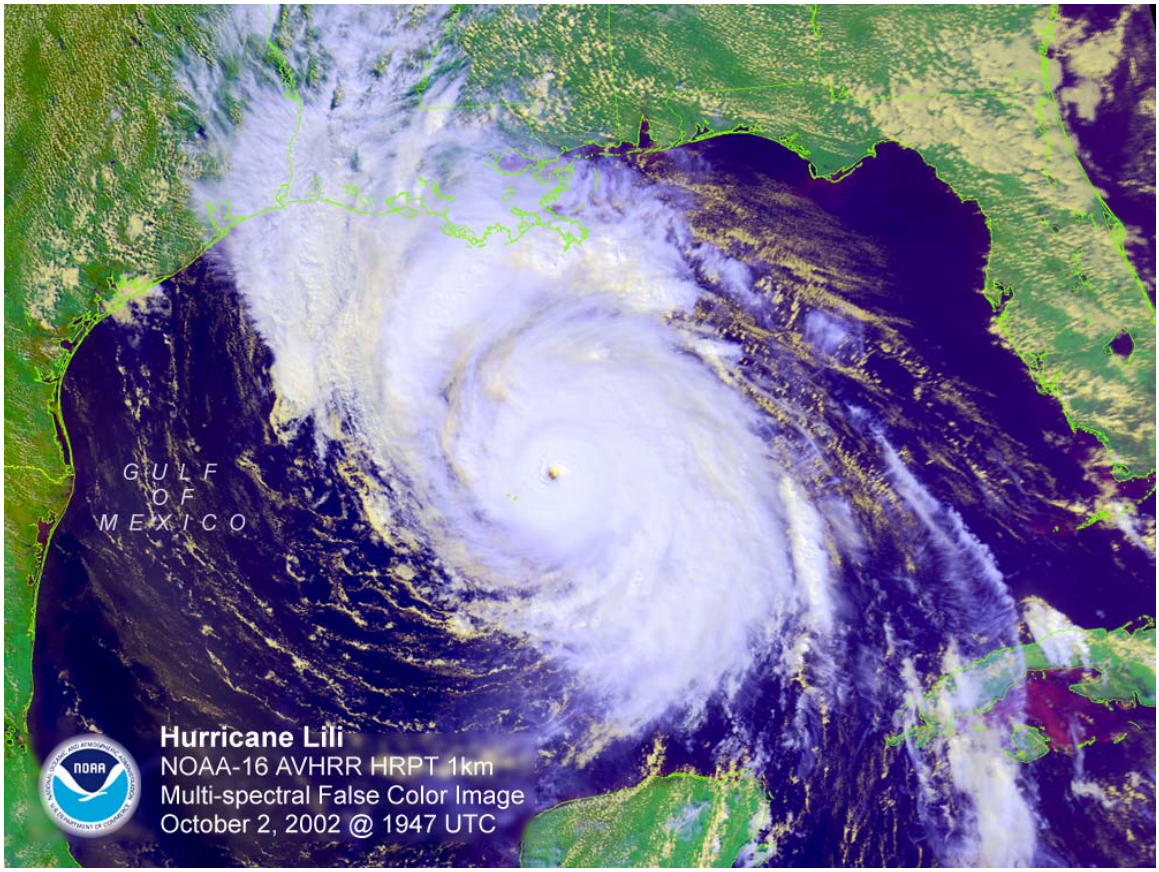
Florida Commission on Hurricane Loss Projection Methodology



Professional Team Audit Report
2002 Standards

Applied Research Associates, Inc.

On-Site Review
May 1 & 2, 2003

Additional Verification Review
May 20, 2003

On May 1 & 2, 2003, the Professional Team visited on-site at Applied Research Associates, Inc. (ARA) in Raleigh, North Carolina. The following people participated in the review.

ARA

Chris Driscoll, Staff Scientist
Marshall B. Hardy, B.S., M.S., Staff Scientist
Srinivas R. Kadasani (Reddy), M.S., Software Developer
Francis M. Lavelle, Ph.D., P.E., Principal Engineer
Jason J-X. Lin, Ph.D., Senior Scientist
Rick Pearson, Software Developer
Peter F. Skerlj, M.E.Sc., B.E.Sc., P.E., Scientist
Lawrence A. Twisdale, Ph.D., P.E., Principal
Peter J. Vickery, Ph.D., P.E., Principal Scientist
Michael A. Young, M.E.Sc., P.E., Scientist

Professional Team

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

The review began with introductions and an overview of the audit process. ARA gave a presentation outlining the model changes since the February 2002 submission and the effect of those changes on loss costs:

- Building Stock
- Output Ranges for Mobile Homes
- Software reorganization including an analysis engine re-written for use in licensable product.

ARA gave a summary of "no changes" in the model components as outlined below:

- HURDAT database updated and analyzed. Existing model passed all statistical tests (Chi-squared and Kolmogorov-Smirnoff). No revisions to the hurricane model were required.
- Vulnerability models had no changes to load, resistance, or damage models
- Loss models had no changes to ground-up or net loss models
- ZIP Code database is updated every other year with the next update on or before October 2003
- Terrain database unchanged with no new data obtained and no changes to ZIP Codes.

The audit then moved into a thorough discussion of each of the items listed in the pre-visit letter included on pages 4-10 of this report.

We discussed the change in wind speed calculations for Hurricane Andrew and the impact it had on the HurLoss model.

We discussed ARA's reorganization of the HurLoss analysis engine and rewritten code in preparation for a licensable version. Reviewed validation tests comparing all 2002 FCHLPM results generated with the new analysis engine to the 2001 results and verified the new module was correctly implemented.

There were no changes made to the vulnerability functions and no significant change in the relationships among coverages, deductibles, mobile homes, and other construction types.

Changes in mobile home deductible relativities were reviewed and found to be reasonable and due to previous error.

Discussed and reviewed corrections to be made in the submission that will be provided to the Commission prior to the May 29 & 30, 2003 meetings.

- Page 43, reference corrected in response to Module 1, Section II, B.2
- Page 66, correction in HURDAT time period
- Page 70, revised Table 7, Historical versus Modeled Hurricane Frequencies
- Page 71, revised Table 8, Probability of Hurricanes by Year
- Page 90, equation for calculating return time
- Output Ranges adjusted through 2001
- Form D, Loss Costs adjusted through 2001
- Form E, Probable Maximum Loss adjusted through 2001
- Page 114, correction made in statement regarding overland values

Verification of Standard 5.2.3 could not be made while on-site owing to the fact that HurLoss Version 3.1 is based on the storm set through 2000, not 2001 as mandated in the standard. The Professional Team expects that verification can be made subject to ARA resubmitting the Output Ranges and other relevant forms reflecting the updated landfall frequency. ARA has indicated the revisions will be provided for verification prior to the May 29 & 30, 2003 Commission meetings.

