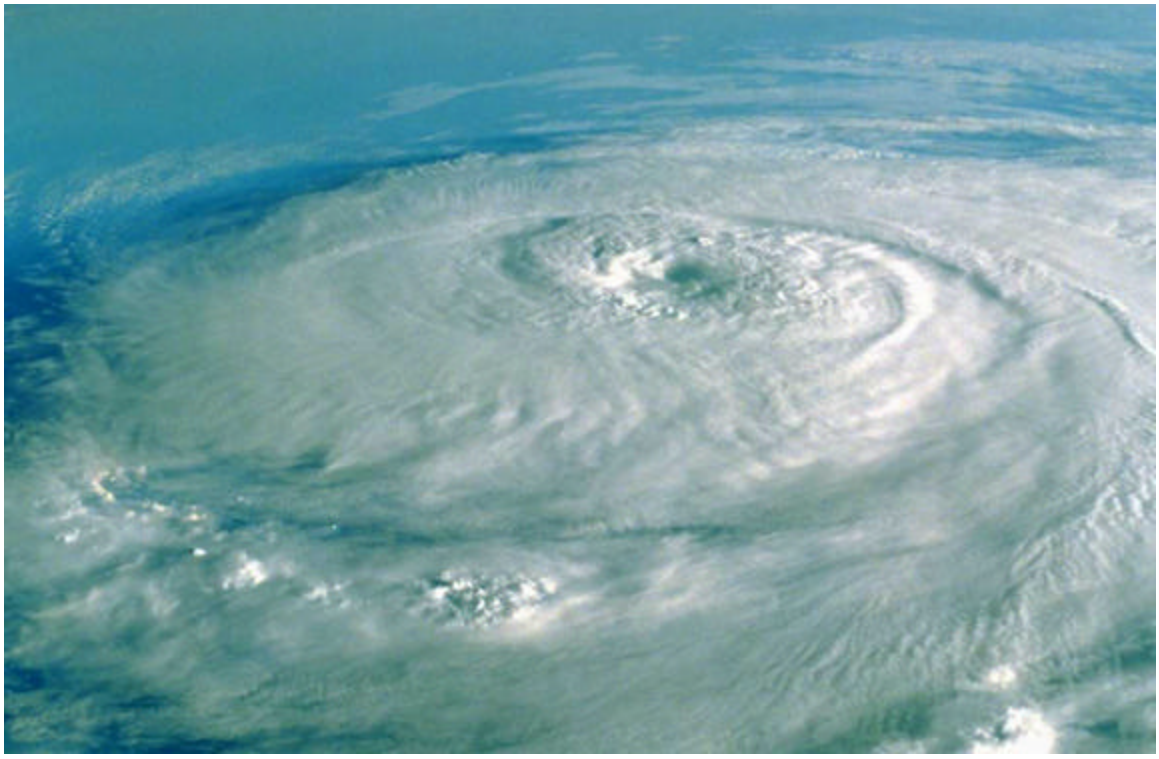
Florida Commission on Hurricane Loss Projection Methodology



Professional Team Audit Report
2001 Standards

Risk Management Solutions, Inc.

On-Site Review
April 25 & 26, 2002

On April 25 & 26, 2002, the Professional Team visited on-site at Risk Management Solutions, Inc. (RMS) in Newark, California. The following people participated in the review.

RMS

Richard R. Anderson, FCAS, MAAA, Chief Actuary
Michael Drayton, Ph.D., Principal Modeler
Atul C. Khanduri, Ph.D., Program and Project Manager
Craig Miller, Ph.D., Senior Wind Engineer
Guy C. Morrow, S.E., Vice President, Principal Engineer
Brian F. Owens, MBA, MSc, Director of Risk Applications
John Reiter, Vice President, RiskLink Software Development
Jim Tomcik, Vice President Catastrophe Applications

Professional Team

Mark Johnson, Ph.D., Statistician, Team Leader
Marty Simons, ACAS, Actuary
Ron Iman, Ph.D., Statistician
Paul Fishwick, Ph.D., Computer Scientist
John Pepper, P.E., Structural Engineer
Peter Ray, Ph.D., Meteorologist
Donna Sirmons, Staff

The review began with introductions and an overview of the audit process. RMS began with a discussion on the changes to the model from the previous year. They provided responses to the issues raised in the March 29th electronic correspondence and discussed during the April 8, 2002 conference call. Further supporting materials were presented upon request.

