Florida Commission on Hurricane Loss Projection Methodology

Professional Team Audit Report

Applied Research Associates, Inc. (ARA)

On-Site Review
April 11, 2000

Additional On-Site Review
June 12, 2000

On April 11, 2000, the Professional Team visited on site at Applied Research Associates, Inc. (ARA) in Raleigh, North Carolina. The following people participated in the review:

ARA

Lawrence A. Twisdale, Ph.D., P.E., Principal
Peter J. Vickery, Ph.D., Senior Scientist
Reddy Kadasani, M.S., Staff Scientist II
Kevin Z. Huang, Ph.D., Senior Engineer II
Peter F. Skerlj, M.E.Sc., B.E. Sc., Scientist
Michael A. Young, M.E. Sc., Scientist
Jason J-X. Lin, Ph.D., Senior Scientist
Peter R. Montpellier, M.E. Sc., Scientist
Marshall B. Hardy, B.S., M.S., Staff Scientist
Douglas Collins, FCAS, MAAA, Principal, Tillinghast-Towers Perrin

Professional Team

Mark Johnson, Statistician, Team Leader
Fred Stolaski, Engineer
Peter Ray, Meteorologist
Marty Simons, Actuary
Paul Fishwick, Computer Scientist
Ron Iman, Statistician*
Richard Nance, Computer Scientist*
Mark Brannon, Actuary*

*Back-up members-
participated as observers

The review began with introductions and an overview of the audit process. ARA provided a presentation describing their company and the background for the development of their model. The Professional Team reviewed insurance data used in the model and discussed the stochastic storm set and the vulnerability functions. ARA provided an overview of the computer codes used.

The Professional Team reviewed Modules 1-3, with ARA providing explanations and additional information when requested.

The second day began with a review of the Standards, Section 1. Paul Fishwick then met separately with Peter Skerlj, Michael Young, Peter Montpellier, Reddy Kadasani, Marshall Hardy, and Kevin Huang to discuss computer system design issues. During this time the remainder of the Professional Team reviewed Sections 2 and 4. The entire Professional Team then reconvened and reviewed Sections 3 and 5. The Professional Team provided ARA a preliminary assessment following each Section of the Standards.

On the second day of auditing against the Commission Standards, ARA produced materials that enabled the Professional Team to verify additional Standards**. There were four (4) Standards that could not be verified by the Professional Team: 5.1.1, 5.3.4, 5.4.11, and 5.4.14**. The Professional Team concluded the review with an exit interview. The Professional Team provided a preliminary draft of the report that will be provided to the Commission in May. ARA was given the opportunity to check for any factual errors and to remove any confidential or proprietary information. The Professional Team acknowledged ARA for their cooperation in the review of the Standards.

ADDITIONAL VERIFICATION REVIEW

Applied Research Associates submitted a letter dated May 15, 2000 stating that they "had revised their model to meet the standards that were not verified by the Professional Team" and "are now ready for a verification review by the Professional Team". The Chair assembled a subset of the Professional Team for one additional verification review. The Professional Team conducted this review in Raleigh, NC on June 12, 2000. ARA summarized the changes in the model as a result of the revision of their model. The new model version is HURLOSS 1.3. The Professional Team reviewed the standards that were not verified during the initial visit (5.1.1, 5.3.4, 5.4.11 and 5.4.14) as well as standards that were changed as a result of the revision. They continued by reviewing the portions of Module 1 and Module 3 that were impacted by the revision. **All standards were verified.** The following people participated in the review:

Applied Research Associates

Lawrence A. Twisdale, Ph.D., P.E., Principal
Peter J. Vickery, Ph.D., Senior Scientist
Kevin Huang, Ph.D., Senior Scientist II
Jason Lin, Ph.D., Senior Scientist
Srinivas (Reddy) Kadasani, M.S. Staff Scientist II

Professional Team

Mark Johnson, Team Leader, Statistician
Marty Simons, Actuary
Peter Ray, Meteorologist
Anne Bert, Staff

Florida Commission on Hurricane Loss Projection Methodology

1999 Standards

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 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: **Lawrence A. Twisdale** **Peter J. Vickery** **Jason X. Lin** **Kevin Z. Huang** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

ALE in version 1.3 makes use of actual insurance data and hence, infrastructure issues are resolved

PROPRIETARY DOCUMENTATION REVIEWED:

Graph: Comparison of Actual and Modeled ALE Losses (version 1.0)
Comparison of Actual and Modeled ALE Losses (version 1.3)
Real Storm Comparison (Andrew, Version 1.3 Model)

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
No	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

Reviewed resumes of modeler personnel.