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Additional Verification Review – May 20, 2003

Applied Research Associates, Inc. (ARA) submitted corrections to the ARA model submission under the 2002 standards on May 13, 2003. The Professional Team completed an additional verification review on May 20, 2003 via teleconference. **All Standards are now verified.**

The following people participated in the additional verification review:

ARA

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

Professional Team

Mark Johnson, Ph.D., Statistician, Team Leader
Marty Simons, ACAS, Actuary
Anne Bert, Staff
Donna Sirmons, Staff

Deficiencies from April 1, 2003 Meeting

1. PDF file of submission text document does not include standards year in file name – provide a corrected pdf file.

   ARA Response:

   The PDF file of ARA main submission document has been renamed to include the standards year. The file is named "ARA_2002FCHLPM_Report.pdf" on the enclosed CDs.

   Verified: Yes

2. Form F – provide an explanation for submitting the following identical Wind Speed Output files:
   ARAOutput02FormF1UAVT.dat and ARAOutput02FormF1UAQuantile1.dat
   ARAOutput02FormF3UAVT.dat and ARAOutput02FormF3UAQuantile1.dat
   ARAOutput02FormF5UAVT.dat and ARAOutput02FormF5UAQuantile1.dat
   If a quantile variable was used, provide the input values for the quantile variable and indicate what the variable represents.

   ARA Response:

   Our original submission for Form F had an error in the routine that computed the values of Quantile1, which represents the Holland *B* parameter in the ARA hurricane model. A complete set of revised files and the specific values of Quantile1 are provided in the folder "ARA_2002FormF_Revised_ April_10_2003" on the enclosed CDs.

   Verified: Yes

   Professional Team Comments:

   Discussed and reviewed in detail the corrections made to the data supplied in the Form F output files.

3. Form F – provide an explanation for the N-S coordinate increments.

   ARA Response:

   The approximate N-S coordinate increments were output incorrectly to the original Form F output files and have been corrected in the revised files. This was simply a typographical error in the code that writes the output file, since the analysis uses the actual latitude and longitude coordinates from the "FormFInput02.xls" input file provided by the Commission.

   Verified: Yes

Professional Team Comments:

Discussed and reviewed in detail the corrections made to the Form F output file.

4. Module 3, Section IV, item 11 (page 81 in your submission) – provide an explanation for "Company Supplied Data."

ARA Response:

On page 81 of our submission, the complete response for "Company Supplied Data" should read: "Coverage A, B, C, D exposure weights by Zip Code along with definitions of types of business, lines of business, construction types, deductible groups, and file layout.

Verified: Yes

Professional Team Comments:

Reviewed correction made to Figure 24, HurLoss Study Disclosure Summary Form for the Output Ranges analysis.

Applied Research Associates, Inc. – Pre-Visit Letter

The main purpose of the on-site review performed by the Professional Team (Pro Team) of the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM) is to verify that the written and electronic submission conforms to the model producing the output ranges included in the submission to the FCHLPM. It is particularly important to review in detail all information relating to the model, including any information that may be considered proprietary. It is the responsibility of the modeler to provide all information necessary for a complete review of the model. For each reference within the submission that cites "material to be shown to the professional team," it is important that the material is presented to the Pro Team during the on-site review. Material that the modeler intends to present to the FCHLPM should be presented to the Pro Team during the on-site review.

In the course of preparing for the on-site review, the Pro Team has identified some specific areas that it intends to cover while on-site. These items are provided below to assist the modeler in preparing for the on-site review. Some of this material may have been shown or available on a previous visit by the Pro Team.

The goal of the Pro Team is to provide the FCHLPM with a clear and thorough report of the model, subject to non-disclosure conditions. All modifications, adjustments, assumptions, or other criteria that were included in producing the information requested by the FCHLPM in the submission should be disclosed and will be reviewed.

It is important that all material prepared for presentation during the on-site review be presented using a medium that is readable by all members of the Pro Team. Access to critical articles or materials referenced in the submission or during the on-site review should be available on-site for the Pro Team. The Pro Team should be provided access to a phone line that can provide internet access through one of the Pro Team member computers for reference work that may be required while on-site.

For your information, the Pro Team will arrive in business casual attire.

1. General

1.1 Pages 1 & 2, Standard 5.1.2 – Explain whether any employees are no longer involved in the model due to professional conduct.
1.2 Page 2, Standard 5.1.3 – Describe how Model Revision Policy was used for revisions from Version 3.0 to Version 3.1.

General items numbered 1.3 through 1.12 below refer to the output ranges.

1.3 Explain any differences in minimum and maximum loss costs for any county where the changes from last year's submission exceed 5%.
1.4 Provide a brief overview of any differences in minimum and maximum loss costs for any county regardless of the magnitude of the difference.
1.5 Explain any significant differences in the relativities between building and contents loss costs from those derived from last year's submission.

1.6 Explain any significant differences in the relativities between mobile homes and other construction types loss costs from those derived from last year's submission.
1.7 Explain any significant differences in the relativities among deductibles from those derived from last year's submission.
1.8 Explain any differences in the relativities between building and additional living expense loss costs from those derived from last year's submission.
1.9 Explain any differences in the relativities between building and appurtenant structure loss costs from those derived from last year's submission.
1.10 Explain the relationship between the loss cost for a $2,500 deductible Personal Residential/Renters/Frame and a 5% deductible Personal Residential/Renters/ Frame loss cost.
1.11 Provide any internal comparisons performed since the prior submission regarding the following:
    a. Model output vs. insurance company data
    b. Model output prior to and after zip code updates
    c. Changes in loss costs brought about by model revisions
    d. Changes in loss costs brought about by other changes.
1.12 Explain the relationship among $0 Deductible Structure, $0 Deductible Contents, $0 Deductible Appurtenant Structure, and $0 Deductible Additional Living Expense.

2. Meteorology

2.1 Page 7, Standard 5.2.3 – Present and describe in detail the input file used in generation of the stochastic storm set.
2.2 Page 7, Standard 5.2.4 – Be prepared to make a detailed presentation of the use of Holland "B" parameter including distributions of "B", especially as it pertains to Form F.
2.3 Page 10, Standard 5.2.6 – Demonstrate the quality of fit of simulated storms to historical records for appropriate coastal segments in Alabama, Georgia, and Mississippi.
2.4 Page 13, Standard 5.2.10 – Present contour plots of wind fields (2-dimensional, instantaneous) as developed for Form F.
2.5 Page 43, Module 1, Section II, B #2 – Explain response to how the asymmetric nature of hurricanes is considered.
2.6 Page 70, Table 7 – Provide an explanation of results.
2.7 Page 71, Table 8 – Provide an explanation of results.
2.8 Page 91, Table 14 – Provide an explanation of the return period calculations.
2.9 Discuss impacts of Hurricane Andrew reclassification on your model.

