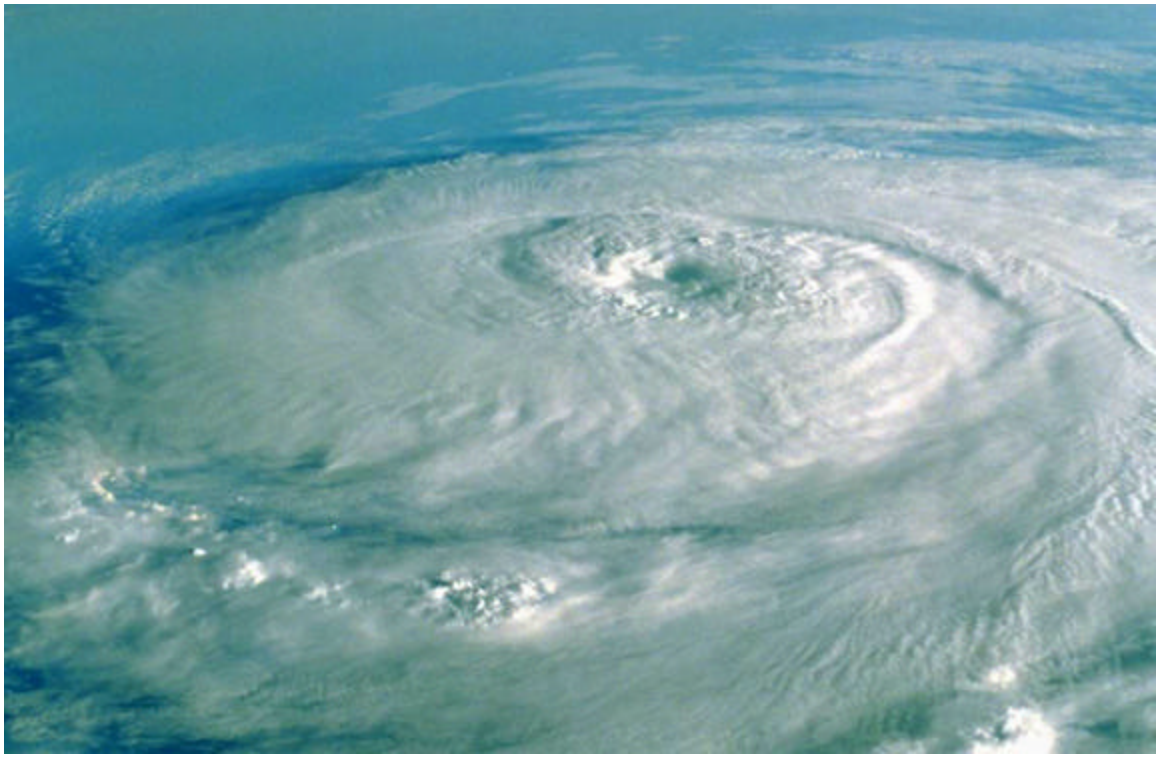
Florida Commission on Hurricane Loss Projection Methodology



Professional Team Audit Report
2001 Standards

Applied Research Associates

On-Site Review
May 9 & 10, 2002

On May 9 & 10, 2002, the Professional Team visited on-site at Applied Research Associates, IntraRisk Division (ARA) in Raleigh, North Carolina. The following people participated in the review.

ARA

Steve Brooks, Staff Scientist
Douglas J. Collins, FCAS, MAAA, Principal, Tillinghast-Towers Perrin (via phone)
Kevin Z. Huang, Ph.D., Senior Engineer II
Srinivas R. Kadasani (Reddy), M.S., Staff Scientist
Francis M. Lavelle, Ph.D., P.E., Principal Engineer
Jason J-X. Lin, Ph.D., Senior Scientist
Rick Pearson, Staff Scientist
Peter F. Skerlj, M.E.Sc., B.E.Sc., Staff Scientist
Lawrence A. Twisdale, Ph.D., P.E., Principal
Peter Vickery, Ph.D., Principal Scientist
Michael A. Young, M.E.Sc., Staff Scientist

Professional Team

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

The review began with introductions and an overview of the audit process. ARA gave a presentation outlining the model changes since the February 2001 submission and the effect of those changes on loss costs:

- Physical Damage Model – probabilistic opening protection resistance model used instead of a deterministic model – resulted in a very minor change to loss cost.
- Building Stock Distribution – updates based on surveys of 5000+ homes in Florida – resulted in an increase in loss cost.
- Updated storm data to include year 2000 storms
- Updated terrain validation for storms in North Carolina and South Carolina had some effect on modeled losses for those states
- Building Valuation
- Updated Zip Codes to 2001 database
- Moved to population weighted centroids from geographic – resulted in a small increase in loss cost.