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
Yes	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

Proprietary Documentation Reviewed:

Source Code Control Procedures
Notebook – Census Tracts, Zip Code, and County Data

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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 (Y or N)	Verified	Cannot Verify
No	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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
Yes	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**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
Yes	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**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	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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
Yes	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

5.3 Vulnerability Standards – <u>Fred Stolaski – Leader</u>

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**		

Pro Team Comments:

Proprietary Documentation Reviewed:

"Analysis of Hurricane Windborne Debris Impact Risk for Residential Structures", prepared by L. Twisdale, Peter Vickery and A.C. Steckley

"Analysis of Hurricane Windborne Debris Impact Risk for Residential Structures: Part II", prepared by P.J. Vickery, J.X. Lin, and L.A. Twisdale

Presentation – HURDAM – Hurricane Damage Simulation Program

Report – "Sensitivity Analysis of Single Family Residential Construction Parameters for Hurricane Damage and Loss"

Publication-RSMeans, Repair and Remodeling Cost Data, 20th Annual Edition, Commercial/Residential, 1999

Publication-RSMeans, Residential Cost Data, 18th Annual Edition, 1999

ARA Notebook – Residential Loss Model Documentation RESCOMLOSS V5

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
Yes	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Jason X. Lin** **Kevin Z. Huang** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

ALE in version 1.3 makes use of actual insurance data and hence, infrastructure issues are resolved.

5.4 Actuarial Standards - Marty Simons - Leader

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	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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
Yes	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani** **Douglas Collins**	**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
Yes	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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
Yes	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

Proprietary Documentation Reviewed:

Presentation - Derivation of Insurance Functions ---Company Loss Estimates

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

Proprietary Documentation Reviewed:

Derivation of Insurance Functions—Company Loss Estimates (charts and graphs)

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	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Jason X. Lin** **Kevin Z. Huang** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

ALE in version 1.3 makes use of actual insurance data and hence, infrastructure issues are resolved.

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
Yes	**Yes**	
Staff: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

Proprietary Documentation Reviewed:

Notebook - Florida Building Construction Characteristics

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**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: **Lawrence A. Twisdale** **Peter J. Vickery** **Jason X. Lin** **Kevin Z. Huang** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

Handling of the Holland B coefficient in the historical storm set has been adjusted to match wind speeds.

Proprietary Documentation Reviewed:

"Comparison of Estimated Hurricane Loss Costs: Analysis of Loss Distribution, Sensitivity Analysis and Demonstration of Statistical Reasonableness"

"Statistical Analysis of Statewide Losses Using Historical 98 Year Distribution", prepared by M.B. Hardy

Chart/graph – Time Series of Stochastic Storm Simulation (100,000 Years)

Graph – CDF of Mean Annual Loss – Approach 1 (Unmatched Wind Speeds)
CDF of Mean Annual Loss – Approach 2 (Matched Wind Speeds)

Table – Historical Storm Set Calculations

Documentation Reviewed:

White papers – "A Hurricane Wind Field Model For Use In Hurricane Simulations" by P.J. Vickery, P.F. Skerlj, A.C. Steckley and L.A. Twisdale
"Simulation of Hurricane Risk in the US Using an Empirical Track Model" by P.J. Vickery, P.E. Skerlj and L.A. Twisdale

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: Lawrence A. Twisdale Peter J. Vickery Peter R. Montpellier Michael A. Young Jason X. Lin Kevin Z. Huang Peter F. Skerlj Marshall B. Hardy Srinivas (Reddy) Kadasani	**Notes:**	**Notes:**

Pro Team Comments:

5.5 Computer Standards - Paul Fishwick - Leader

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

Proprietary Documentation Reviewed:

Reviewed Model-to-Code translation procedure

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

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: **Lawrence A. Twisdale** **Peter J. Vickery** **Peter R. Montpellier** **Michael A. Young** **Jason X. Lin** **Kevin Z. Huang** **Peter F. Skerlj** **Marshall B. Hardy** **Srinivas (Reddy) Kadasani**	**Notes:**	**Notes:**

Pro Team Comments:

Proprietary Documentation Reviewed relating to 5.5.1 – 5.5.3:

1. HURLOSS Architecture and Design Document
2. HURRISK: ARA's Insurance Portfolio Hurricane Risk Analysis Software System
3. HURDAM Reference
4. ARA Residential Loss Model Documentation, RESCOMLOSS V5
5. FWMD Land-Use Database
6. ARA Terrain Database for Florida
7. User, Security and Source Control Documentation
8. On-Site Test of Current Model
9. Hurricane-Induced Building Damage Model Validation
10. Hurricane Wind Field Validation

Documentation Reviewed:

The attached list of Proprietary and Non-Proprietary Materials was made available and was reviewed by the Professional Team members according to its relevance to the Commission Standards.

Additional Non-Proprietary Documentation Reviewed:

"Elimination of Exposure D along Hurricane Coastline in ASCE 7", prepared by Peter J. Vickery and Lawrence A. Twisdale

"The Size Distribution of Raindrops" by A.C. Best

Letter dated April 10, 2000, prepared by Douglas Collins, Consulting Actuary, "Actuarial Review of the ARA Hurricane Model".

Additional Proprietary Documentation Reviewed:

De Maria/Kaplan Comparisons -Wind Speed reduction with Time – Graphs for Hurricanes Erin, Fran, Hugo, Alicia, Andrew, Opal and Elena

Color coded map and associated graphs - Terrain Roughness Coefficient

Color coded map showing upper bound of Hurricane Damage

E-mail from Journals indicating acceptance of papers.

Graph - Hurricane Andrew Track Simulations

Chart – Module 3, Section 9 – Table presented using Windspeed Catagorized Storms