3. Vulnerability

3.1 Page 14, Standard 5.3.2 – Provide several examples of vulnerability function curves for each type required. Typical examples of regional variation shall be shown.

3.2 Page 15, Standard 5.3.3 – Show, in computer code, where peak gust wind speed of 50 mph is used as the starting point of damage being considered.

3.3 Page 15, Standard 5.3.4 – Explain the assumptions and their base as related to construction types and construction characteristics. Provide range of variation in magnitude of losses and the direction (either positive or negative).

3.4 Page 15, Standard 5.3.4 – Provide a basic overview of the effect of the new Florida Building Code. What is the percentage of building stock based on new code and when is this effect going to be considered? Discuss how the effect varies with wind speed.

3.5 Page 16, Standard 5.3.5 – Provide details of the methods used to determine the reduction in losses due to mitigation measures. Examples of calculations of individual measures on building stock shall be available.

3.6 Page 16, Standard 5.3.5 – Provide a detailed explanation of the vulnerability model as cited in the first paragraph of the response to 5.3.5.

3.7 Page 16, Standard 5.3.5 – Explain the differences in percent reductions for Owners verses Renters categories in Table 1.

3.8 Page 16, Standard 5.3.5, Table 1 – The high and low percentage numbers for Renters/Frame in “Roof Strength” and “Roof Covering Performance” do not appear correct. The low percentages are, at times, higher than the high percentages. Provide an explanation.

3.9 Page 16, Standard 5.3.5 – Mitigation measures such as “Roof Shape,” “Opening Protection for non-glazed openings,” and “Gable end bracing for roof shapes other than hip roof” were not specifically mentioned but should be considered. Some examples of the total effect of the use of multiple mitigation measures are required.

3.10 Page 17, Standard 5.3.6 – Verify ALE losses are considered for instances where no building or content losses occur.

3.11 Page 17, Standard 5.3.6 – Are abnormal working conditions considered in determining the time factor to repair/reconstruct the property?

3.12 Page 38, Module 1, Section I, A #7 – Discuss the number of categories or building classes considered in the loss projection studies and show examples of various studies. (Standard 5.3.1)

3.13 Page 43, Module 1, Section II, A #5 – Has any new insurance data been obtained? Have any new field investigations been made? Has any new building stock been added? Has any new data on mobile homes been obtained? (Standard 5.3.1)

3.14 Page 73, Module 3, Section III – Provide various instances where quality of construction has been considered and show comparisons of modeled and observed physical states. (Standard 5.3.1)

3.15 Page 74, Module 3, Section III, #5 – Provide examples of relative magnitude of the effect of wind borne debris in comparison to damage due to wind loads. (Standard 5.3.1)
3.16 Page 74, Module 3, Section III, #6 – Describe the basis for determining the proportion of each construction type in the composite for "unknown" vulnerability curve. (Standard 5.3.1)
3.17 Page 75, Module 3, Section IV, #3 – Provide examples of appurtenant structures losses. The data upon which they are based shall be available. (Standard 5.3.1)
3.18 Page 76, Module 3, Section IV, #4 – Provide results of validation tests.
3.19 Page 76, Module 3, Section IV, #5 – Is there a threshold of damage percent at which damage to contents is assumed to occur? (Standard 5.3.1) Provide results of validation tests.
3.20 Page 76, Module 3, Section IV, #6 – Verify that direct and indirect losses are considered. Is there a threshold of damage percent at which ALE expenses are assumed to occur? (Standard 5.3.1) Provide results of validation tests.
3.21 Copies of any papers, reports, and studies used in the development of the vulnerability functions shall be available for review. Copies of all public record documents used may be requested for review.

4. Actuarial

4.1 Page 17, Standard 5.4.1 – Present detailed examples of the adjustments referred to in the response to this standard. Be prepared to produce sensitivity analyses referred to in the final sentence of that response.
4.2 Page 17, Standard 5.4.1 – Describe in detail how inherent hazard mitigation and building code criteria are considered when utilizing insurance company data for creation or validation of model components. Explain how this process is expected to change as mitigation criteria apply to greater percentages of properties in Florida.
4.3 Page 21, Standard 5.4.7 – Provide details of the methods used to reflect deductibles and co-insurance as cited in your response to this standard.
4.4 Page 22, Standard 5.4.8 – Provide the most recent insurance company experience available to your company. Provide any insurer vs. model comparisons performed since the prior submission.
4.5 Page 23, Standard 5.4.10 – Provide the details of actual to modeled zip-code level losses referred to in your response to this standard.
4.6 Page 25, Standard 5.4.12 – Provide a presentation that describes, in detail, the errors referred to in your response to this standard. Include, in the presentation, how the errors were discovered and corrected, and how the current submission has been reviewed to ensure that similar errors have not been included in the current submission. Provide ARA's analysis of how the errors have affected any users of the model output as well as how many users may have included the erroneous data in producing Florida loss costs.
4.7 Page 25, Standard 5.4.12 – Describe the "reorganization of the software" referred to in the final sentence of your response to this standard.

4.8 Page 51, Module 1, Section II, C #4 – Provide numbers corresponding to tick marks on vertical axis in Figure 16.

4.9 Page 62, Module 2, 5B – Provide details of the consulting firm referenced under item 3, Actuarial. Provide the most recent relevant correspondence and analysis to and from that consulting firm.

4.10 Page 79, Module 3, Section IV, #10 – Provide copies and describe the HurLoss User Manual as cited.

4.11 Pages 83 & 84, Module 3, Section V, #3 – Describe black colored areas on maps in Figures 25, 26, and 27.

4.12 Page 87, Module 3, Section V, #7 – Provide maps for each construction type.

4.13 Page 104, Form E, Part B – Provide an explanation of results.

4.14 In all cases where insurance company inputs are used to derive or to verify model output, be prepared to provide the following:

a. Identify insurance company
b. Provide initial insurance company submission for review
c. Provide correspondence between model and insurance company relative to data amendments
d. Provide example of model adjustments for invalid zip code information
e. Provide methods used to remove demand surge from Hurricane Andrew data, if such data is used for modeling or verification.

4.15 Be prepared to explain differences in average annual loss provided in Standard 5.4.11 between this submission and the previous submission.

4.16 Be prepared to describe the impact upon loss costs of any model revisions not specifically referenced above.

4.17 Describe any differences between this submission and the prior submission relative to results displayed on Forms A, B, and C.

4.18 Table 1 below summarizes the percentage changes in maximum wind speed for each of the coverage categories as reported in Form B (2002 relative to 2001) by city. Table 2 provides the same information by hurricane category. The average wind speed changed very little from 2001; however, each loss (by city and category) shows a double digit increase. Losses for Coverage D for categories 1 and 2 are typically small and therefore subject to big percentage changes based on small changes in loss. However, the other categories are not as subject to such wide percentage fluctuations. Please explain how such small changes in maximum wind speed have resulted in such large percentage changes in loss.