ARA 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.

Discussed ARA's list of clients and their level of involvement including FEMA, State of Florida and State of Hawaii.

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 51 – 57)
Reference: Module 2, Section I, #5 (pages 57 – 58)

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

Professional Team Comments:

Reviewed resumes of new ARA personnel:

- Richard W. Pearson, B.S., Computer Science, North Carolina State University
- Steve Brooks, B.S., Physics, Appalachian State University

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 28)
Reference: Module 1, Section I, A.9 (page 35)

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

Professional Team Comments:

Reviewed ARA Hurloss Model Study Disclosure Summary.

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 42)
Reference: Module I, Section II, B.13-15 (pages 42 – 43)
Reference: Standard 5.5.3 (page 23)

Proprietary: **Some Proprietary**
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 88)
Reference: Module 3, Form A (page 91)

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

Professional Team Comments:

Verified ARA changed from geographic to population weighted Zip Code centroids. Discussed the methodology used in developing and verifying the population weighted zip code centroids. Reviewed maps showing the Zip Code boundaries and reviewed scatter plots showing the effects of changing from geographic to population centroids on loss cost.

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 37)

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 78 – 80)

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

Professional Team Comments:

Verified that all visualizations to be presented to the Commission had the required characteristics. Reviewed several color-coded maps, charts, and graphs.

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:

Verified in the 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 69)

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

Professional Team Comments:

Verified no change from previous year.

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 41)
Reference: Module 3, Section I (pages 59 – 68)

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

Professional Team Comments:

Examined storm origination point input file used in stochastic storm set generation. Confirmed that ARA 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 39 – 41)
Reference: Module 3, Section I (pages 59 – 68)
Reference: Standard 5.6.2 (page 25)

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

Professional Team Comments:

Verified no change from previous year. Extensive discussion of the wind field model. Reviewed distribution of Holland B parameter. Examined wind fields generated on-site.

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 (page 59)
Reference: Module 3, Form B
Reference: Standards 5.6.2 and 5.6.3 (pages 25 – 27)

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

Professional Team Comments:

Verified no change from previous year.

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 35)
Reference: Module 1,Section II, B.7 (page 41)
Reference: Module 3, Section I (pages 59 – 68)
Reference: Standards 5.6.2 and 5.6.3 (pages 25 – 27)

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

Professional Team Comments:

Examined K-S tests for modeled versus historical storm for Florida coastlines.

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 39)

Reference: Module 1, Section II, B.7-8 (page 41)
Reference: Module 3, Section 1, #2 (page 59)
Reference: Module 3, Section 1, #8 (page 62)
Reference: Standards 5.6.2 and 5.6.3 (pages 25 – 27)

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

Professional Team Comments:

Verified no change from previous submission. Reviewed distribution of wind speeds from stochastic storm set.

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 39 – 40)
Reference: Module 3, Section I (pages 59 – 68)

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

Professional Team Comments:

Reviewed land friction maps.

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 39)
Reference: Module 3, Section I (pages 59 – 68)

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

Professional Team Comments:

Examined decay rates for several storms. Verified ARA's compliance.

5.3 Vulnerability Standards – *Fred Stolaski, Leader*

Reviewed Year Built Tax Record Data provided by the Florida Department of Revenue.

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 34)
Reference: Module 3, Section III (pages 70 – 71)
Reference: Module 3, Section IV, #3-6 (pages 72 – 73)
Reference: Standard 5.6.2 (page 25)

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

Professional Team Comments:

Verified no change in the derivation of vulnerability functions from last year's submission. Found the method of derivation 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 70 – 71)
Reference: Module 3, Section IV, #3 (pages 72 - 73)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Verified no change in the model with regards to separate vulnerability functions.

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 70 – 71)

Proprietary: No
Verified: Yes

Professional Team Comments:

Verified no change in the model from last year; use 50 mph peak gust for minimum wind speed that generates damage.

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 (page 34)
Reference: Module 3, Section III (pages 70 – 71)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed computer files showing the numbers and values of building stock. Discussed worksheets with construction characteristics listed and compared with

values from previous year. Looked through inspection forms and checklists used to gather field data for building stock. Reviewed reports and actual inspection forms for original inspections and also follow-up QA re-inspection forms and reports.

