assumptions

For damage estimates derived from historical insured hurricane losses, the assumptions in the derivations concerning (1) construction characteristics, (2) policy provisions, and (3) relevant underwriting practices underlying those losses shall be identified and demonstrated to be reasonable and appropriate.

Adjustments, edits, inclusions, or deletions to insurance company input data used by the modeler in the modeling process shall be based upon accepted actuarial, underwriting, and statistical procedures. The methods used shall be documented in writing.

*Reference: Module 1, I.B.4*
*Reference: Module 1, II.A.3-5*
*Reference: Module 3, Section IV*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **No** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Unable to verify that adjustments, edits, inclusions, or deletions to insurance company input data used by the modeler in the modeling process were based upon accepted actuarial, underwriting, and statistical procedures.**

**Non-Proprietary Documentation Reviewed:**

- **Assessment of Damage to Homes Caused by Hurricane Opal, Final Report, Prepared for the Florida State Home Buildings Association, Prepared by: NAHB Research Center Upper Marlboro, MD, January 31, 1996**
- **Wind Effects on Structures, Second Edition, by Emil Simiu and Robert H. Scanlan**

**Proprietary Documentation Reviewed:**

- **Treatment of Damage Data**

### 5.4.2 Actuarial Modifications

All modification factors to the actuarial functions or characteristics including but not limited to building code, quality, age, occupancy, stories, or condition of structure and their corresponding affects must be disclosed and shall be clearly defined and their actuarial soundness demonstrated**.** The disclosure of modification shall include a description of the impact upon loss costs of the modification in accordance with the following:

A: < - 50%.
B: -50% to -25%
C: -25% to 0
D: 0 to 25%
E: 25% to 50%
F: >50%

*Reference: Module 1, I.A.6,11, I.C.1.c*
*Reference: Module 3, Section III, 3*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**The model accepted by the Commission shall not include modification factors. See 5.3.3.**

### 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.

*Reference: Module 3, Section V*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **No** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.4.4 Economic Inflation

Hurricane loss projection models shall not make a prospective provision for economic inflation.

*Reference: Module 1, I.B.4*
*Reference: Module 1, I.C.1.a*
*Reference: Module 1, II.A.3*
*Reference: Module 3, Section III, 2; Section VII*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **No** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.4.5 Insurer Inputs

Any assumption or method that relates to a specific insurers inputs (e.g., insurance to value, demographic assumptions, insurer exposures by zip code) to the model, if any, for the purposes of preparing the insurers rate filing shall be clearly identified by the modeler. A modeler shall disclose any implicit assumptions relating to, but 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 expense 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 shall validate all zip code information received from its insurance company clients to assure that valid zip codes are used.

*Reference: Module 1, I.A.11*
*Reference: Module 1, I.B.4*
*Reference: Module 1, II.A.3*
*Reference: Module 1, II.A.4*
*Reference: Module 3, Section IV*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Replacement cost coverage limits may be entered by the user and impacts are clearly disclosed in the model output.**

### 5.4.6 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.

*Reference: Module 1, I.C.1.a*
*Reference: Module 3, Section III. 2*
*Reference: Module 3, Section VII*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **No** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.4.7 Loss Costs – Meaning of "Damage"

In calculating loss costs, damage shall be expressed as insurable losses.

*Reference: Module 1, II.A.5*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.4.8 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 must 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. If the model considers the quality of building codes and enforcement, then loss costs cannot increase as the quality increases, all other factors held constant.

6. Loss costs must decrease as deductibles increase, all other factors held constant.

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, 1.C.1.b*
*Reference: Module 3, Section V.2, Section VII*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Previous output ranges adjusted for deductible and appurtenant structures.**

**Viewed color-coded maps.**
**Investigated potential anomalies.**

### 5.4.9 Deductibles

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

*Reference: Module 1, I.B.3*
*Reference: Module 3, Section IV.1-2*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.4.10 Contents

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

*Reference: Module 3, Section IV.5, 7*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **No** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Viewed model vs. insurer data. See 5.4.1.**

### 5.4.11 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.

*Reference: Module 3, Section IV.6*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.4.12 Building Codes

Information upon which building code quality and enforcement is assessed, if incorporated in the model, shall be objective and reasonably accurate and reliable.

*Reference: Module 1, I.C.1.b*
*Reference: Module 3, Section III.3*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **No** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Building code modifier not used.**

### 5.4.13 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.

*Reference: Module 3, Section IV.9*
*Reference: Module 3, Section V.2*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.4.14 Comparison of Estimated Hurricane Loss Costs

The model shall provide the annual average statewide loss costs produced using the list of hurricanes in standard 5.2.4 historical hurricanes in Florida based on the 1998 Florida Hurricane Catastrophe Funds (FHCF) aggregate 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 3, Section I.7, 9*
*Reference: Module 3, Section V.2*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.4.15 Output Ranges

Any model previously found acceptable by the Commission shall provide an explanation suitable to the Commission concerning the updated output ranges.

*Reference: Module 3, Section V.3*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Not applicable** | |
| **Staff:**<br><br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

### 5.4.16 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.

*Reference: Module 1, II.C.2*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**The set of events used within AllRisk to produce loss costs at the county level is sufficient to meet this standard.**

### 5.4.17 Zip Codes - Derivation

Loss cost projections by zip code produced by the model shall be derived by using either population centroid or geographic centroid.