Table 1. Percentage Changes in Form B by City: 2002 Relative to 2001

City	Max WS	Total Loss	Cov A Loss	Cov C Loss	Cov D Loss
Ft. Myers	-0.1	23.9	23.2	26.8	30.9
Ft. Pierce	0.1	24.1	24.7	20.0	25.2
Jacksonville	-0.4	10.5	10.2	12.7	11.7
Miami	-0.3	14.9	14.6	14.8	14.3
Panama City	0.3	11.0	10.6	11.0	1.9
Tampa	-0.3	11.2	11.2	8.3	4.8
Average	-0.1	16.0	15.8	15.6	14.8

Table 2. Percentage Changes in Form B by Category: 2002 Relative to 2001

Category	Max WS	Total Loss	Cov A Loss	Cov C Loss	Cov D Loss
1	0.2	13.5	13.5	10.7	7.8
2	0.3	15.3	15.3	15.0	14.2
3	-0.5	12.1	12.3	10.5	10.3
4	-1.0	22.1	21.5	23.7	23.9
5	0.5	16.8	16.3	18.1	17.9
Average	-0.1	16.0	15.8	15.6	14.8

5. Computer

5.1 During the Computer Software audit, the Pro Team will expect all elements of the code base (i.e., actuarial, engineering, scientific, user interface, database) to be addressed. Please ensure that all personnel involved with designing, writing, and maintaining of this software are available.

5.2 During the overall audit process, the Pro Team may request “code spot checks” to assist in verifying a standard that is related to such code, either in terms of its structure (i.e., syntax) or its execution. During a spot check, it will be necessary to convene the coder or software engineer responsible for this aspect.

5.3 Page 26, Standard 5.5.1 – The Pro Team will verify that “All computer software (i.e., user interface, scientific, engineering, actuarial) relevant to the modeler's submission is consistently documented.” It is expected that any and all software that is used in the model will be so documented.

5.4 Pages 26 & 27, Standard 5.5.4 – With reference to the modeler's response to 5.5.3, the Pro Team will audit the hierarchy of sub-components within the detailed control and data flow diagrams, and expect forward references to the source code as well as the modeler's stated backward references within the source code back to the design specifications.

5.5 Page 27, Standard 5.5.5 – The Pro Team will audit documentation associated with each response (a) through (f).

6. Statistical

6.1 Page 29, Standard 5.6.2 – Provide results of all statistical tests as cited in the response.

6.2 Page 30, Standard 5.6.3 – Provide estimates of uncertainty as cited in the response.

6.3 Page 30, Standard 5.6.4 – Provide estimates of sensitivity as cited in the response.

6.4 Page 30, Standard 5.6.5 – Provide estimates of uncertainty as cited in the response.

6.5 Page 114, Module 3, Section VII, Form F – Provide Pro Team with lost cost analysis.

6.6 In addition to the FCHLPM required analyses, be prepared to present any internal sensitivity and/or uncertainty analyses performed on your model by internal staff members or by outside consultants.

5.1 General Standards – *Mark Johnson, Leader*

5.1.1 Scope of the Computer Model and Its Implementation

The computer model shall project loss costs for personal lines residential property from hurricane events, excluding flood and storm surge, except as flood and storm surge apply to Additional Living Expense (ALE). References to the model throughout the Standards shall include its implementation.

If the modeler uses historical data that include losses from flood and storm surge, then the modeler shall disclose the techniques employed to exclude such losses, and those techniques shall be based on accepted scientific methods.

If the modeler uses engineering or other data that include losses from flood and storm surge, then the modeler shall disclose the techniques employed to exclude such losses, and those techniques shall be based on justifiable methods.

Reference: Module 1, Section I, C.1.d (storm surge and flood damage to the infrastructure) (page 41)

Audit: This standard concerns the scope of the computer model and its implementation that is expected to project loss costs for personal residential property due to hurricane events. ALE is mentioned explicitly since flood and storm surge can in fact impact ALE. The main intent of the audit is to determine the capabilities of the model and to assess its implementation for purposes of Florida estimated loss costs.

Is there a flood or storm surge component to the model? Is it in the "off" position for the production of Florida output ranges as well as other information supplied in the standards and modules (e.g., 5.4.11 and Form B)?

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

Professional Team Comments:

Verified no change in the model with respect to the appropriate exclusion of flood and storm surge. Discussed ARA's methodology used to predict damage and losses given a wind speed, and examined the corresponding computer code for verification.

5.1.2 Qualifications of Modeler Personnel and Independent Experts

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

The model or any modifications to an accepted model shall be reviewed by modeler personnel or independent experts in the following professional disciplines, if relevant: structural/wind engineering (licensed Professional Engineer (PE)), statistics (advanced degree), actuarial science (Associate or Fellow of Casualty Actuarial Society or Member of the American Academy of Actuaries), meteorology (advanced degree), and computer science/engineering (advanced degree). These individuals shall abide by the standards of professional conduct adopted by their profession.

Reference: *Module 2 #2 (professional credentials),* (page 55)
#3 (multi-discipline team), (page 60)
#5 (independent expert review) (page 61)

Audit: The Professional Team would like to review the professional vitae of modeler personnel and independent experts responsible for the current model and information on their predecessors, if different than current personnel. For the actuarial personnel, professional status in the appropriate actuarial organization or organizations is usually apparent on the vitae. For other disciplines, the vitae ought to be sufficient to make a determination for this standard, with further commentary possible during the on-site interactions. Background information on individuals providing testimonial letters in the submission must be provided.

Do you have any new personnel (since last year) working on the model? If so, resumés should be available. Were any personnel dismissed for violations of the professional code of conduct? If so, what influence would it have on the model under review?

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

Professional Team Comments:

Discussed the change in Peter Vickery's affiliation with ARA.

Examined the actuarial review of the HurLoss model performed by Douglas J. Collins, FCAS, MAAA of Tillinghast-Towers Perrin. Also reviewed Collins' resume.

ARA disclosed the peer reviewers for published journal articles which described the windfield and climatological modeling.

5.1.3 Model Revision Policy

The modeler shall have developed and implemented a clearly written policy for model revision with respect to methodologies and data. The modeler shall clearly identify the model version under review. Any revision to any portion of the model that results in a change in any Florida residential hurricane loss cost must be accompanied by a new model version number.

Reference: *Module 1, Section I, A.1 (model version number),* (page 32)
A.9 (model revisions) (page 39)

Audit: The Professional Team would like to see the process for model revisions (both methodology and data, especially updates from year-to-year with new storms). What safeguards or controls are in place? How does the annual update take place? How is it identified? How are each of the changes mentioned in 5.4.12 consistent with this policy? Citing specific examples gives further strength to the Professional Team assessment (for 1996 storms, we did the following ... and now the updated storm set is in place....). The Professional Team computer expert could then review the current set up.