Discussed the effects of the new Florida building code to loss costs. Reviewed ARA's documentation on Florida Building Construction Characteristics.

References: Completed "Mitigation Survey Check List"
Construction Characteristics Worksheets (wood frame and masonry)

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 70)
Reference: Module 3, Section III, #6 (page 71)

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

Professional Team Comments:

Verified ARA does not use modification factors in their vulnerability functions.

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 (page 73)

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

Professional Team Comments:

Discussed the modification of the ALE module to account for situations when ALE losses can exist even though there are no building or content losses. This resulted in the development of Version 1.3 ALE Module that considers this ALE based on insurance loss data.

References: "Additional Living Expenses (ALE) Caused by Infrastructure Degradation"
"Flowchart of ALE add-on model to version 1.0 Hurricane Loss Model"

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:

Discussed change of using probabilistic opening protection resistance instead of deterministic and the effects of this change on loss cost. Reviewed detailed structure of mitigation factors. Reviewed effects on loss costs.

Reference: "Development of Loss Relativities for Wind Resistive Features of Residential Structures"

5.4 Actuarial Standards – *Marty Simons, Leader*

Examined the peer review, "Actuarial Review of ARA Hurricane Model" completed by Douglas J. Collins, FCAS, MAAA, Consulting Actuary from Tillinghast-Towers Perrin.

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 36)
Reference: Module 1, Section II, A.3-5 (pages 38 – 39)
Reference: Module 3, Section IV (pages 72 – 77)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed comparisons of new model outputs with insurance data. Verified no new insurance data were incorporated in the model revisions and there was no change from the submission last year.

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 34)
Reference: Module 1, Section I, A.10 (page 35)
Reference: Module 1, Section I, C.1.c (page 36)
Reference: Module 3, Section III, #3 (page 70)

Proprietary: No
Verified: Yes

Professional Team Comments:

Verified ARA does not use modification factors to their actuarial functions. Reviewed detailed structure of mitigation factors that would allow for categorization of credits.

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 36)
Reference: Module 1, Section I, C.1.a	(page 36)
Reference: Module 3, Section III, #2	(page 70)
Reference: Module 3, Section V	(pages 78 – 87)
Reference: Module 3, Section VII	(pages 89 – 99)

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

Professional Team Comments:

Teleconference with Doug Collins, Consulting Actuary who attested there were no changes from the previous year.

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 35)
Reference: Module 1, Section I, B.4	(page 36)
Reference: Module 1, Section II, A.3-4	(pages 38 – 39)
Reference: Module 3, Section IV	(pages 72 – 77)

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

Professional Team Comments:

Verified no change to the model from last year. A sample copy of ARA's input form is included in their 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 36)
Reference: Module 3, Section III, #2 (page 70)
Reference: Module 3, Section VII (pages 89 – 99)

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

Professional Team Comments:

Verified that demand surge was not used in preparation of loss cost projections and the approach used for handling demand surge in Hurricane Andrew loss data.

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 (page 39)

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

Professional Team Comments:

Verified vulnerability functions calculate loss costs expressed as insurable losses. Discussed the use of insurance and engineering data to relate to the contents loss costs.

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 36)
Reference: Module 3, Section V, #2 (page 78)
Reference: Module 3, Section V, #5 (page 81)
Reference: Module 3, Section VII (pages 89 – 99)

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

Professional Team Comments:

Reviewed color-coded maps and plots showing the relationship between modeled and actual losses for building loss, contents loss, Coverage D loss, and ALE loss with all other factors being held constant.

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 (page 35)
Reference: Module 3, Section IV, #1-2 (page 72)
Reference: Standard 5.6.2 (page 25)

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

Professional Team Comments:

Reviewed details on the methodology used for handling deductibles and policy limits.

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 73)
Reference: Module 3, Section IV, #7 (page 74)
Reference: Standard 5.6.2 (page 25)

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

Professional Team Comments:

Verified no change in the submission from last year for calculating damage to contents. Discussed changes due to building failure modes as influenced by the change in building stock.

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 73)
Reference: Standard 5.6.2 (page 25)

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

Professional Team Comments:

Reviewed methods used in the development of ALE loss costs and verified no change from last year's submission.

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 36)
Reference: Module 3, Section III, #3 (page 70)
Reference: Standard 5.6.2 (page 25)

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

Professional Team Comments:

Discussed the changes in building stock. Reviewed state of Florida map showing region breakouts and data charts showing the effects of changes to masonry and wood frame building stocks.

