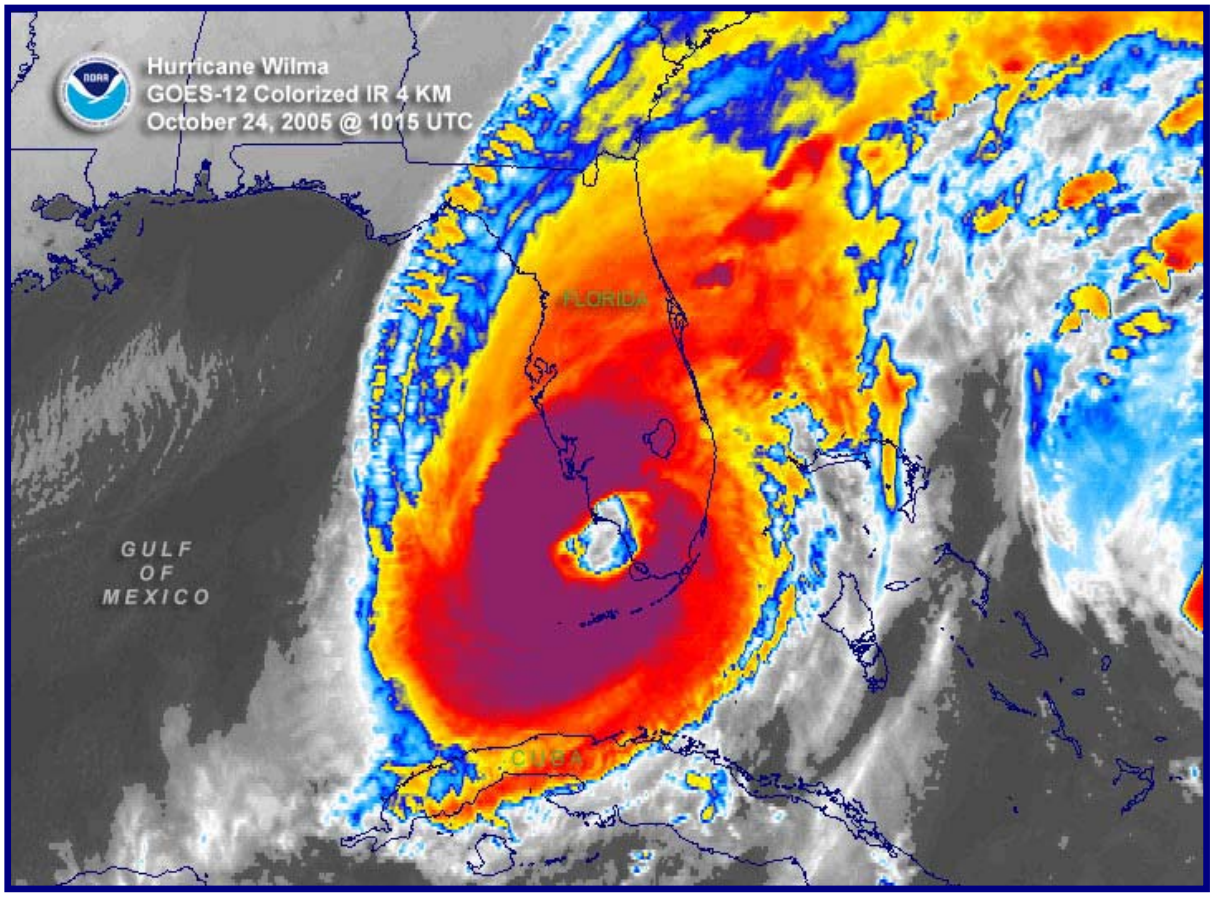
Florida Commission on Hurricane Loss Projection Methodology



Professional Team Report
2006 Standards

Applied Research Associates, Inc.

On-Site Review
April 5 – 7, 2007

Additional Verification Review
May 7, 2007

On April 5-7, 2007 the Professional Team visited on-site at Applied Research Associates, Inc. (ARA) in Raleigh, North Carolina. The following individuals participated in the review.

ARA

Douglas Collins, Actuarial Consultant (via phone)
Chris Driscoll, Staff Scientist
Brian Grant, Computer Scientist (via phone)
Francis M. Lavelle, Ph.D., P.E., Principal Engineer
Larry Twisdale, Ph.D., P.E., Chief Technical Officer
Peter J. Vickery, Ph.D., P.E., Principal Engineer
Dhiraj Wadhera, Staff Scientist

Professional Team

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

The review began with introductions and an overview of the audit process. ARA discussed the error found in the generation of the stochastic storm set that necessitated a re-run of the model to produce corrected Forms as required by the Commission. ARA had previously informed the Professional Team of this error during the pre-visit conference call on March 21, 2007, and provided to the Commission corrected Forms and revisions to the Meteorological, Actuarial, and Statistical Standards sections of the February 28, 2007 submission on March 29, 2007.

At the opening of the on-site review, ARA informed the Professional Team that a subsequent error was discovered on April 2, 2007 in the coding of a branching statement, which necessitates re-running the model to correct all Forms involving the stochastic storm set. All Standards involving these Forms were not verified during the on-site review.

ARA presented the changes made in the 2007 model (HurLoss 4.0a):

- New boundary layer model in the hurricane wind field model
- Revised model for hurricane intensity to include the effects of wind shear, variable tropopause temperature, and a reduction in sea surface temperature brought about by a simple hurricane-ocean mixing model
- Updated statistical models for the Holland *B* parameter and treatment of Rmax
- Inclusion of demand surge.

Reviewed the following corrections to be included in the revised submission that will be provided to the Commission in addition to the editorial corrections noted in the Professional Team pre-visit letter.

1. Page 46, M-2.2, central pressure dependency
2. Page 47, M-2.8, clarify Pmin over-water
3. Page 47, M-2.10, descriptive material on Wilma and other storms

4. Page 166, S-1.1, update wording on the Holland B parameter
5. Page 166, S-1.2, correct date for HURDAT data set period
6. Page 184, Form S-4, correct previous year value produced by model.

****

Additional Verification Review – May 7, 2007

ARA submitted corrections to the original February 28, 2007 model submission under the 2006 Standards on April 26, 2007. A subset of the Professional Team completed the additional verification review on May 7, 2007 in Tallahassee. **All Standards are now verified**.

The following individuals participated in the additional verification review:

ARA

Francis M. Lavelle, Ph.D., P.E., Principal Engineer
Peter J. Vickery, Ph.D., P.E., Principal Engineer
Dhiraj Wadhera, Staff Scientist

Professional Team

Jenni Evans, Ph.D., Meteorologist
Paul Fishwick, Ph.D., Computer Scientist
Mark Johnson, Ph.D., Statistician, Team Leader
Marty Simons, ACAS, Actuary
Donna Sirmons, Staff

The additional verification review began with ARA stating the changes to the model since the initial verification review on April 5-7, 2007 that included correcting the errors and testing of the hurricane track model and updating the demand surge model to reflect the effect of storms impacting areas of Mississippi, Alabama, and Georgia adjacent to Florida.

Report on Deficiencies

The Professional Team reviewed the following deficiencies cited by the Commission at the March 13, 2007 meeting. The deficiencies were corrected by the established time frame and the corrections have been verified.

1. Standard G-1, Disclosure 5 (page 21)
   Response not provided.

2. Form V-1.B (pages 74-75)
   Modeler did not confirm that the structures used in completing the form are identical to those in the table provided.

Additionally, in re-submitting Form V-1, besides ensuring that the structure was appropriate, ARA included demand surge in the calculation of damage ratios.

Pre-Visit Letter

The following editorial corrections are noted. The Professional Team will need to review the corrected pages before completing the on-site review.