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

Professional Team Comments:

Reviewed ARA's policy on revisions made to the model:

- Applied Research Associates, Inc. – Policy of HURLOSS Model Revision

Discussed how the policy was used with the changes to the building stock, and the procedures followed when an error is identified and corrected.

5.1.4 Independence of Model Components

The meteorology, vulnerability, and actuarial components of the model shall each be demonstrated to be theoretically sound without compensation for potential bias from the other two components. Relationships within the model among the meteorological, vulnerability, and actuarial components shall be demonstrated to be reasonable.

Reference: *Module 1, Section II, B.11 (independent functions or variables),* (page 46)
B.13 (model sensitivity), (page 47)
B.14 (sensitivity in output results), (page 47)
B.15 (SA & UA performed on model) (page 47)
Standard 5.5.3 (Model Architecture and Component Design) (page 26)
Standard 5.5.5 (Verification) (page 27)

Audit: This standard will be considered after the review of meteorology, vulnerability, and actuarial sections. The modeler needs to demonstrate to the Professional Team that their choices of model components adequately portray hurricane phenomena and effects (damage and loss costs). This can be accomplished indirectly via agreement with historical loss costs and attendant tests but also requires an assessment of the theoretical soundness of each component. A model would not be found to meet this standard, if an artificial calibration adjustment had been made to improve the match of historical and model results for a specific storm. What impact do changes in the model from the previous year potentially impact this standard? How can you demonstrate that in fact these changes do not impinge on this standard?

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

Professional Team Comments:

The independence of the meteorology, vulnerability, and actuarial components of the model were verified throughout the course of the review.

5.1.5 Risk Location

Zip codes used in the model shall be updated at least every 24 months using information originating from the United States Postal Service. The United States Postal Service issue date of the updated information shall be disclosed.

Zip code centroids, when used in the model, shall be based on population data and shall be visually demonstrated to be reasonable.

Zip code information purchased by the modeler shall be verified by the modeler for accuracy and appropriateness.

Reference: *Module 1, Section II, A.2 (primary databases)* (page 42)
Module 3, Section VI, #1 (handling of invalid zip codes) (page 75)
Module 3, Section VII, Form A (Zip Code Data Base) (page 99)

Audit: Aside from disclosure of updates, the Professional Team is likely to ask to view the location of centroids for specific zip codes. Interest in specific zip codes arises in the context of logical relationship to risk or in basic assessments of loss costs. What is the effective (official United States Post Office) date corresponding to the database of zip codes? What is the date at which the zip codes and their centroids were introduced into the model?

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

Professional Team Comments:

Reviewed maps that showed the ZIP Code boundaries and the associated population weighted centroids.

5.1.6 Identification of Units of Measure and Conversion Factors

All units of measure for model inputs and outputs shall be clearly identified. All conversion factors used by the model shall be disclosed.

Reference: Module 1, Section I, C.2 (input variables) (page 41)

Audit: Are there any units of measure omitted or incorrectly stated?

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

Professional Team Comments:

All visual presentations were clearly labeled with the appropriate units of measure, and verified throughout the review.

5.1.7 Visual Presentation of Data

Visualizations shall be accompanied by legends and labels for all elements. Individual elements shall be clearly distinguishable, whether presented in original or copy form.

a. For data indexed by latitude and longitude, by county or by zip code, a color contour map and a continuous tone map with superimposed county and zip code boundaries shall be produced.

b. Florida Map Colors: Maps will use two colors, blue and red, along with shades of blue and red, with dark blue and dark red designating the lowest and highest quantities, respectively. The color legend and associated map shall be comprised of an appropriate number of intervals to provide readability.

Reference: Module 3, Section I, #10 (maps of maximum winds at zip code level) (page 67)
Module 3, Section V, #3 (maps of loss costs by zip code), (page 83)
#7 (maps of output ranges % change by county) (page 87)

Audit**:** The modeler will have key maps, charts, and graphs pre-prepared and will have the ability to quickly prepare such maps during an on-site review. All visualizations should be presented in a manner that enables simultaneous viewing by the entire Professional Team.

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

Professional Team Comments:

Reviewed color contour maps, graphs, charts, and plots. All visualizations shown to the Professional Team were verified.

5.2 Meteorological Standards – *Tom Schroeder, Leader*

5.2.1 Units of Measure for Model Output

All model outputs of length, wind speed, and pressure shall be in units of statute miles, statute miles per hour, and millibars, respectively.

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

Professional Team Comments:

Correct units of measure were verified throughout the review.

5.2.2 Damage Function Wind Inputs

Wind inputs to the damage function shall be in units consistent with currently used wind measurement units and/or shall be converted using standard meteorological/engineering conversion factors which are supported by literature and/or documented measurements available to the Commission.

Reference: Module 3, Section II, #2 (wind speed conversion) (page 72)
Standard 5.1.6 (Identification of Units of Measure and Conversion Factors) (page 6)

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

Professional Team Comments:

Verified there was no change to the model from the previous year.

5.2.3 Official Hurricane Set or Suitable Approved Alternatives

Modelers shall include in their base storm set all hurricanes, including by-passing hurricanes, which produce hurricane force winds in Florida. The storm set, derived from the Tropical Prediction Center/National Hurricane Center (TPC/NHC) document *Tropical Cyclones of the North Atlantic Ocean, 1871-1998,* updated through the 2001 hurricane season and/or the HURDAT (HURricane DATa) data set, is found in the *Report of Activities as of November 1, 2002* under Section VII, Compliance With Standards and Related Information, #4 (Base Storm Set). All proposed alternatives to the characteristics of specific storms in the storm set shall be subject to the approval of the Commission.

Reference: *Module 1, Section II, A.1 (deviation from official hurricane set),* (page 41)
A.2 (primary databases), (page 42)
B.7 (parameters for hurricane frequency), (page 45)
B.8 (stochastic hurricane generation) (page 45)
Module 3, Section I (Hurricane Set) (page 63)

Audit: The input file used in generation of the stochastic storm set is useful evidence of compliance with this standard. The modeler should be prepared to show the storm set used.

Proprietary: **Yes**
Verified: ~~**Conditional Verification**~~ **Yes**

Professional Team Comments:

Initial Review Comments

Verification of 5.2.3 cannot be made at this time owing to the fact that HurLoss Version 3.1 is based on the storm set through 2000, not 2001 as mandated in the standard. The Professional Team expects that verification can be made subject to ARA resubmitting the Output Ranges and other relevant forms reflecting the updated landfall frequency. ARA has indicated the revisions will be provided for verification prior to the May 29 & 30, 2003 Commission meetings.

Additional Verification Review Comments

Reviewed and discussed the revised Output Ranges and other relevant forms adjusted through 2001. Verified ARA has now updated the stochastic storm set for 2001.

5.2.4 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, and tracks shall be based on information documented by scientific literature or modeler information accepted by the Commission.