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 34)

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

Professional Team Comments:

Verified ARA has the ability to run the model with mitigation credits. Reviewed detailed structure of mitigation factors that would allow for categorization of credits.

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 74 – 75)
Reference: Module 3, Section V, #2 (page 78)
Reference: Standard 5.6.3 (page 27)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed plots comparing actual to modeled losses and plots showing the terrain effect.

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 (page 61)
Reference: Module 3, Section I, #10 (pages 63 – 64)
Reference: Module 3, Section V, #2 (page 78)

Reference: Module 3, Section V, #4 (Output Ranges page 102)
Reference: Standard 5.6.3 (page 27)

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

Professional Team Comments:

Reviewed K-S tests on comparison of historical versus stochastic losses. Discussed t-tests results showing the difference between historical and modeled loss to be statistically insignificant.

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 81, Output Ranges start page 102)

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

Professional Team Comments:

Verified that the changes from previous year submission were attributable to the revised storm set, updated Zip Code database, change from geographic to population weighted Zip code centroids, and changes to building stock.

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 (pages 43 – 46)
Reference: Standard 5.6.3 (page 27)

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

Professional Team Comments:

Discussed Form B and Form D and the relationships between building construction, appurtenant structures, contents, and ALE. Discussed difference among relationships caused by model revisions.

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 28 – 37)
Reference: Module 1, Section II (pages 37 – 48)

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

Professional Team Comments:

Reviewed the primary document binder which references and organizes the following document binders:

HURLOSS RISK ANALYSIS SUITE documentation

Volume	Binder Section	Title
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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 28 – 37)
Reference: Module 1, Section II (pages 37 – 48)
Reference: Module 3, Section VI, #2 (page 88)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Refer to 5.5.1.

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 28 – 37)
Reference: Module 1, Section II (pages 37 – 48)

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed the Model Custodian Primary and Secondary Reviewer chart.

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 28 – 37)
Reference: Module 1, Section II (pages 37 – 48)

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

Professional Team Comments:

Refer to 5.5.1.

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 28 – 37)
Reference: Module 1, Section II (pages 37 – 48)

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

Professional Team Comments:

Spot checked examples of error checking in Fortran and exception handling in C++ source.

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 28 – 37)
Reference: Module 1, Section II (pages 37 – 48)
Reference: Standards 5.6.4 and 5.6.5 (page 27)

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

Professional Team Comments:

Reviewed augmented testing and regression procedures.

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 28 – 37)
Reference: Module 1, Section II (pages 37 – 48)

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

Professional Team Comments:

Reviewed ARA's Version Control and Source Code Control Procedures in the primary document binder.

5.5.8 User Documentation

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

Reference: Module 1, Section I (pages 28 – 37)
Reference: Module I, Section II (pages 37 – 48)

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

Professional Team Comments:

Refer to 5.5.1.

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 (page 42)
Reference: Module 3, Section I, #7 (page 61)

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

Professional Team Comments:

Reviewed results of statistical tests on various distribution fits and ARA publications.

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 37 – 38)
Reference: Module I, Section II, B.7 (page 41)
Reference: Module 1, Section II, C.1 (page 43)
Reference: Module 1, Section II, C.3 (page 46)
Reference: Module 1, Section II C.5-6 (page 48)
Reference: Module 3, Section III, #4-5 (pages 70 – 71)
Reference: Module 3, Section IV, #3-6 (pages 72 – 73)

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

Professional Team Comments:

Reviewed several Kolmogorov-Smirnov tests showing the fit between historical data and modeled data. Examined binders containing supporting material.

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 (page 41)

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

Professional Team Comments:

Reviewed probability distributions on the fits to historical data and the standard errors computed for parameter estimates. Discussed confidence interval calculations. Reviewed relevant ARA publications.

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 (page 33)
Reference: Module 1, Section II, B.13-15 (page 43)

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

Professional Team Comments:

Reviewed numerous sensitivity tests based on central pressure, forward speed, Rmax, Kaplan/DeMaria filling rates, etc. Reviewed building stock sensitivity analysis study.

References: Individual Risk Sensitivity Study (Primary), Volume II-G1, 2002

Individual Risk Sensitivity Study (Secondary), Volume II-G2, 2002
Analysis of Florida Building Stock, Hurloss 3.0, Volume III-A3, 2002

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 (page 33)
Reference: Module 1, Section II, B.9 (page 41)
Reference: Module 1, Section II, B.13-15 (page 43)

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

Professional Team Comments:

Reviewed numerous graphical representations on the coefficient of variation which show that small perturbations in wind speeds result in large adjustments to loss costs.