1. Page 45, no equation (3).
2. Page 45, sentence above equation (4), “model” should be “modeled.”
3. Page 49, first sentence, “of requested stochastic” should be “of the requested stochastic.”
4. Page 51, M-4.2, “for” should be “to.”
5. Page 85, last sentence, delete “to”.
6. Page 118, “2005FormA6.xls” should be “2006FormA6.xls.”
7. Page 180, “FormA2Input05.xls” should be “FormA1Input06.xls.”

Provide for the Professional Team’s review, all insurance company claims data received since the review by the Professional Team in 2004 (three years prior). Be prepared to describe any processes used to amend or validate the model that incorporates this data.

Provide for the Professional Team’s review, all engineering data (post event surveys, tests, etc.) received since the review by the Professional Team in 2004 (three years prior). Be prepared to describe any processes used to amend or validate the model that incorporates this data.

The Professional Team reviewed the editorial corrections noted above during the course of the audit. Corrections will be included in the revised submission that will be provided to the Commission.

The Professional Team’s pre-visit letter questions are provided in the report under the corresponding Standards.

GENERAL STANDARDS – Mark Johnson, Leader

G-1 Scope of the Computer Model and Its Implementation*

*(*Significant Revision due to new Audit language)*

The computer model shall project loss costs for personal lines residential property from hurricane events.

Audit

1. The main intent of the audit is to determine the capabilities of the model and to assess its implementation for purposes of Florida projected loss costs. Copies of all representative or primary technical papers that describe the underlying model theory shall be made available.

2. All software located within the model, used to compile data used by the model, used to validate the model, and used to project model loss costs (1) fall within the scope of the Computer Standards, and (2) will be reviewed interactively (viewed simultaneously by all Professional Team members in conjunction with the review of each Standard).

3. Databases or data files relevant to the modeler's submission will be reviewed.

Pre-Visit Letter

1. G-1, Disclosure 3, page 21 – Provide proprietary flow-charts for review by the Professional Team.

Verified: YES

Professional Team Comments:

In conjunction with G-1.5, requested and received for review copies of manuscripts describing all new model components.

Reviewed detailed presentation of model changes from last year with details to follow in the relevant Meteorology and Actuarial Standards.

Reviewed proprietary flow chart mentioned on page 21 of the submission.

*****Additional Verification Review Comments*****

Discussed reference wind-speed averaging time.

G-2 Qualifications of Modeler Personnel and Consultants

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

B. The model or any modifications to an accepted model shall be reviewed by either modeler personnel or consultants in the following professional disciplines: structural/wind engineering (licensed Professional Engineer), statistics (advanced degree), actuarial science (Associate or Fellow of Casualty Actuarial Society), meteorology (advanced degree), and computer/information science (advanced degree). These individuals shall be signatories on Forms G-1 through G-6 as applicable and shall abide by the standards of professional conduct if adopted by their profession.

Audit

1. The professional vitae of modeler personnel and consultants responsible for the current model and information on their predecessors if different than current personnel will be reviewed. Background information on individuals providing testimonial letters in the submission shall be provided.

2. Forms G-1, G-2, G-3, G-4, G-5, G-6, and all independent peer reviews of the model under consideration will be reviewed. Signatories on the individual Forms will be required to provide a description of their review process.

3. Discuss any incidents where modeler personnel or consultants have been found to have failed to abide by the standards of professional conduct adopted by their profession.

Pre-Visit Letter

2. G-2, Disclosure 2.B, page 30 – Provide the resume for Mr. Dhiraj Wadhera.

Verified: ~~**Contingent upon receiving updated Expert Certification Forms**~~ **YES**

Professional Team Comments:

Reviewed resume of Dhiraj Wadhera, only new personnel on team for model version 4.0a.

Dhiraj Wadhera, M.E.Sc. Civil Engineering, Boundary Layer Wind Tunnel Laboratory, University of Western Ontario. Thesis Title: Wind Induced Interference Effects on Medium Rise Structures.

*****Additional Verification Review Comments*****

Reviewed independent reviews of the changes to ARA model HurLoss 4.0.c by Doug Collins, consulting Actuary, and Brian Grant, Computer Scientist.

G-3 Risk Location

A. ZIP Codes used in the model shall be updated at least every 24 months using information originating from the United States Postal Service. The United States Postal Service issue date of the updated information shall be reasonable.

B. ZIP Code centroids, when used in the model, shall be based on population data.

C. ZIP Code information purchased by the modeler shall be verified by the modeler for accuracy and appropriateness.

Audit

1. Provide geographic displays for all ZIP Codes. The location of specific centroids will be reviewed.

2. Provide the third party vendor, if applicable, and a complete description of the process used to validate ZIP Code information.

Pre-Visit Letter

3. G-3.C, page 33 – Describe the process used to validate the ZIP Code data. Provide material cited as available for review by the Professional Team.

Verified: YES

Professional Team Comments:

Reviewed ZIP Code process for several areas including an example ZIP Code specified by the Professional Team.

Verified that ZIP Codes were not updated in the 2006 submission.

G-4 Independence of Model Components

The meteorological, vulnerability, and actuarial components of the model shall each be theoretically sound without compensation for potential bias from the other two components.

Audit

1. Demonstrate that the model components adequately portray hurricane phenomena and effects (damage and loss costs). Attention will be paid to an assessment of (1) the theoretical soundness of each component and (2) the basis of their integration. For example, a model would not meet this Standard if an artificial calibration adjustment had been made to improve the match of historical and model results for a specific hurricane.

2. Describe all changes in the model since the previous submission that might impact the independence of the model components.

Verified: ~~**Contingent on verification of all other Standards**~~ **YES**

Professional Team Comments:

No bias detected during the initial on-site review.

*****Additional Verification Review Comments*****

No bias detected among the meteorological, vulnerability, and actuarial components of the model.

Reviewed updated wind speed plots provided in Figures 5 and 6, pages 36-44.

METEOROLOGICAL STANDARDS – Jenni Evans, Leader

M-1 Base Hurricane Storm Set*

*(*Significant Revision)*

For validation of landfall and by-passing storm frequency in the stochastic storm set, the modeler shall use the latest updated Official Hurricane Set or the National Hurricane Center HURDAT as of June 1, 2006 or later. Complete additional season increments based on updates to HURDAT approved by the Tropical Prediction Center/National Hurricane Center are acceptable modifications to these storm sets. Peer reviewed atmospheric science literature can be used to justify modifications to the Base Hurricane Storm Set.

Audit

1. The modeler's Base Hurricane Storm Set will be reviewed.

Verified: YES

Professional Team Comments:

Verified the Base Hurricane Storm Set is the complete HURDAT database for the years 1886-2005 inclusive.

M-2 Hurricane Characteristics

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

Audit

1. All hurricane characteristics used in the model will be reviewed.

2. Prepare graphical depictions of hurricane characteristics as used in the model. Describe and justify:
   - the data set basis for the fitted distributions,
   - the modeled dependencies among correlated characteristics in the wind field component and how they are represented,
   - the asymmetric nature of hurricanes,
   - the fitting methods used and any smoothing techniques employed.

3. The goodness-of-fit of distributions to historical data will be reviewed.

4. For wind and/or pressure fields not previously reviewed, the modeler will present time-based contour animations (capable of being paused) to demonstrate scientifically reasonable wind field characteristics.

5. The treatment of uncertainties associated with the conversion of gradient winds to surface winds will be compared with currently accepted literature. Variation of the conversion factor with storm intensity will be reviewed.

6. All modeler-specific scientific literature provided in Standard G-1 will be reviewed to determine acceptability.

7. Identify all external data sources that affect model generated wind fields.

Pre-Visit Letter

4. M-2, page 44 – Provide specifics of the updates performed to the hurricane wind field model.

5. M2, pages 44-45 – Referring to paragraph, “The relative intensity approach…,” how is the temperature at the bottom of the tropopause evaluated? Is this evaluated for all historical storms from 1950-2005?

6. M-2, page 45 – Referring to paragraph, “The coefficients…,” describe how ocean mixing and vertical wind shear have been incorporated into the updated intensity model.