Reference: *Module 1, Section II, B.1 (wind speeds used for loss estimation),* (page 43)
B.2 (asymmetric nature of hurricanes), (page 43)
B.3 (filling rate function), (page 43)
B.4 (land friction), (page 43)
B.5 (characteristics used for wind speed estimation), (page 44)
B.6 (dependent wind speed variables), (page 44)
B.7 (parameters for hurricane frequency), (page 45)
B.8 (stochastic hurricane generation) (page 45)
Module 3, Section I (Hurricane Set) (page 63)
Module 3, Section VII, Form F (Hypothetical Events for SA & UA) (page 105)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)

Audit: Prepare graphical depictions (e.g., histograms overlaid with fitted density functions) of storm characteristics as used in the model. The modeler should be prepared to describe the data set basis for the fitted distributions, to describe assessments of correlated characteristics (e.g., central pressure and radius of maximum winds), to describe the fitting methods used and any smoothing techniques employed, and to defend choices of parametric distributions used. The modeler should be prepared to present information on the spatial distribution of hurricane force winds (e.g., the radius of hurricane force winds) associated with both modeled and historical events. Throughout the review of this standard, an assessment of the goodness-of-fit of parametric distributions to historical should be provided, consistent with 5.6.2.

With respect to storm tracks, the stochastic storm set or its equivalent should depict realistic storm tracks. This can be demonstrated through Figure 3 in Module 3, Section 1, for example. Consistency between historical and modeled tracks means: (1) distributions of storm tracks should accurately depict actual storm tracks in Florida; and (2) comparisons are to be based on methods documented in accepted scientific literature or proposed by the modeler and accepted by the Commission.

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

Professional Team Comments:

ARA discussed in detail the effect of Holland B on radial wind speeds in the HurLoss model and provided an explanation of how the Holland B parameter is calculated and validated.

Reviewed probability distributions of Holland B as used in the HurLoss model and as used in completion of Form F.

Verified there was no change in the model from the previous year.

Documentation reviewed:

- The Hurricane Research Division Archive of Post-Season Processed Hurricane Data – Fitted Pressure Distributions (Bi-Modal Fits)
- The Hurricane Research Division Archive of Post-Season Processed Hurricane Data – Holland's Parameter B from Flight Level Wind Speed Data (Gradient Balance Model)
- I-E Wind Field Model (HURWND)
- Vol. I-A LIFESIM-I: Hurricane Model

5.2.5 Landfall Intensity

Models shall use maximum one-minute sustained 10-meter wind speed when defining hurricane landfall intensity. This applies both to the base storm set adopted in 5.2.3 used to develop landfall strike probabilities as a function of coastal location and to the modeled winds in each hurricane which causes damage. The associated maximum one-minute sustained 10-meter wind speed shall be within the range of wind speeds (in statute miles per hour) categorized by the Saffir-Simpson scale.

Saffir-Simpson Hurricane Scale (for displayed parameters):
A scale from 1 to 5 that measures hurricane intensity.

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

Reference: *Module 3, Section I, #1 (definition of event),* (page 63)
#2 (upper limit of wind speeds produced), (page 63)
#3 (multiple landfalls), (page 63)
#11 (frequency and annual occurrence rates), (page 69)
#12 (number of events, relative frequency and annual occurrence rate by category) (page 70)
Module 3, Section VII, Form B (30 Hypothetical Events)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)
Standard 5.6.3 (Uncertainty Characterization) (page 30)

Audit: The modeler should be prepared to describe and to support category 3-5 storms with respect to intensity and wind speed. In particular, defend the goodness-of-fit

of historical versus modeled frequencies (by intensity), providing confidence intervals where appropriate.

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

Professional Team Comments:

Verified there was no change in the model from the previous year.

5.2.6 Hurricane Probabilities

Modeled hurricane probabilities shall reasonably match the historical record through 2001 for category 1 to 5 hurricanes, shall be consistent with those observed for each geographical area of Florida, and shall be displayed in vertical bar graphs. "Consistent" means: (1) spatial distributions of modeled hurricane probabilities shall accurately depict vulnerable coastlines in Florida and the states of Alabama, Georgia, and Mississippi; and (2) probabilities are compared with observed hurricane frequency using methods documented in accepted scientific literature or proposed by the modeler and accepted by the Commission.

Reference: *Module 1, Section I, B.2 (handling of beach/coastal areas)* (page 39)
Module 1, Section II, A.1 (historical database for wind speeds and frequency), (page 41)
B.7 (parameters for hurricane frequency), (page 45)
B.8 (stochastic hurricane generation) (page 45)
Module 3, Section I (Hurricane Set) (page 63)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)
Standard 5.6.3 (Uncertainty Characterization) (page 30)

Audit: The modeler should be prepared to describe and to support the method of selecting stochastic storm tracks and angle of landfall. The modeler should be prepared to describe and to 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. Assess the goodness-of-fit of modeled to historical frequencies for the four sections of the state and overall. The modeler should be prepared to demonstrate that the quality of fit extends beyond the Florida border by showing results for appropriate coastal segments in Alabama, Georgia, and Mississippi. Explain any significant discrepancies. In particular, defend the goodness-of-fit of historical versus modeled frequencies (by intensity), providing confidence intervals where appropriate.

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

Professional Team Comments:

ARA discussed their approach in handling coastal segments in Alabama, Georgia, and Mississippi. Reviewed graphical representations of the modeled versus historical landfall counts as a function of Saffir-Simpson category as defined by wind speed.
Reviewed numerous graphical plots of distributions on occurrence rate, heading, translational speed, and distance to coastal approach.

Examined K-S tests for modeled versus historical storms for Florida.

Documentation reviewed:
- Historical Storm Validation 2002, Vol. III-E
- Florida Hurricane Model, Vol. I-B/C, Validation and Testing Results

5.2.7 Hurricane Probability Distributions

Modeled probability distributions for hurricane intensity, eye diameter, forward speed, radii for maximum winds, and radii for hurricane force winds shall be consistent with historical hurricanes in the Atlantic basin as documented in accepted scientific literature available to the Commission.

Reference: *Module 1, Section I, A.2 (probability distributions)* (page 32)
Module 1, Section II, B.1 (wind speeds used for loss estimation), (page 43)
B.7 (parameters for hurricane frequency), (page 45)
B.8 (stochastic hurricane generation) (page 45)
Module 3, Section 1, #2 (upper limit of wind speeds produced), (page 63)
#5 (hurricane tracks), (page 64)
#9 (radius of hurricane force winds, Rmax and FFP by CP), (page 66)
#11 (frequency and annual occurrence rates), (page 69)
#12 (number of events, relative frequency and annual occurrence rate by category) (page 70)
Module 3, Section VII, Form F (Hypothetical Events for SA & UA) (page 105)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)
Standard 5.6.3 (Uncertainty Characterization) (page 30)

Audit: The modeler should be prepared to disclose the goodness-of-fit of parametric distributions to historical hurricane characteristics.