*Reference: Module 3, Section VI.2*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Viewed model code.**

## 5.5 Computer Standards – Paul Fishwick

### 5.5.1 Model and Software Design

The modeler shall clearly specify and make available to the Commission or its Professional Team the following:

1. Model Design - This provides visual, equational and/or technical specifications for the simulation model. Simplifying assumptions, chosen parameters, input modeling methods, and technical design shall also be specified.

2. Algorithm Design - This includes but is not limited to pseudo-code specifications, flow-charts, class and aggregation hierarchies, and/or data flow diagrams for all numerical and event handling algorithms including random number generation, interpolation, parameter estimation for specified probability distributions and simulation control.

3. Data Design - This specifies methods used for the organization and maintenance of data, including database and/or file organization approaches.

   All critical design decisions must be based on accepted scientific, simulation and software engineering principles.

   *Reference: Module 1, Section I and II for all computer standards*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Documentation for this Standard is specified in 5.5.4 (Part 1)**

## Proprietary Documentation Reviewed:

1. **AllRisk Technical Overview**
2. **Software Description Manual for AllRisk**
3. **Exhibit A: General Description of Development of "EQ2000"**
4. **Collection of Data Flow Graphs:**
    a. **Preprocess Portfolio Data Flow**
    b. **Create Preprocess Portfolio Setup Algorithm**
    c. **Validation Preprocess Algorithm**
    d. **Create Map Exposure Algorithm**
    e. **Run a Loss Algorithm**
5. **Data Design/Modeling**
    a. **Meeting Minutes: First Meeting of EQ2000 , Project Advisory Board, April 24, 1995**
    b. **Set of Documents for data fields of exposure data**

### 5.5.2 Implementation

The modeler shall clearly specify the process of translating the model, algorithm, and data designs into a computer program. The process of developing an implementation from these designs must be based on generally accepted practices of good software engineering. The modeler shall specify the methodologies employed and the programming language(s) used to encode the model, as well as provide justification for these choices. In particular the methodologies must provide a high degree of encapsulation of data and code.

*Reference: Module 1, Section I and II for all computer standards*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

**Documentation for this Standard is specified in 5.5.4 (Part 1)**

## Proprietary Documentation Reviewed:

1. **Software Description Manual for AllRisk**
2. **Sample header files from C++ source code**
3. **Viewed model revisions code**

### 5.5.3 Validation, Verification, and Testing

The modeler shall specify methods used for testing computer programs to verify that the programs produce output that is consistent with the model. Model verification is a comparison of the model behavior and program behavior, whereas model validation is a comparison between model behavior and empirical (i.e., physical) behavior. These methods may include, but are not limited to, sample hand calculations, aggregate and simplified analysis, dimensional analysis, testing using extreme values for initial conditions and parameters, and testing based on perturbations and sensitivity. Modeled output variables shall be consistent in dimensions and units with the cited equations and methods. The modeler shall specify the procedures it enforces with its clients to assure accuracy of input data prior to running the model. All data sources used during the validation process shall be specified. The choices of procedures shall be based on sound scientific reasoning.

*Reference: Module 1, Section I and II for all computer standards*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

## Proprietary Documentation Reviewed:

1. **AllRisk Software: Implementation and Baseline Test Results**
2. **Documentation containing hand calculations and Excel tests**

### 5.5.4 Written Documentation

The modeler shall maintain and make available to the Commission or its Professional Team a comprehensive and complete set of documentation that tracks and explains the development of the model, its design, implementation, verification, testing, and maintenance. The contents of the documentation shall be logically organized and shall include key background scientific papers and references, analytical derivations, calculations, justifications of parameters, assumptions, sensitivity analyses, and hand calculations. Expert testimony on the model and its implementation shall be clearly documented. A comprehensive set of documentation is expected in each of the following areas:

1. Technical Documentation - This includes all model and software design documents relevant to the current state of the model and its implementation. With regard to models, this documentation shall cover decisions related to meteorology, engineering, statistics, actuarial science, and insurance. With regard to software, this documentation shall cover all phases of the software engineering life cycle. *(See 5.5.1, 5.5.2, and 5.5.3)*

2. Testing Documentation - This includes all procedures for testing and error handling, as well as those used for verification of the program and validation of the model. Moreover, the results of all these procedures must be retained in a form amenable to expert review. *(See 5.5.3)*

3. User Documentation - This includes release notes and user documentation.

4. Maintenance Documentation - This includes documentation of the maintenance methodology including tracking of all changes whether done to improve the product or to correct errors. Each change must be accompanied by a clear description of the purpose of the change and verification/test results that support the efficacy of this change.

5. Security Documentation - The modeler shall disclose to the professional team its security processes. This includes appropriate computer and networking procedures relating to the model design, implementation, and management of data.

*Reference: Module 1, Section I and II for all computer standards*

| Proprietary (Y or N) | Verified | Cannot Verify |
|---|---|---|
| **Yes** | **Yes** | |
| **Staff:**<br>**Robin McGuire**<br>**Bob Kilcup**<br>**Tom Stone** | **Notes:** | **Notes:** |

**Pro Team Comments:**

## Proprietary Documentation Reviewed:

**Documentation for 5.5.1, 5.5.2 and 5.5.3 covered in those Standards**

**Reviewed:**

1. **AllRisk User's Manual, March 2000**
2. **Maintenance Provisions – AllRisk Revision Procedures, April 2000**
3. **Maintenance Provisions – AllRisk Code Security, April 2000**