7. M-2, page 45 – Referring to paragraph, "The radius to maximum winds (expressed miles) for hurricanes…," does the reference to the error term relate to Equation (2) or have Equations (4) and (5) been truncated? Should there have been an Equation (3)?

8. M-2, page 45 – Referring to paragraph, "The modeling of the Holland…," provide specifics about the "model developed over the past 24 months" in which the Holland B parameter is apparently modified once the storm makes landfall.

9. M-2, Disclosure 1, page 46 – Provide information relative to any additional items such as wind shear, sea surface temperature (SST), and ocean mixed layer depth.

10. M-2, Disclosure 2, page 46 – Reconcile the apparent discrepancies in the description of storm central pressure tendencies between pages 45 & 46.

11. M-2, Disclosure 2, page 46 – How have RMAX(pMIN, lat) and pMIN(RMAX, lat) changed such that the reference to Vickery et al. (2000) appears to no longer be relevant?

12. M-2, Disclosure 2, page 46 – How did splitting the RMAX characterization into the 2 regions (Atlantic and Gulf) change its distribution?

13. M-2, Disclosure 3, page 46 – How is the Kepert (2001) boundary layer incorporated? If it is not incorporated directly, how does it relate to this approach?

14. M-2, Disclosure 8, page 47 – Provide a list of random variables or consider rewording the response.

15. M-2, Disclosure 9, page 47 – Describe the reasoning behind modeling the Holland B parameter over land with an exponential decay functional form over land.

16. M-2, Disclosure 10, page 47 – Provide descriptive material beyond the present response in conjunction with the paragraph just before Disclosure 1 on page 45.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

The Pmin model has not been finalized and verification is conditional on finalization of the Pmin over-water intensity model.

The following responses were reworded, reviewed on-site, and will be included in the revised submission provided to the Commission.

- M-2.2, central pressure dependency
- M-2.8, clarify Pmin over water
- M-2.10, descriptive material on Wilma and other storms to be added

Reviewed changes to the hurricane wind field model including a new boundary layer model and sea to land transition.

Reviewed dropsonde profiles and data analyses used as basis for the new boundary layer model.

Reviewed regression equations for calculating surface wind speed and drag coefficients.

Reviewed flowchart for computing return wind speeds for different averaging times.

Reviewed wind field model validation plots comparing modeled and observed maximum peak gust wind speeds for landfalling Hurricanes Wilma, Rita, Katrina, Dennis, Ivan, Jeanne, Frances, Charley, Irene, Floyd, Bonnie, Georges, Fran, Bertha, Opal, and Erin.

Reviewed comparisons of modeled and observed peak gust wind speeds for land and marine based stations.

Reviewed changes to the track and intensity model including new “stand alone” statistical models for the Holland B parameter and Rmax, introduction of ocean mixing for intensity limits, introduction of wind shear, and new data bases for sea surface temperature, isothermal layer, tropopause temperature, wind shear, and bathymetry.

Reviewed examples of pressure profiles used for analysis of the Holland B value, the central pressure difference, and the Rmax.

Reviewed examples of smoothed and point estimates of the Rmax and Holland B parameters derived from aircraft data.

Reviewed regression analysis of Holland B versus Rmax, latitude, sea surface temperature, and central pressure.

Reviewed testing of the Holland B model implemented, another version of the Holland B model, and the basis for the model chosen to be implemented.

Reviewed coastal variation of Holland B values in the new model for all stochastic storms.

Reviewed comparisons of flight level Holland B and Rmax versus Holland B and Rmax used in the wind model.

Reviewed implementation of the Rmax Atlantic and Gulf of Mexico models. Reviewed testing on the new Rmax model version.

Reviewed implementation of the new track model. Reviewed high level flowchart of time stepping intensity model over water.

Reviewed time-based contour animations for the new wind field of a stochastic storm that demonstrated the impact of implementing the new Holland B over land.

Documentation reviewed:

- A Hurricane Boundary Layer and Wind Field Model for Use in Engineering Applications by Peter J. Vickery, Dhiraj Wadhera, Mark D. Powell, and Yingzhao Chen, **Draft Paper**
- Appendix E, The Characteristics of the Holland Pressure Profile Parameter and the Radius to Maximum Winds for Gulf of Mexico and Atlantic Hurricanes as Determined From an Analysis of Flight Level Pressure Data and H*Wind Surface Wind Speed Data, **Draft Paper**
- Hurricane Intensity Model, **Draft Paper**

*****Additional Verification Review Comments*****

Reviewed modifications in the ocean mixing model.

Reviewed detailed testing on the revisions to the model for hurricane intensity that include the effects of wind shear, variable tropopause temperature, and a reduction in sea surface temperature brought about by the ocean mixing model.

Reviewed landfall pressure verification plots by region in Florida.

Reviewed statistical tests for landfall pressures by individual regions and combined regions.

Reviewed radial plots of the mixing model testing on radial point location validation, sea surface data validation, temperature increase in loop current validation, bathymetry validation, thermocline strength and gradient balance wind speed validation.

Reviewed plots of azimuthal average of mixed layer depth and surface stress verification for all radial bands.

Reviewed plots of a specific storm tested for interpolation validation of mixed layer depth estimation and sea surface temperature.

Reviewed examples of shear and tropopause temperature tests by radial band.

Reviewed simulated random error validations on the pressure distribution.

Reviewed wind model interpolation validation plots.

Reviewed code for change in sea surface temperature due to mixing.

Reviewed the Rmax model code.

M-3 Landfall Intensity

Models shall use maximum one-minute sustained 10-meter wind speed when defining hurricane landfall intensity. This applies both to the Base Hurricane 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. 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:

Category	Winds (mph)	Damage
1	74 – 95	Minimal
2	96 – 110	Moderate
3	111 – 130	Extensive
4	131 – 155	Extreme
5	Over 155	Catastrophic

Audit

1. Demonstrate that the hurricane intensity at landfall is consistent with the Saffir-Simpson wind range for the stochastic storm set.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Response to M-3.3 will be updated in the revised submission. Relies on determination of over-water Pmin.

Reviewed changes to the intensity model including wind shear and tropopause temperature data and an ocean mixing model.

Reviewed the composition of the ocean mixing model, associated equations, and testing of the model on returned sea surface temperatures and central pressures.

Reviewed model validation process for central pressures at landfall.

Documentation reviewed:

Environmental Control of Tropical Cyclone Intensity, Kerry Emanuel, Christopher Desautels, Christopher Holloway, and Robert Korty, American Meteorological Society, 1 April 2004.

*****Additional Verification Review Comments*****

Reviewed revised response provided for M-3.3. Discussed Vmax value relative to other parameters in Holland wind equation.

M-4 Hurricane Probabilities

A. Modeled probability distributions for hurricane intensity, forward speed, radii for maximum winds, and storm heading shall be consistent with historical hurricanes in the Atlantic basin.

B. Modeled hurricane probabilities shall reflect the Base Hurricane Storm Set used for category 1 to 5 hurricanes and shall be consistent with those observed for each coastal segment of Florida and neighboring states (Alabama, Georgia, and Mississippi).

Audit

1. Modeled probabilities are compared with observed hurricane frequency using methods documented in currently accepted scientific literature. The goodness-of-fit of modeled to historical hurricane frequencies for the four regions of Florida and overall as provided in Form M-1 will be reviewed.

2. Demonstrate that the quality of fit extends beyond the Florida border by showing results for appropriate coastal segments in Alabama, Georgia, and Mississippi.

3. Describe and support the method of selecting stochastic storm tracks.

4. Describe and support the method of selecting storm track strike intervals. If strike locations are on a discrete set, show the landfall points for major metropolitan areas in Florida.

5. Provide any modeler specific research performed to develop the functions used for simulating model variables or to develop databases.