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.

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

Professional Team Comments:

Verified no change in the model with regards to the exclusion of flood and storm surge.

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, Section I, #2-#3 (pages 75 – 86)
Reference: Module 2, Section I, #5 (pages 88 – 90)

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

Professional Team Comments:

Reviewed vitas on new members of RMS development team:

- Brian Owens, Director of Risk Applications – B.S. in Computer Science from the National University of Ireland, MBA in Finance from the Wharton

Graduate School of Business, MS in Atmospheric Science from the Rosenstiel School of Marine and Atmospheric Science at the University of Miami – joined RMS in October 2001 – responsible for managing the technical interface between RMS clients/client relationship managers and the model development team, particularly with respect to US hurricanes.

- Claire Souch, Ph.D., Risk Analyst – B.Sc. in Environmental Science and Ph.D. in Water Resource Management from Cranfield University in the U.K. – joined RMS in October 2000 – responsible for real-time hurricane monitoring and event response, using the RMS Hurricane model to pick storm tracks and produce industry loss estimates.

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. 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 (page 38)
Reference: Module 1, Section I, A.9 (page 55)

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

Professional Team Comments:

Reviewed RMS's documentation for model revision and release. Verified that changes from previous year's submission are embodied in computer model.

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 (page 69)
Reference: Module I, Section II, B.13-15 (pages 70 – 71)
Reference: Standard 5.5.3 (page 31)

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

Professional Team Comments:

In the course of the review, verified the independence of the meteorology, vulnerability, and actuarial components of the model and found them to be theoretically sound and unbiased. (We detected no dependence.)

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 date of the updated information shall be disclosed.

Zip code centroids, when used in the model, shall be based upon 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 3, Section VI, #1 (page 122)
Reference: Module 3, Form A (page 126)

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

Professional Team Comments:

Discussed the Zip Code database used in the RMS model and verified the Zip codes were not changed in the model this year – database is the Zip Code update of February 2000 which was implemented by October 2000.

5.1.6 Identification of Units of Measure of the Model

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

Reference: Module 1, Section I, C.2 (page 58)

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

Professional Team Comments:

All visual presentations shown were clearly labeled in the appropriate units of measure.

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 V, #3 (pages 113 – 115)

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

Professional Team Comments:

Verified that all visualizations to be presented to the Commission have the required characteristics. Reviewed numerous color-coded maps.

5.2 Meteorological Standards – *Peter Ray, 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:

Verified in materials presented throughout the review.

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 (page 101)

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

Professional Team Comments:

Verified output from the RMS wind model is in mph gust. Reviewed details on the gust factor expression and discussed the scientific literature used as the basis.

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 2000 hurricane season and/or the HURDAT (HURricane DATa) data set, is found in the *Report of Activities as of November 1, 2001* under Section VII, Compliance With Standards and Related Information, #4. 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, B.7-8 (page 68)
Reference: Module 3, Section I (pages 91 – 100)

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

Professional Team Comments:

Verified that RMS storm set matches that provided by the Commission.

5.2.4 Hurricane Characteristics

Methods for depicting all modeled hurricane characteristics (e.g., wind speed, 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.1-8 (pages 67 – 68)
Reference: Module 3, Section I (pages 91 – 100)
Reference: Standard 5.6.2 (page 34)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed details of the major components of the RMS hurricane model:

- Landfall/strike probabilities
- Storm track parameter probabilities
- Modeling of storm tracks using a random-walk technique
- Windfield model calculations
- Inland 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:
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, #1-3 (pages 91 – 92)
Reference: Module 3, Form B
Reference: Standards 5.6.2 and 5.6.3 (pages 34 – 35)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Verified there was no change in the RMS model. Saffir-Simpson intensity is not a parameter of the RMS hurricane model and is not used for calculation of wind speeds or associated loss costs.