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

Professional Team Comments:

Verified no change from last year. Reviewed distribution of wind speeds from the stochastic storm set.

Reviewed documentation provided in ARA's Florida Hurricane Model, Vol. I-B/C, Validation and Testing Results.

5.2.8 Land Friction

Land friction shall be used in the model to reduce wind speeds over land, shall be based on scientific methods, and shall provide realistic wind speed transitions between adjacent zip codes, counties, and territories. The magnitude of friction coefficients shall be consistent with accepted scientific literature, consistent with geographic surface roughness, and shall be implemented with appropriate geographic information system data.

Reference: *Module 1, Section II, B.4 (land friction),* (page 43)
B.5 (characteristics used for wind speed estimation) (page 44)
Module 3, Section I (Hurricane Set) (page 63)
Module 3, Section VII, Form F (Hypothetical Events for SA & UA) (page 105)

Audit: The modeler should be prepared to describe the handling of land friction. Maps by zip codes are required.

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

Professional Team Comments:

Reviewed ARA's Boundary Layer Model compared with NOAA's Dropsonde Data for various wind speeds.

Verified no change was made in the model's terrain database. Discussed in detail the methodology used in modeling the terrain. Reviewed graphical representations of open and real terrain effects and comparisons of modeled versus historical wind speeds.

Reviewed documentation provided in ARA'sTerrain Database for Florida, Vol. III-B.

5.2.9 Hurricane Overland Weakening Rate

The hurricane overland weakening rate methodology used by the model shall be provided to the Commission and shall be shown to be (1) reasonable as observed in comparison to historical records, and (2) documented in accepted scientific literature or in modeler information accepted by the Commission.

Reference: *Module 1, Section II, B.3 (filling rate function)* (page 43)
Module 3, Section I (Hurricane Set) (page 63)
Module 3, Section VII, Form F (Hypothetical Events for SA & UA) (page 105)

Audit: The modeler should be prepared to compare the model's weakening rates to historical Florida storms and to weakening rates documented in scientific literature.

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

Professional Team Comments:

Verified no change from last year. Reviewed documentation provided in ARA's Florida Hurricane Model, Vol. I-B/C, Validation and Testing Results.

5.2.10 Temporal and Spatial Wind Field Characteristics

The time variant wind field, including the radial distribution of wind speeds, shall be demonstrated to be consistent with accepted scientific principles, such as:

1. The radius of maximum winds shall reflect specified hurricane characteristics.
2. The magnitude of the asymmetry shall increase as translational speed increases, all other factors held constant.
3. The wind speed shall decrease with increasing surface roughness (friction), all other factors held constant.

Reference: *Module 3, Section I, #6 (decay rates),* (page 64)
#9 (radius of hurricane force winds, Rmax and FFP by CP) (page 66)
Module 3, Section II (Hurricane Wind Field) (page 72)
Module 3, Section VII, Form B (30 Hypothetical Events),
Form C (One Hypothetical Event), (page 101)
Form F (Hypothetical Events for SA & UA) (page 105)

Audit: Forms B, C, and F provide the information used in auditing this standard. Contour plots of the wind field from Form F are desired. If prepared, they should be presented to the Professional Team on-site and be consistent with the sensitivity and uncertainty analyses for wind speed.

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

Professional Team Comments:

Reviewed how the model considers the asymmetric nature of hurricanes and the equation used in the model's code. Reviewed graphical examples of the wind field asymmetry over water and over land.

5.3 Vulnerability Standards – *Fred Stolaski, Leader*

5.3.1 Derivation of Vulnerability Functions

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.

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

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

Reference: *Module 1, Section I, A.7 (categories of vulnerability functions),* (page 38)
A.8 (documents/research used in development of vulnerability functions),(38)
C.1.a (socio-economic effects) (page 40)
Module 1, Section II, A.5 (claims data used in development of vulnerability functions) (page 43)
Module 3, Section III (Vulnerability Functions-Damage Estimates)(page 73)
Module 3, Section IV, #3 (appurtenant structures vulnerability function),(75)
#4 (mobile home vulnerability function), (page 76)
#5 (contents vulnerability function), (page 76)
#6 (ALE vulnerability function) (page 76)
Standard 5.4.1 (Underwriting Assumptions) (page 17)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)

Audit: Historical data shall 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, be prepared to demonstrate the goodness-of-fit of the data to fitted

models per 5.6.2. 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 building types and construction characteristics may be selected for review. The basis for expert opinion and original site inspection reports shall be available.

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

All modifications to the vulnerability functions shall be individually listed with the direction (either positive or negative) and the range of magnitude of the change indicated. Any variation in the change over the range of wind speeds shall be identified.

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

Professional Team Comments:

Verified no changes were made to the vulnerability functions and there are no modification factors applied to the vulnerability functions. Discussed in detail the resistance factor incorporated in the model and the factors that tend to dominate the roof sheathing performance, opening protection, and others.

Reviewed examples of vulnerability curves comparing the effect of peak gust speed and open terrain on a weak house and a stronger house with and without windborne debris.

Reviewed documentation including:

- Development of Loss Relativities Table in Florida DCA study
- Building Component Load Models, Vol. II-A
- Individual Building Damage Model, Vol. II-B
- Individual Building Damage Model, Vol. II-C
- Building Damage Comparisons, Vol. II-D

5.3.2 Required Vulnerability Functions

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

Reference: *Module 1, Section I, A.7 (categories of vulnerability functions),* (page 38)
Module 3, Section III (Vulnerability Functions-Damage Estimates) (page 73)
Module 3, Section IV, #3 (appurtenant structures vulnerability function), (76)
#4 (mobile home vulnerability function), (page 76)

#5 (contents vulnerability function), (page 76)
#6 (ALE vulnerability function) (page 76)
Module 3, Section V, #2 (loss cost relationships by type of coverage and type of construction), (page 82)
#4 (output ranges) (page 117)
Module 3, Section VII, Form B (30 Hypothetical Events),
Form C (One Hypothetical Event), (page 101)
Form D (Loss Costs),
Form F (Hypothetical Events for SA & UA) (page 105)

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

Proprietary: Yes
Verified: Yes

Professional Team Comments:

Reviewed examples of vulnerability function curves showing the effect of peak gust in open terrain on different coverages (building, contents, ALE) by different construction types. Reviewed examples of how ARA's building stocks are distributed by region.

Discussed the methodology used for damage to contents, appurtenant structures, and ALE.

Verified no change in the model from last year.

5.3.3 Wind Speeds Causing Damage

Damage associated with a declared hurricane event shall include damage incurred for wind speeds above and below the hurricane threshold of 74 mph. The minimum wind speed that generates damage shall be specified.