6. Describe any short term and long term variations in annual storm frequencies incorporated in the model.

Pre-Visit Letter

17. M-4, Disclosure 1, page 50 – What is the mixed layer depth database used? What are its spatial and temporal resolutions? Is it used at full resolution?

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Form M-1 involves the stochastic storm set and will be resubmitted.

Reviewed comparisons of modeled and historical landfall rates by central pressure for 1970-2006 and 1900-2006.

Verified there are no short term or long term variation enhancements in annual storm frequencies incorporated in the model. The complete HURDAT is used.

*****Additional Verification Review Comments*****

Reviewed results provided in the revised Form M-1.

M-5 Land Friction and Weakening

A. The magnitude of land friction coefficients shall be consistent with currently accepted scientific literature relevant to current geographic surface roughness distributions and shall be implemented with appropriate geographic information system data.

B. The hurricane overland weakening rate methodology used by the model shall be consistent with historical records.

Audit

1. Identify other variables in the model that affect over land wind speed estimation.

2. Maps depicting land friction effects are required. Describe the representation of land friction effects in the model. Describe the variation in decay rate over land used in the model.

3. Comparisons of the model's weakening rates to weakening rates for historical Florida hurricanes will be reviewed.

4. Transition of winds from over water to over land (i.e. landfall) will be reviewed.

5. Form M-2 will be reviewed.

Pre-Visit Letter

18. M-5, Disclosure 1, pages 52-53 – How does the over-land wind field differ with the additional reduction in the magnitude of the pressure profile parameter (i.e. B) via an exponential decay function? Vickery et al. (2000a) appears to no longer be relevant?

19. Form M-2, pages 62-63 – Comment on the changes from the previous submission.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Form M-2, Figure 13, 100-year return period maximum winds from the stochastic storm set will be resubmitted.

Reviewed the Holland B weakening model as implemented in the code, the associated equations, and comparisons of Holland B estimates as a function of time after landfall for Hurricanes Ivan, Rita, Katrina, and Dennis.

Reviewed Form M-2 and the differences from the previous submission using the new requirement of local terrain rather than open terrain as modeled previously.

*****Additional Verification Review Comments*****

Reviewed revised Figure 13 in Form M-2. Discussed impacts of new Holland B formulation over land.

M-6 Logical Relationships of Hurricane Characteristics

A. The magnitude of asymmetry shall increase as the translation speed increases, all other factors held constant.

B. The mean wind speed shall decrease with increasing surface roughness (friction), all other factors held constant.

Audit

1. Form M-3 and the modeler's sensitivity analyses provide the information used in auditing this Standard.

2. Justify the relationship between central pressure and radius of maximum winds.

Pre-Visit Letter

20. Form M-3, pages 64-65 – Discuss Figure 14 relative to the information provided on page 64.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Form M-3 involves the stochastic storm set and will be resubmitted.

Reviewed the new Rmax model.

*****Additional Verification Review Comments*****

Reviewed revised Form M-3.

VULNERABILITY STANDARDS – Fred Stolaski, Leader

V-1 Derivation of Vulnerability Functions

A. Development of the vulnerability functions is to be based on a combination of the following: (1) historical data, (2) tests, (3) structural calculations, (4) expert opinion, or (5) site inspections. Any development of the vulnerability functions based on structural calculations or expert opinion shall be supported by tests, site inspections, or historical data.

B. The method of derivation of the vulnerability functions shall be theoretically sound.

C. Any modification factors/functions to the vulnerability functions or structural characteristics and their corresponding effects shall be clearly defined and be theoretically sound.

D. Construction type and construction characteristics shall be used in the derivation and application of vulnerability functions.

E. In the derivation and application of vulnerability functions, assumptions concerning building code revisions and building code enforcement shall be justified.

F. Vulnerability functions shall be separately derived for building structures, mobile homes, appurtenant structures, contents, and additional living expense.

G. The minimum wind speed that generates damage shall be reasonable.

Audit

1. Historical data should be available in the original form with explanations for any changes made and descriptions of how missing or incorrect data were handled. To the extent that historical data are used to develop vulnerability functions, demonstrate the goodness-of-fit of the data to fitted models. Complete reports detailing loading conditions and damage suffered are required for any test data used. Complete structural calculations shall be presented so that a variety of different structure types and construction characteristics may be selected for review. The basis for expert opinion and original site inspection reports should be available for review.

2. Copies of any papers, reports, and studies used in the development of the vulnerability functions should be available for review. Copies of all public record documents used may be requested for review.

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

4. Justify the construction types and characteristics used, and provide validation of the range and direction of the variations in damage.

5. Document and justify all modifications to the vulnerability functions due to building codes and their enforcement.

6. Provide validation material for the disclosed minimum wind speed. Provide the computer code showing the inclusion of the minimum wind speed at which damage occurs.

7. Form V-1 will be reviewed.

Pre-Visit Letter

21. V-1.D and V-1.F, page 68 – Provide material cited as shown to the Professional Team.

22. V-1, Disclosure 5, page 70 – Provide material cited as reviewed with the Professional Team.

23. [This question is under Standard V-2]

24. Form V-1, page 74 – Explain no change to Part A and Part B from the previous submission.

Verified: YES

Professional Team Comments:

Verified there were no changes to the vulnerability functions since the previous version.

Reviewed revisions to Form V-1 in response to the deficiency noted at the March 13, 2007 Commission meeting. Form was completed to include demand surge and the prescribed base structure.

Reviewed Appendix I of Florida Department of Community Affairs Report, "Development of Loss Relativities for Wind Resistive Features of Residential Structures." Reviewed data sources for the field inspection data. Reviewed the range of loss relativities provided in Tables 3-2 and 3-3.

Reviewed the building stock distribution by regions. Reviewed new insurance data that will be used to increase and validate building stock data.

Reviewed computer code used to select and apply the correct vulnerability function for producing selected losses.

Discussed limited site inspections completed after Hurricane Katrina.

Documentation reviewed:

HURLOSS Risk Analysis Suite, Building Component Load Models, Volume II-A

V-2 Mitigation Measures*

*(*Significant Revision due to new Audit language)*

A. Modeling of mitigation measures to improve a structure's wind resistance and the corresponding effects on vulnerability shall be theoretically sound. These measures shall include fixtures or construction techniques that enhance:

- ***Roof strength***
- ***Roof covering performance***
- ***Roof-to-wall strength***
- ***Wall-to-floor-to-foundation strength***
- ***Opening protection***
- ***Window, door, and skylight strength.***

B. Application of mitigation measures shall be empirically justified both individually and in combination.

Audit

1. Forms V-2 and V-3 provide the information used in auditing this Standard.

2. Individual mitigation measures as well as total effect on damage due to use of multiple mitigation measures will be reviewed. Any variation in the change over the range of wind speeds for individual and multiple mitigation measures will be reviewed.

3. Mitigation measures used by the model that are not listed as required in this Standard will be disclosed and shown to be theoretically sound and reasonable.

Pre-Visit Letter

23. V-2.A, page 72 – Provide material cited as disclosed to the Professional Team.

24. [This question is under Standard V-1]

25. Form V-2, page 78 – Discuss the values for the items in the ROOF-WALL STRENGTH section.

26. Form V-2, page 78 – Discuss the large values shown for the MITIGATED STRUCTURE.

27. Form V-3 – Please complete the REFERENCE STRUCTURE row in Form V-3. Provide a copy of Form V-3 when the Professional Team arrives, and also provide the electronic file used to complete Form V-3 on a removable drive medium. (This material will be used during the on-site review and will be returned when the on-site review is complete.)

Verified: YES

Professional Team Comments:

Verified there were no changes to vulnerability mitigation since the previous version.

Documentation reviewed:
HURLOSS Risk Analysis Suite – Vulnerability Standard – Form V-2

Reviewed details of the vulnerability model used to estimate the effects of individual and multiple mitigation techniques.