5.2.6 Hurricane Probabilities

Modeled hurricane probabilities shall reasonably match the historical record through 2000 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 (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 (page 56)
Reference: Module 1,Section II, B.7 (page 68)
Reference: Module 3, Section I (pages 91 – 100)
Reference: Standards 5.6.2 and 5.6.3 (pages 34 – 35)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed graphical representations and statistical tests showing the modeled landfall probabilities are consistent with observed historical data.

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 II, B.1 (page 67)
Reference: Module 1, Section II, B.7-8 (page 68)
Reference: Module 3, Section 1, #2 (page 91)
Reference: Module 3, Section 1, #8 (page 94)
Reference: Standards 5.6.2 and 5.6.3 (pages 34 – 35)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed probability distributions for parameters and the details of the methodology used to smooth the historical data and derive the probability distributions. Discussed details of the sea-surface temperature based methodology used to develop the upper bound intensity of Florida hurricanes and the methodology used to develop extreme event probabilities.

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.4-5 (pages 67 – 68)
Reference: Module 3, Section I (pages 91 – 100)

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

Professional Team Comments:

Reviewed details of the methodology used in the RMS hurricane model on land friction effects.

5.2.9 Hurricane Overland Weakening Rate

The hurricane overland weakening rate used by the model shall be bounded by the observed extremes in historical records for Florida. The mean wind speed shall be within twenty percent (20%) of the Kaplan/DeMaria decay value or an alternative acceptable to the Commission.

Reference: Module 1, Section II, B.3 (page 67)
Reference: Module 3, Section I (pages 91 – 100)

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

Professional Team Comments:

Discussed the pressure filling methodology used in the RMS model and reviewed graphical plots verifying RMS' compliance within 20% of the Kaplan/DeMaria filling rate.

5.3 Vulnerability Standards – *John Pepper, Leader*

5.3.1 Derivation of 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.

Reference: Module 1, Section I, A.8 (page 54)

Reference: Module 3, Section III (pages 102 – 103)
Reference: Module 3, Section IV, #3-6 (pages 104 – 106)
Reference: Standard 5.6.2 (page 34)

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

Professional Team Comments:

The method of derivation of the twenty-six structural vulnerability functions was described and found to be theoretically sound.

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 3, Section III (pages 102 – 103)
Reference: Module 3, Section IV, #3 (page 104)

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

Professional Team Comments:

Separate vulnerability functions exist for building structures, mobile homes, appurtenant structures, contents and ALE.

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 3, Section III (pages 102 – 103)

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

Professional Team Comments:

The minimum wind speed that causes damage is 50 mph (peak gust).

5.3.4 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, Section I, A.7 (pages 53 – 54)
Reference: Module 3, Section III (pages 102 – 103)

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

Professional Team Comments:

Reviewed summaries showing exposure and loss data and how they are used in the development of RMS's vulnerability functions. Construction characteristics used in the derivation of the vulnerability functions were demonstrated to be reasonable and appropriate.

5.3.5 Modification Factors

Modification factors 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 3, Section III, #3 (page 102)
Reference: Module 3, Section III, #6 (page 103)

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

Professional Team Comments:

RMS gave a presentation on the development and use of secondary modification factors. Reviewed in detail the modeling of mitigation measures and modifications to the base vulnerability functions.

Modification factors and mitigation factors are secondary characteristics applied to the base vulnerability functions. They are handled in the same way, with modification factors causing both increases and decreases in the damage ratio to the base vulnerability functions and mitigation factors causing only decreases in the damage ratio. Assuming modifications are retrofitted, all cause decreases in loss cost. Unknown structure type is the base class in all cases.

Modification/mitigation factors reviewed were:

- Roof covering
- Roof sheathing strength
- Roof-to-wall anchor type
- Roof geometry
- Window shutter type
- Foundation system

The theoretical soundness and the effect of the modification/mitigation factors were demonstrated to be theoretically sound.