Reviewed the results provided in Form V-2 with particular attention to the values provided in the Roof-Wall Strength section and the high values provided for the Mitigated Structure.

Reviewed the results provided in Form V-3 (Trade Secret List) and discussed occurrence of maximum values for base frame and masonry structures at lower than peak winds.

ACTUARIAL STANDARDS – Marty Simons, Leader

A-1 Modeled Loss Costs

Modeled loss costs shall reflect all damages from storms that reach hurricane strength and produce minimum damaging wind speeds or greater on land in Florida.

Audit

1. The model will be reviewed to determine that the definition of an event in the model is consistent with Standard A-1.

2. The model will be reviewed to determine that by-passing storms and their effects are considered in a manner that is consistent with Standard A-1.

Verified: YES

Professional Team Comments:

Discussed with Doug Collins his review and confirmation that there were no changes in the model relative to the definition of an event and the handling of by-passing storms.

A-2 Underwriting Assumptions

A. 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.

B. For loss cost estimates derived from or validated with historical insured hurricane losses, the assumptions in the derivations concerning (1) construction characteristics, (2) policy provisions, (3) claim payment practices, and (4) relevant underwriting practices underlying those losses, as well as any actuarial modifications, shall be appropriate.

Audit

1. Demonstrate how the claim practices of insurance companies are accounted for when claims data for those insurance companies are used to develop or to verify model calculations. For example, the level of damage the insurer considers a loss to be a "total loss." Provide the methods used to delineate among the insurer claim practices in the use of historical claims data to verify model outputs.

Pre-Visit Letter

28. A-2, Disclosure 4 – Describe how the model incorporates information in the input exposure data base related to replacement cost vs. actual cash value.

Verified: YES

Professional Team Comments:

Discussed with Doug Collins his review of how insurance claims data were used for validation.

Reviewed insurance claims data from the 2004 and 2005 hurricane season losses. Reviewed correspondence between ARA and the insurance companies regarding the claims data.

Reviewed Hurricane Wilma claim files.

Reviewed how the model incorporates information in the exposure database relative to replacement cost value and actual cash value.

A-3 Loss Cost Projections*

*(*Significant Revision)*

A. Loss cost projections produced by hurricane loss projection models shall not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margin.

B. Loss cost projections shall not make a prospective provision for economic inflation.

Audit

1. Describe how the model handles expenses, risk load, investment income, premium reserves, taxes, assessments, profit margin, and economic inflation.

Verified: YES

Professional Team Comments:

Discussed with Doug Collins his confirmation that the method for producing loss costs has not changed.

Verified that model loss costs do not include prohibited items listed in A and B above.

A-4 Demand Surge*

*(*New Standard)*

A. Demand surge shall be included in the model's calculation of loss costs.

B. The methods, data, and assumptions used in the estimation of demand surge shall be actuarially sound.

Audit

1. Provide the data and methods used to determine the effects of demand surge.

Pre-Visit Letter

29. A-4, page 83 – Provide a detailed description of the process used in the model to account for demand surge, including any analyses performed to determine that the resulting demand surge adjustments are actuarially reasonable. Have available any data, reports, expert opinions, etc. used in developing this process.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Reviewed the lack of a demand surge factor in Florida for big storms that make landfall in neighboring states. This will be addressed and reviewed at the additional verification review.

Reviewed the demand surge model, its development, and the process for determining the factor to be applied in the calculation.

Reviewed the rationale, references, and judgment used to develop the demand surge model.

Reviewed computer code for the demand surge model.

Reviewed verification procedures.

Discussed with Doug Collins his review of the demand surge model and his agreement that the implementation is judgment-based.

*****Additional Verification Review Comments*****

Reviewed modifications to the demand surge model to reflect the effect of storms impacting areas of Mississippi, Alabama, and Georgia adjacent to Florida.

Reviewed computer code for the modified demand surge model.

Reviewed test documentation for the modifications to the demand surge model.

Reviewed verification tests completed on the demand surge model modifications.

Reviewed letter from Doug Collins commenting on his review of the changes in the demand surge model.

A-5 User Inputs

All modifications, adjustments, assumptions, and defaults necessary to use the inputs in the model shall be actuarially sound and included with the model output. Treatment of missing values for user inputs required to run the model shall be actuarially sound and described with the model output.

Audit

1. Quality assurance procedures should include methods to assure accuracy of insurance data. Compliance with this Standard will be readily demonstrated through documented rules and procedures.

2. All insurer inputs and assumptions will be reviewed.

Pre-Visit Letter

30. A-5, page 85 – Provide the material cited as reviewed by the Professional Team.

Verified: YES

Professional Team Comments:

Discussed with Doug Collins his review of assumptions made regarding inputs in the model and verified no change in the methodology from the previous version.

Verified methods used by modeler to assure accuracy of insurance data.

A-6 Logical Relationship to Risk

A. 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.

B. Loss costs produced by the model shall be positive and non-zero for all valid Florida ZIP Codes.

C. Loss costs cannot increase as the quality of construction type, materials and workmanship increases, all other factors held constant.

D. Loss costs cannot increase as the presence of fixtures or construction techniques designed for hazard mitigation increases, all other factors held constant.

E. Loss costs cannot increase as the quality of building codes and enforcement increases, all other factors held constant.

F. Loss costs shall decrease as deductibles increase, all other factors held constant.

G. The relationship of loss costs for individual coverages, (e.g., structures and appurtenant structures, contents, and loss of use/additional living expense) shall be consistent with the coverages provided.

Audit

1. Graphical representations of loss costs by ZIP Code and county will be reviewed.

2. Color-coded maps depicting the effects of land friction on loss costs by ZIP Code will be reviewed.

3. Individual loss cost relationships will be reviewed. Forms A-1, A-2, A-3, A-4, and A-5 will be used to assess coverage relationships.

Pre-Visit Letter

33. Form A-3, page 109 – Describe any differences from the previous submission.

34. Form A-5, page 116 – Describe the process used to produce figure 25, including computer code or other means used to generate figure 25.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Forms A-1, A-2, A-3, and A-5 will be resubmitted in light of model changes and error detections/corrections.

Discussed with Doug Collins his review of the various forms to determine whether the loss costs looked logical. Discussed his communications with ARA to satisfy his concerns over results for Company A Andrew losses produced in Figure 39, page 174, comparison of modeled and observed losses for homeowner policies; correction was made in Coverage D database for this company.

Reviewed results provided in Form A-4.

Reviewed methods and procedures used to generate Figure 25.

*****Additional Verification Review Comments*****

Reviewed revised results provided in Forms A-1, A-2, A-3, and A-5.

Reviewed changes in the average annual loss provided in Form A-1 for Escambia County.

Reviewed changes in Form A-3 for Hurricane Ivan.

A-7 Deductibles and Policy Limits

A. The methods used in the development of mathematical distributions to reflect the effects of deductibles and policy limits shall be actuarially sound.

B. The relationship among the modeled deductible loss costs shall be reasonable.

C. Deductible loss costs shall be calculated in accordance with s. 627.701(5)(a), F.S.

Audit

1. Describe the process used to determine the accuracy of the insurance-to-value criteria in data used to develop or validate the model results.

2. The actuary for the modeler may be asked to attest to the actuarial soundness of the procedure for handling deductibles and policy limits. To the extent that historical data are used to develop mathematical depictions of deductibles and policy limit functions, demonstrate the goodness-of-fit of the data to fitted models. Justify changes from the prior submission in the relativities among corresponding deductible amounts for the same coverage.

Pre-Visit Letter

31. A-7.A, page 91 – Provide the material cited as presented to the Professional Team.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Relationship among modeled deductible loss cost will be reviewed following submission of revised Forms and output ranges.

Discussed with Doug Collins his confirmation that no changes were made in the model relative to applying deductibles and policy limits from the previous submission that required further review on his part.

Reviewed methods and formulae for applying and validating deductibles and policy limits.