5.3.6 Additional Living Expenses

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

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

Reference: Module 3, Section IV, #5-6 (pages 105 – 106)

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

Professional Team Comments:

The ALE vulnerability functions are based on historical data and therefore implicitly include storm surge demand to the infrastructure and the time to reconstruct the home.

5.3.7 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.

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

Professional Team Comments:

See 5.3.5.

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 upon accepted actuarial, underwriting, and statistical procedures. The methods used shall be documented in writing.

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.

Reference: Module 1, Section I, B.4 (page 56)
Reference: Module 1, Section II, A.3-5 (pages 65 – 67)
Reference: Module 3, Section IV (pages 104 – 110)

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

Professional Team Comments:

Verified RMS uses actual insurance claims data and discussed the method for detecting and correcting any errors. Reviewed examples of claims 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 shall 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, Section I, A.6 (page 53)

Reference: Module 1, Section I, A.10 (page 55)
Reference: Module 1, Section I, C.1.c (page 57)
Reference: Module 3, Section III, #3 (page 102)

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

Professional Team Comments:

Verified that RMS has no modifications to the actuarial functions other than the secondary modifiers discussed in Standards 5.3.5 and 5.3.7. Viewed presentation of impacts of modifications in ranges consistent with requirements.

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 (page 56)
Reference: Module 1, Section I, C.1.a (page 57)
Reference: Module 3, Section III, #2 (page 102)
Reference: Module 3, Section V (pages 111 – 121)
Reference: Module 3, Section VII (pages 124 – 134)

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

Professional Team Comments:

Model uses insurance company claims data. Verified by Rick Anderson that RMS loss cost does not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margin.

5.4.4 Insurer Inputs

The modeler shall disclose any assumptions, fixed and 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 (page 55)
Reference: Module 1, Section I, B.4 (page 56)
Reference: Module 1, Section II, A.3-4 (pages 65 – 66)
Reference: Module 3, Section IV (pages 104 – 110)

Proprietary: No
Verified: Yes

Professional Team Comments:

Verified no change to the model from last year. RMS submitted their input form in the submission.

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 shall be demonstrated to be reasonable.

Reference: Module 1, Section I, C.1.a (page 57)
Reference: Module 3, Section III, #2 (page 102)
Reference: Module 3, Section VII (pages 124 – 134)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed details on the methodology used in handling demand surge when it is detected. Verified that demand surge was not used in preparation of loss cost projections.

5.4.6 Loss Costs - Meaning of "Damage"

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

Reference: Module 1,Section II, A.5 (pages 66 – 67)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Loss costs are expressed as insurable losses and are based on insurance company claims data.

5.4.7 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.

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 I, C.1.b (page 57)
Reference: Module 3, Section V, #2 (pages 111 – 113)
Reference: Module 3, Section V, #5 (page 116)
Reference: Module 3, Section VII (pages 124 – 134)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed color-coded maps in discussing the roughness and deductible impact on loss costs. Reviewed mitigation factors.

5.4.8 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.

Reference: Module 1, Section I, B.3 (pages 56)
Reference: Module 3, Section IV, #1-2 (page 104)
Reference: Standard 5.6.2 (page 34)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Discussed in detail the mathematical equations used to handle deductibles and policy limits and reviewed graphical representations of the distributions.

5.4.9 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 (page 105)
Reference: Module 3, Section IV, #7 (page 106)
Reference: Standard 5.6.2 (page 34)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Verified RMS uses actual loss data to calibrate the contents vulnerability function. Reviewed methods used in the development of contents loss costs.

5.4.10 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 (page 106)
Reference: Standard 5.6.2 (page 34)

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

Professional Team Comments:

Reviewed details on the development of ALE damage functions from actual coverage specific claims data. Reviewed methods used in the development of ALE loss costs.

5.4.11 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, Section 1, C.1.b (page 57)
Reference: Module 3, Section III, #3 (page 102)
Reference: Standard 5.6.2 (page 34)

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

Professional Team Comments:

Verified that the model does not include adjustments for building code enforcement.

5.4.12 Hazard Mitigation

Data or information upon which differences in loss costs due to fixtures, design features, or construction techniques designed for hazard mitigation are derived, if incorporated in the model, shall be objective and actuarially reasonable.

Reference: Module 1, Section I, A.6 (page 53)

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

Professional Team Comments:

Reviewed in detail how the secondary modifiers to the base vulnerability functions are incorporated in the model.

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 by county or an appropriate level of geographic detail.

Reference: Module 3, Section IV, #9 (pages 107 – 109)
Reference: Module 3, Section V, #2 (pages 111 – 113)
Reference: Standard 5.6.3 (page 35)

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

Professional Team Comments:

No new insurance company data has been added to the model therefore no change from previous submission. Reviewed insurance company data comparisons with model outputs.

5.4.14 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 standard 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 3, Section I, #7 (pages 93 – 94)
Reference: Module 3, Section I, #10 (page 95)
Reference: Module 3, Section V, #2 (pages 111 – 113)
Reference: Module 3, Section V, #4 (Output Ranges pages 137 – 178)
Reference: Standard 5.6.3 (page 35)

Proprietary: No
Verified: Yes

Professional Team Comments:

Reviewed details in the changes to the loss cost. Annual average loss cost different this year due to being net of deductible last year and the inclusion of additional year in the storm set this year.

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. Differences between the prior year submission and the current submission shall be explained in the submission including, but not limited to:

1. Differences from prior submission of greater than ten percent in maximum or minimum loss costs for any county shall be specifically listed and explained.
2. Differences from prior submission in the relativities between loss costs for building and the corresponding loss costs for contents shall be explained.
3. Differences from prior submission in the relativities among corresponding deductibles shall be explained.

Reference: Module 3, Section V, #4-5 (page 116, Output Ranges pages 137 – 178)

Proprietary: No
Verified: Yes

Professional Team Comments:

Reviewed changes from previous year and verified they were only attributable to the revised storm set.

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,Section II, C.2 (page 71)
Reference: Standard 5.6.3 (page 35)

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

Professional Team Comments:

Verified there were no changes from the previous submission.

5.4.17 Total Estimated Losses

The modeler shall demonstrate through the information submitted in Form B and Form D (Module 3, Section VII) that the model produces reasonable relationships among the total estimated losses produced by the model for building, appurtenant structures, contents, and additional living expense.

Reference: Module 3, Section VII Form B & Form D

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

Professional Team Comments:

Discussed in detail Form B and Form D and the relationships between building construction, appurtenant structures, contents, and ALE.

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 (pages 38 – 61)
Reference: Module 1, Section II (pages 62 – 73)

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

Professional Team Comments:

Reviewed the primary document binder which contained flowcharts of the overall hurricane model, data flow diagrams of the model components, diagrams of class inheritance, other class properties, and engineering specifications.

Changes from previous year included two code performance enhancements (distance to coast (DTC) calculation and import mechanism for MS Access to permit larger database files), and one change in data to account for the extra year without storms.

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 (pages 38 – 61)
Reference: Module 1, Section II (pages 62 – 73)
Reference: Module 3, Section VI, #2 (pages 122 – 123)

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

Professional Team Comments:

Reviewed the following documentation:

- RiskLink v4.2 Product Definition
- RiskLink Functional Specification
- RiskLink Technical Specification

5.5.3 Software 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* (that individual who can explain the functional behavior of the component and respond to questions concerning changes in code, documentation, or data for that component) shall be identified and documented. 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).

Reference: Module 1, Section I (pages 38 – 61)
Reference: Module 1, Section II (pages 62 – 73)

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

Professional Team Comments:

Component Custodian documentation included both primary and backup (secondary) custodians. Discussed in detail the methodology for changes made to the source code and the security system in place. Reviewed the following documentation:

- HU Class Diagrams
- General Class Diagrams
- Component Diagrams
- HU DLM Flow Charts
- Data Flow Diagrams and Data Dictionary
- Component Custodian
- Most Recent Change by Component
- MR Import Design for large data sets

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 (pages 38 – 61)
Reference: Module 1, Section II (pages 62 – 73)

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

Professional Team Comments:

Reviewed the following documentation:

- Component Diagrams
- Data Flow Diagrams and Data Dictionary
- StormIND.US file containing storm rates for Florida

5.5.5 Software Verification

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.