*****Additional Verification Review Comments*****

Reviewed relationship among modeled deductible loss costs in the revised Forms.

A-8 Contents

A. The methods used in the development of contents loss costs shall be actuarially sound.

B. The relationship between the modeled structure and contents loss costs shall be reasonable, based on the relationship between historical structure and contents losses.

Audit

1. The actuary for the modeler may be asked to attest to the actuarial soundness of the procedure for calculating loss costs for contents coverage. To the extent that historical data are used to develop mathematical depictions of contents functions, demonstrate the goodness-of-fit of the data to fitted models. Justify changes from the prior submission in the relativities between loss costs for structures and the corresponding loss costs for contents.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Contents losses will be reviewed following submission of revised Forms and output ranges.

Discussed with Doug Collins his confirmation that no changes were made in the model relative to contents losses from the previous submission that required further review on his part.

*****Additional Verification Review Comments*****

Reviewed contents loss costs in the revised Forms.

A-9 Additional Living Expense (ALE)

A. The methods used in the development of Additional Living Expense (ALE) loss costs shall be actuarially sound.

B. ALE loss cost derivations shall consider the estimated time required to repair or replace the property.

C. The relationship between the modeled structure and ALE loss costs shall be reasonable, based on the relationship between historical structure and ALE losses.

D. ALE loss costs produced by the model shall appropriately consider ALE claims arising from damage to the infrastructure.

Audit

1. The actuary for the modeler may be asked to attest to the actuarial soundness of the procedure for calculating loss costs for ALE coverage. Documentation and justification of the following will be reviewed:
   a. The method of derivation and data on which the ALE vulnerability function is based;
   b. Validation data specifically applicable to ALE;
   c. Assumptions regarding the coding of ALE losses by insurers;
   d. The effects of demand surge on ALE for Hurricane Andrew;
   e. Assumptions regarding the variability of ALE by size of property;
   f. Statewide application of ALE assumptions;
   g. Assumptions regarding ALE for mobile homes, tenants, and condo unit owners exposure;
   h. The methods used to incorporate the estimated time required to repair or replace the property;
   i. The methodology and available validation for determining the extent of infrastructure damage and its effect on ALE costs.

2. To the extent that historical data are used to develop mathematical depictions of ALE functions, demonstrate the goodness-of-fit of the data to fitted models.

3. Justify the differences in the relationship of structure and ALE loss costs from those previously found acceptable.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

ALE losses will be reviewed following submission of revised Forms and output ranges.

Discussed with Doug Collins his confirmation that no changes were made in the model relative to ALE losses from the previous submission that required his further review.

*****Additional Verification Review Comments*****

Reviewed ALE losses in the revised Forms.

A-10 Output Ranges

A. Output ranges shall be logical and any deviations supported.

B. All other factors held constant, output ranges produced by the model shall reflect lower loss costs for:

1. masonry construction versus frame construction,

2. residential risk exposure versus mobile home risk exposure,

3. in general, inland counties versus coastal counties, and

4. in general, northern counties versus southern counties.

Audit

1. Forms A-6, A-7, and A-8 will be reviewed.

2. The modeler will be required to justify the following:
   a. Changes from the prior submission of greater than five percent in weighted average loss costs for any county.
   b. Changes from the prior submission of five percent or less in weighted average loss costs for any county.

3. Output ranges will be reviewed to ensure appropriate differentials among deductibles, coverage, and construction types.

4. Anomalies in the output range data will be reviewed and shall be justified.

Pre-Visit Letter

32. A-10.B, page 96 – Provide a detailed description of the underlying contributions to the changes in the output ranges from the prior submission to the current submission produced by each contributing factor to those changes.

33. [This question is under Standard A-6]
34. [This question is under Standard A-6]

35. Form A-8, pages 160-163 – Explain why counties indicating greater changes on pages 98 – 104 are excluded from presentation on Form A-8. (For example, the increase in zero deductible owners frame for Martin County is shown in Form A-7 as +59.56%, but Form A-8 has an upper limit of +50.0%.)

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Forms A-6, A-7, and A-8 will be resubmitted in light of model changes and error detections/corrections.

Discussed with Doug Collins his review of the output ranges and the differences in the statewide losses for masonry and frame due to a change in the distribution for these structures.

*****Additional Verification Review Comments*****

Reviewed revised Forms A-6, A-7, and A-8.

Reviewed the changes in loss costs provided in the revised Form A-7 and the rationale for the significant reduction in Northern counties as well as changes in the rest of Florida.

STATISTICAL STANDARDS – Mark Johnson, Leader

S-1 Modeled Results and Goodness-of-Fit

A. The use of historical data in developing the model shall be supported by rigorous methods published in currently accepted scientific literature.

B. Modeled and historical results shall reflect agreement using currently accepted scientific and statistical methods.

Audit

1. Forms S-1 and S-2 will be reviewed.

2. The modeler's characterization of uncertainty for wind speed, damage estimates, annual loss, and loss costs will be reviewed.

Pre-Visit Letter

36. S-1, Disclosure 4, page 167 – No storms since 1998 are listed. Are there other results from 2004-2005 for this purpose?

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Response to S-1.1 reworded for Holland B parameter. Response to S-1.2 corrected for date of HURDAT data set.

Forms S-1 and S-2 will be resubmitted in light of model changes and error detections/ corrections.

Reviewed relative intensity models and fitted distributions to the model errors.

Numerous model fits to data were reviewed in the context of the meteorology review.

*****Additional Verification Review Comments*****

Reviewed various statistical tests for pressure distribution.

Reviewed Kolmogorov-Smirnoff tests on the random error terms for several parameters.

Reviewed validation plots for the B filling model and Rmax model.

Reviewed changes in the goodness of fit test results provided in Figures 35 and 36 (pages 184 & 185) due to sampling.

S-2 Sensitivity Analysis for Model Output

The modeler shall have assessed the sensitivity of temporal and spatial outputs with respect to the simultaneous variation of input variables using currently accepted scientific and statistical methods and have taken appropriate action.

Audit

1. The modeler's sensitivity analysis will be reviewed in detail. Statistical techniques used to perform sensitivity analysis shall be explicitly stated. The results of the sensitivity analysis displayed in graphical format (e.g., contour plots with temporal animation) will be reviewed.

2. Form S-5 will be reviewed for models submitted by modeling organizations which have not previously provided the Commission with this analysis.

Pre-Visit Letter

37. S-2 initial response and S-2, Disclosure 3, pages 169-170 – Provide materials cited as presented to the Professional Team.

Verified: YES

Professional Team Comments:

Reviewed analyses that supported the development of a new over-water intensity model, the new Holland B over land model, and the new treatment of the slab boundary layer model.

S-3 Uncertainty Analysis for Model Output

The modeler shall have performed an uncertainty analysis on the temporal and spatial outputs of the model using currently accepted scientific and statistical methods and have taken appropriate action. The analysis shall identify and quantify the extent that input variables impact the uncertainty in model output as the input variables are simultaneously varied.

Audit

1. The modeler's uncertainty analysis will be reviewed in detail. Statistical techniques used to perform uncertainty analysis shall be explicitly stated. The results of the uncertainty analysis displayed in graphical format (e.g., contour plots with temporal animation) will be reviewed.

2. Form S-5 will be reviewed for models submitted by modeling organizations which have not previously provided the Commission with this analysis.

Pre-Visit Letter

38. S-3, page 171 – Provide materials cited as presented to the Professional Team.

Verified: YES

Professional Team Comments:

Reviewed analyses that supported the development of a new over-water intensity model, the new Holland B over land model, and the new treatment of the slab boundary layer model.

S-4 County Level Aggregation

At the county level of aggregation, the contribution to the error in loss cost estimates attributable to the sampling process shall be negligible.

Audit

1. Provide a graph assessing the accuracy associated with a low impact area such as Nassau County. We would expect that if the contribution error in an area such as Nassau County is small, the error in the other areas would be small as well. Assess where appropriate, the contribution of simulation uncertainty via confidence intervals.

Verified: YES

Professional Team Comments:

Verified no change in the process of sample size determination.

*****Additional Verification Review Comments*****

Reviewed revised standard error results provided in Figure 38, page 193.

S-5 Replication of Known Hurricane Losses

The model shall estimate incurred losses in an unbiased manner on a sufficient body of past hurricane events from more than one company, including the most current data available to the modeler. This Standard applies separately to personal residential and, to the extent data are available, to mobile homes. Personal residential experience may be used to replicate structure-only and contents-only losses. The replications shall be produced on an objective body of loss data by county or an appropriate level of geographic detail.

Audit

1. The following information for each insurer and hurricane will be reviewed:
   a. The validity of the model assessed by comparing expected losses produced by the model to actual observed losses incurred by insurers at both the state and county level,
   b. The version of the model used to calculate modeled losses for each hurricane provided,
   c. A general description of the data and its source,
   d. A disclosure of any material mismatch of exposure and loss data problems, or other material consideration,
   e. The date of the exposures used for modeling and the date of the hurricane,
   f. An explanation of differences in the actual and modeled hurricane parameters,
   g. A listing of the departures, if any, in the wind field applied to a particular hurricane for the purpose of validation and the wind field used in the model under consideration,
   h. The type of property used in each hurricane to address:
      i. Personal versus commercial
      ii. Residential structures
      iii. Mobile homes
      iv. Condominiums
      v. Structures only
      vi. Contents only,
   i. The inclusion of demand surge, storm surge, loss adjustment expenses, or law and ordinance coverage in the actual losses, or the modeled losses.

2. The following documentation will be reviewed:
   a. Publicly available documentation referenced in the submission,
   b. The data sources excluded from validation and the reasons for excluding the data from review by the Commission (if any),
   c. An analysis that identifies and explains anomalies observed in the validation data,
   d. User input sheets for each insurer and hurricane detailing specific assumptions made with regard to exposed property.

3. The confidence intervals used to gauge the comparison between historical and modeled losses will be reviewed.

4. Form S-3 will be reviewed.

5. The results of one hurricane event for more than one insurance company and the results from one insurance company for more than one hurricane event will be reviewed to the extent data are available.

Pre-Visit Letter

39. S-5 initial response and S-5, Disclosure 1, pages 174-175 – Provide materials cited as presented to the Professional Team. Why have the actual losses changed?

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Form S-3 will be resubmitted in light of model changes and error detections/corrections.

*****Additional Verification Review Comments*****

Reviewed Form S-3.

S-6 Comparison of Projected Hurricane Loss Costs

The difference, due to uncertainty, between historical and modeled annual average statewide loss costs shall be reasonable, given the body of data, by established statistical expectations and norms.

Audit

1. Form S-4 will be reviewed.

2. Justify the following:
   a. Meteorological parameters,
   b. The effect of by-passing storms,
   c. The effect of actual hurricanes that had two landfalls impacting Florida,
   d. The departures, if any, from the wind field, vulnerability functions, or insurance functions applied to the actual hurricanes for the purposes of this test and those used in the model under consideration, and
   e. Exposure assumptions.

Pre-Visit Letter

40. Form S-4.B, page 184 – Verify the value given for Previous Year under Produced by Model.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Form S-4 will be resubmitted in light of model changes and error detections/corrections.

*****Additional Verification Review Comments*****

Reviewed results provided in the revised Form S-4.

COMPUTER STANDARDS – Paul Fishwick, Leader

C-1 Documentation

A. The modeler shall maintain a primary document binder, containing a complete set of documents specifying the model structure, detailed software description, and functionality. Development of each section shall be indicative of accepted software engineering practices.

B. All computer software (i.e., user interface, scientific, engineering, actuarial, data preparation, and validation) relevant to the modeler's submission shall be consistently documented and dated.

C. Documentation shall be created separately from the source code.

Audit

1. The primary document binder, in either electronic or physical form, and its maintenance process will be reviewed. The binder shall contain fully documented sections for each Computer Standard.

2. All documentation shall be easily accessible from a central location.

3. Complete user documentation, including all recent updates, will be reviewed.

4. Modeler personnel, or their designated proxies, responsible for each aspect of the software (i.e. user interface, quality assurance, engineering, actuarial) shall be present when the Computer Standards are being audited. Internal users of the software will be interviewed.

5. Provide verification that documentation is created separately from the source code.

Pre-Visit Letter

41. Show the implementation of the new frequency methodology from the flow chart through to the code.

42. C-1, page 187 – Provide documentation on all code and data relating to the changes that will be provided in G-1, Disclosure 5.

Verified: YES

Professional Team Comments:

Documentation reviewed:

HURLOSS Risk Analysis Suite – Primary Documents Binder – Volume O-A
HURLOSS Risk Analysis Suite – Vulnerability Standard – Form V-2
HURLOSS Risk Analysis Suite – Wind Field Model – Volume I-E

HURLOSS RISK ANALYSIS SUITE documentation reviewed:

Volume	Binder	Title
0		Primary Documents Binder

Reviewed the primary documents binder containing documentation on requirements, component design, implementation, verification, maintenance and revision, security, and user documentation.

I		Hurricane Simulation Model
	I-A	**LIFESIMi Model**
	I-B	**Hurricane Model:** Validation Results/ Statistical Tests/Verification/Testing Results
	I-D	**Hurricane Model:** Sensitivity and Uncertainty Studies
	I-E	**Windfield Model**
II		Individual Building Damage & Loss Model
	II-R	**Regression Test Results**
III		Portfolio Analysis Model
	III-E	**Historical Storm Validation**
		Demand Surge Model & References

*****Additional Verification Review Comments*****

Reviewed the changes documentation to Volume I-A, LIFESIM-I: Hurricane Model.

Reviewed the May 4, 2007, memorandum of the demand surge changes and ocean model verification, signed by Brian Grant, Senior Computer Scientist, Applied Research Associates, Inc.

C-2 Requirements

The modeler shall maintain a complete set of requirements for each software component as well as for each database or data file accessed by a component.

Audit

1. Provide confirmation that a complete set of requirements for each software component, as well as for each database or data file accessed by a component, has been maintained and documented.

Pre-Visit Letter

43. C-2, page 188 – Provide documentation on the new requirements indicated by the changes that will be provided in G-1, Disclosure 5.

Verified: YES

Professional Team Comments:

Reviewed the requirements specifications for application of the demand surge model, the over-water intensity model, the ocean mixing model, the Holland B over-land model, and the new treatment of the slab boundary layer model.

Documentation reviewed:

- Powerpoint documentation presented and printed by the modeler for the Professional Team
- HURLOSS Risk Analysis Suite – Demand Surge Model & References Binder
- A Hurricane Boundary Layer and Wind Field Model for Use in Engineering Applications by Peter J. Vickery, Dhiraj Wadhera, Mark D. Powell, and Yingzhao Chen, **Draft Paper**
- Appendix E, The Characteristics of the Holland Pressure Profile Parameter and the Radius to Maximum Winds for Gulf of Mexico and Atlantic Hurricanes as Determined From an Analysis of Flight Level Pressure Data and H*Wind Surface Wind Speed Data, **Draft Paper**
- Hurricane Intensity Model, **Draft Paper**

*****Additional Verification Review Comments*****

Reviewed the test requirements for the revised ocean model and demand surge model.

C-3 Model Architecture and Component Design

The modeler shall maintain and document (1) detailed control and data flow diagrams and interface specifications for each software component, and (2) schema definitions for each database and data file. Documentation shall be to the level of components that make significant contributions to the model output.

Audit

1. The following will be reviewed:
   a. Detailed control and data flow diagrams, completely and sufficiently labeled for each component,
   b. Interface specifications for all components in the model,
   c. Documentation for schemas for all data files, along with field type definitions,
   d. Each network diagram including components, sub-component diagrams, arcs, and labels.