Reference: Module 1, Section I (pages 38 – 61)
Reference: Module 1, Section II (pages 62 – 73)

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

Professional Team Comments:

Reviewed the following documentation:

- Sample C++ Source Files

5.5.6 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. All components when interfaced shall function correctly.

Reference: Module 1, Section I (pages 38 – 61)
Reference: Module 1, Section II (pages 62 – 73)
Reference: Standards 5.6.4 and 5.6.5 (pages 35 – 36)

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

Professional Team Comments:

Reviewed the following documentation:
- RiskLink 4.2 Test Procedures – MR Input Test Suite

5.5.7 Software Maintenance and Revision

The modeler shall specify all policies and procedures used to maintain code, data, and documentation. The modeler shall use tracking software to track all errors, as well as modifications to code, data, and documentation.

Reference: Module 1, Section I (pages 38 – 61)
Reference: Module 1, Section II (pages 62 – 73)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed the following documentation:
- Product Delivery Overview
- Sample Incident Report from RiskLink Visual Intercept Database
- Visual Intercept Quick Reference Guide
- File Versioning

5.5.8 User Documentation

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

Reference: Module 1, Section I (pages 38 – 61)
Reference: Module I, Section II (pages 62 – 73)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed the following documentation:
- RiskLink DLM User Guide
- RiskLink DLM Reference
- RiskLink DLM System Administration
- RiskLink Version 4.2 Release Notes

- RiskLink Version 4.2SPI Release Notes

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 (pages 69 – 70)
Reference: Module 3, Section I, #7 (page 94)

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

Professional Team Comments:

Reviewed several Kolmogorov-Smirnov tests showing the fit between historical data and modeled data. Reviewed contingency table analysis of storm track crossings on historical versus modeled frequencies.

5.6.2 Comparison of Historical and Modeled Results

The modeler shall demonstrate the agreement between historical and modeled results for hurricane frequencies, tracks, intensities, and physical damage using accepted scientific and statistical methods.

Reference: Module 1, Section II, A.1 (pages 62 – 64)
Reference: Module I, Section II, B.7 (page 68)
Reference: Module 1, Section II, C.1 (page 71)
Reference: Module 1, Section II, C.3 (page 72)
Reference: Module 1, Section II C.5-6 (page 73)
Reference: Module 3, Section III, #4-5 (pages 102 – 103)
Reference: Module 3, Section IV, #3-6 (pages 104 – 106)

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

Professional Team Comments:

Reviewed several K-S tests provided on comparisons of historical versus modeled results on central pressure, forward velocity, and Rmax using Florida official historical storms and RMS' expanded historical storms.
Reviewed vulnerability tests using insurance claims data comparing modeled versus observed structural loss and graphical representations of same.

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 (pages 68 – 69)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed graphical representations of stochastic variation of Rmax with CP and correlations between CP and Rmax by storm intensity. Reviewed confidence interval calculations where given.

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 parameters 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 (pages 51 – 53)
Reference: Module 1, Section II, B.13-15 (pages 70 – 71)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed sensitivity tests using various scenarios of central pressure, forward speed, Rmax, filling rates based on Kaplan-DeMaria, and vulnerability. Losses were based on the FHCF exposure data.

Reviewed other sensitivity tests comparing vulnerability to Rmax with central pressure.

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 (pages 51 – 53)
Reference: Module 1, Section II, B.9 (pages 68 – 69)
Reference: Module 1, Section II, B.13-15 (pages 70 – 71)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed uncertainty analysis on historical average annual loss versus modeled AAL.

RMS presented their analysis on Form F which paralleled the Professional Team demonstration analysis. Verified RMS analysis agreed with the results prepared by the Professional Team and were consistent with engineering judgment. RMS further expanded on the demonstration analysis by plotting the actual variances and utilizing the mean damage ratio based on the maximum wind speeds generated from Form F.