2. A model component custodian, or designated proxy, should be available for the review of each component.

Pre-Visit Letter

44. C-3, page 189 – Describe how the items that will be provided in G-1, Disclosure 5 are reflected in changes to the model architecture and component design.

Verified: YES

Professional Team Comments:

Reviewed the overall flowchart for the major model components for the HURLOSS Risk Analysis Suite.

Reviewed deductibles and policy limits flowchart.

Reviewed flowchart for the new treatment of the slab boundary layer model.

*****Additional Verification Review Comments*****

Reviewed the modified ocean model flowchart, including flowchart additions for testing over a polar grid.

C-4 Implementation

A. The modeler shall maintain a complete procedure of coding guidelines consistent with accepted software engineering practices.

B. The modeler shall maintain a complete procedure used in creating, deriving, or procuring and verifying databases or data files accessed by components.

C. All components shall be traceable, through explicit component identification in the flow diagrams, down to the code level.

D. The modeler shall maintain a table of all software components affecting loss costs, with the following table columns: (1) Component name, (2) Number of lines of code, minus blank and comment lines; and (3) Number of explanatory comment lines.

E. Each component shall be sufficiently and consistently commented so that a software engineer unfamiliar with the code shall be able to comprehend the component logic at a reasonable level of abstraction.

Audit

1. The interfaces and the coupling assumptions will be reviewed.

2. Provide the documented coding guidelines and confirm that these guidelines are uniformly implemented.

3. The procedure used in creating, deriving, or procuring and verifying databases or data files accessed by components will be reviewed.

4. The traceability among components at all levels of representation will be reviewed.

5. The following information shall be available and will be reviewed for each component, either in a header comment block, source control database, or the documentation: component name, date created, dates modified and by whom, purpose or function of the component, and input and output parameter definitions.

6. The table of all software components as specified in C-4.D will be reviewed.

7. Model components and the method of mapping to elements in the computer program will be reviewed.

8. Comments within components will be examined for sufficiency, consistency, and explanatory quality.

Pre-Visit Letter

45. C-4, page 190 – Show the modified code implementation resulting from the changes that will be provided in G-1, Disclosure 5.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Verification depends upon reviewing the revised implementation related to verifying Standard M-2.

Reviewed implementation for the track model, before and after the two coding errors were corrected.

Reviewed implementation of demand surge.

Reviewed coding guidelines revised February 2007: FORTRAN Coding Standards for the HURLOSS Family of Hurricane Loss Simulation Models

Reviewed Code Statistics for the HURLOSS Suite of models:
Volume I – Hurricane Simulation Model
Volume II – Individual Building Damage & Loss Model
Volume III – Portfolio Analysis Model

Reviewed implementation of the ocean mixing model.

Reviewed implementation of the slab boundary layer model, including the logic associated with gust transition.

Reviewed implementation of retrieving the loss functions relating to vulnerability.

Reviewed LIFESIM 2007 Software Flowchart.

*****Additional Verification Review Comments*****

Reviewed the revised intensity Fortran calculation to limit the change in sea surface temperature due to mixing.

Reviewed the revised storm demand surge factor implementation due to the influence of neighboring states to Florida.

C-5 Verification

A. General

For each component, the modeler shall maintain procedures for verification, such as code inspections, reviews, calculation crosschecks, and walkthroughs, sufficient to demonstrate code correctness.

B. Component Testing

1. The modeler shall use testing software to assist in documenting and analyzing all components.

2. Unit tests shall be performed and documented for each component.

3. Regression tests shall be performed and documented on incremental builds.

4. Aggregation tests shall be performed and documented to ensure the correctness of all model components. Sufficient testing shall be performed to ensure that all components have been executed at least once.

C. Data Testing

1. The modeler shall use testing software to assist in documenting and analyzing all databases and data files accessed by components.

2. The modeler shall perform and document integrity, consistency, and correctness checks on all databases and data files accessed by the components.

Audit

1. The components will be reviewed for containment of sufficient logical assertions, exception-handling mechanisms, and flag-triggered output statements to test the correct values for key variables that might be subject to modification.

2. The testing software used by the modeler will be reviewed.

3. The component (unit, regression, aggregation) and data test processes and documentation will be reviewed.

Pre-Visit Letter

46. C-5, pages 191-192 – Describe the code and data testing and verification procedures resulting from the changes that will be provided in G-1, Disclosure 5.

Verified: ~~**NO**~~ **YES**

Professional Team Comments:

Verification depends on choice of over-water intensity model and the associated aggregate and integration testing of the revised implementation related to verifying Standard M-2.

Reviewed HURLOSS Software Testing Improvement Plan which was created on-site as a result of issues surfaced by the Professional Team during the audit.

Reviewed testing option in the hurricane track model implemented after discovery of error in code relating to Rmax.

Reviewed tests for the Holland B filling procedure created through cross-checking using a dual implementation (Fortran and Excel) approach.

Reviewed tests for Rmax weights regarding the blending of the Gulf and Atlantic regions.

Reviewed test relating to the limits of storm intensity.

Reviewed a dual implementation test relating to the shear and tropopause temperature.

Reviewed a test for correct sampling relating to the Holland B parameter.

Reviewed a dual implementation test for the hurricane boundary layer code.

Reviewed a two-sigma limit test for Rmax.

*****Additional Verification Review Comments*****

Verified that the modeler located and corrected errors in the code while performing the unit and integration testing.

Reviewed unit testing of subroutines for sea surface temperatures, loop current verifications, gradient balance wind speed validations, mixed layer validation, validation of the upper and lower limits for intensity

Reviewed regression tests for integration and mixed layer depth estimation validations.

Reviewed landfall pressure testing and verification over coast regions for Florida, including:

- Dataset QA verification for sea surface temperature, bathymetry, and mixed layer depths
- Variable re-initialization
- Latitude/longitude to x/y correspondence
- Tropopause and wind shear value data import, including the interpolation procedure.

Reviewed geographically overlaid plots used in the ocean model verification procedure.

Reviewed the verification cross-check approach using dual Fortran/Excel calculations.

Mapped each test back to flowchart in C-3.

C-6 Model Maintenance and Revision

A. The modeler shall maintain a clearly written policy for model revision, including verification and validation of revised components, databases, and data files.

B. A revision to any portion of the model that results in a change in any Florida residential hurricane loss cost shall result in a new model version number.

C. The modeler shall use tracking software to identify all errors, as well as modifications to code, data, and documentation.

Audit

1. All policies and procedures used to maintain the code, data, and documentation will be reviewed. For each component in the system decomposition, the modeler should provide the installation date under configuration control, the current version number, and the date of the most recent change(s).

2. The policy for model revision will be reviewed.

3. The tracking software will be reviewed.

Pre-Visit Letter

47. C-6, page 193 – Describe how the changes that will be provided in G-1, Disclosure 5 are reflected by the requirements for this Standard.

Verified: YES

Professional Team Comments:

Reviewed ARA's software revision policy.

Reviewed the maintenance and revision documentation that covers changes between incremental versions of the models.

*****Additional Verification Review Comments*****

Reviewed the model revision change to HurLoss Version 4.0.c.

C-7 Security

The modeler shall have implemented and fully documented security procedures for: (1) secure access to individual computers where the software components or data can be created or modified, (2) secure operation of the model by clients, if relevant, to ensure that the correct software operation cannot be compromised, (3) anti-virus software installation for all machines where all components and data are being accessed, and (4) secure access to documentation, software, and data in the event of a catastrophe.

Audit

1. The written policy for all procedures and methods used to ensure the security of code, data, and documentation will be reviewed. Specify all security procedures.

2. Documented security procedures for access, client model use, anti-virus software installation, and off-site procedures in the event of a catastrophe will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed the security policies and procedures for modeler's organization and the HURLOSS suite of programs.