Reference: *Module 1, Section II, B.1 (wind speeds used for loss estimation)* (page 43)
Module 3, Section III (Vulnerability Functions-Damage Estimates) (page 73)
Module 3, Section VII, Form F (Hypothetical Events for SA & UA) (page 105)

Audit: The disclosed minimum wind speed shall be reasonable with validation material available. The computer code showing the inclusion of the minimum wind speed at which damage occurs shall be verified.

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

Professional Team Comments:

Verified through a review of the computer code the conditions that must be met in order to compute losses and verified that the peak gust wind speed exceeds 50 mph.

5.3.4 Construction Characteristics

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

Reference: *Module 1, Section I, A.7 (categories of vulnerability functions),* (page 38)
B.7 (vulnerability modifications range of impacts on loss costs), (page 40)
C.1.b (building code and enforcement), (page 40)
C.1.c (construction characteristics) (page 40)
Module 1, Section II, A.3 (damageability assumptions) (page 42)
Module 3, Section III (Vulnerability Functions-Damage Estimates) (page 73)
Module 3, Section IV, #4 (mobile home vulnerability function), (page 76)
Module 3, Section VII, Form D (Loss Costs),
Form F (Hypothetical Events for SA & UA) (page 105)

Audit: Construction types and characteristics used shall be listed and include validation of the range of magnitude and direction of the variations in damage. Any variation in differences, such as less damage to obviously stronger structures (masonry verses frame), shall be fully explained.

All modifications to the vulnerability functions due to a new building code or revisions to the existing building code shall be documented and include the range of magnitude and direction of any changes. Any variation in the change over the range of wind speeds shall be identified.

These modifications shall fully comply with 5.3.1.

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

Professional Team Comments:

ARA presented their detailed analysis of the effects of the new Florida Building Code (FBC) funded by Florida DCA. Discussed the methodology used in the analysis and the loss functions developed for modeling the effects of the new

FBC. Verified no weight is given to the building stock model in the state of Florida based on the assumption 0% of the building stock has been built to the new FBC.

Discussed the various construction characteristics. Reviewed relativities by various construction factors and a matrix showing the effect on loss costs of all the different combinations. Discussed the methodology used between individual and multiple factors.

Reviewed examples of the categories or building classes considered in ARA's loss projection studies.

Documentation reviewed:

- Florida Building Construction Characteristics, Vol. III-A2
- Analysis of Florida Building Code Stock, HurLoss 3.0, Vol. III-A3
- Individual Risk Analysis Building Database, FCHLPM, Vol. II-F
- Building Component Load Models, Vol. II-A
- Individual Building Damage Model, Vol. II-B
- Individual Building Damage Model, Vol. II-C

5.3.5 Mitigation Measures

Modeling of mitigation measures to improve a building's wind resistance and the corresponding effects on vulnerability shall be disclosed and demonstrated to be theoretically sound. These measures shall include, but not be limited to, 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.

The percentage changes in the statewide, zero deductible personal residential non-mitigated loss costs that would be produced in the output ranges due to each mitigation measure shall be individually and specifically provided to the Commission, including ranges of possible impacts on damage for each mitigation measure listed.

Methods for estimating the effects of mitigation measures shall be shown to be reasonable both individually and in combination.

Reference: *Module 1, Section I, A.6 (mitigation factors)* (page 38)
Module 3, Section III, #5 (hazard mitigation) (page 74)

Audit: The comprehensive and detailed listings of items that are required or should be considered ensures consistency and completeness among all modelers in presenting the necessary disclosures and demonstrations of theoretical soundness.

Total effect on damage due to use of multiple mitigation measures shall be documented and shown to be reasonable.

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

Professional Team Comments:

Discussed in detail ARA's methodology used for estimating the effects of individual and multiple mitigation measures. Thoroughly reviewed the percent reductions in statewide ground-up loss costs for the mitigation measures provided in Table 1 on page 16 of ARA's submission including a discussion of the differences in percent reductions for the categories listed and the high and low percentages.

ARA presented the methodology used, the details of their mitigation model, and results of comparison studies.

5.3.6 Additional Living Expenses (ALE)

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

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

Reference:
Module 1, Section I, C.1.d (storm surge and flood damage to the infrastructure) (page 41)
Module 3, Section IV, #6 (ALE vulnerability function) (page 76)
Module 3, Section V, #4 (output ranges) (page 117)
Module 3, Section VII, Form B (30 Hypothetical Events), Form D (Loss Costs), Form F (Hypothetical Events for SA & UA) (page 105)
Standard 5.4.9 (ALE) (page 22)

Audit: The methodology and available validation for determining the extent of infrastructure damage and its effect on undamaged properties shall be made available to the Professional Team.

Documentation and calculations used to determine the time to repair/reconstruct the property shall be shown. Use of expert opinion or other modifications shall be explained.

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

Professional Team Comments:

Verified no change in the model. Reviewed graphical representations of modeled ALE losses confirming that ALE losses can occur without damage to the infrastructure.

5.4 Actuarial Standards – *Marty Simons, Leader*

5.4.1 Underwriting Assumptions

When used in the modeling process or for verification purposes, adjustments, edits, inclusions, or deletions to insurance company input data used by the modeler shall be based on accepted actuarial, underwriting, and statistical procedures. The methods used shall be documented in writing.

For damage 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 shall be identified and demonstrated to be reasonable and appropriate.

Reference: *Module 1, Section I, B.4 (annual aggregate loss distributions)* (page 40)
Module 1, Section II, A.3 (damageability assumptions), (page 42)
A.4 (other assumptions), (page 43)
A.5 (claims data used in development of vulnerability functions) (page 43)
Module 3, Section IV (Insurance Functions-Company Loss Estimates) (75)
Standard 5.3.4 (Construction and Codes) (page 15)
Standard 5.6.1 (Use of Historical Data) (page 28)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)

Audit: Quality assurance procedures will include methods to assure accuracy of input insurance data prior to code execution. Compliance with this standard shall be readily demonstrated through rules and documented procedures.

Be prepared to disclose 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." Be prepared to disclose the methods used to delineate among the insurer claim practices in the use of historical claims data to verify model outputs.

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

Professional Team Comments:

Verified no change in the model. Discussed in detail the methodology used for validating model components against insurance company data including adjustments made to the insurance data.

5.4.2 Actuarial Modifications

All actuarial modifications made to the model shall be disclosed to the Commission and based on accepted engineering and actuarial criteria.

Reference: Module 1, Section I, A.6 (actuarial functions modification factors), (page 38)
A.10 (modifications available for model user), (page 39)
B.7 (actuarial modifications range of impacts on loss costs), (page 40)
C.1.b (building code and enforcement), (page 40)
C.1.c (construction characteristics) (page 40)
Module 3, Section III, #3 (building code enforcement), (page 73)
#4 (quality of construction type, materials and workmanship), (page 73)
#5 (hazard mitigation) (page 74)
Module 3, Section V, #4 (output ranges) (page 117)
Module 3, Section VII, Form D (Loss Costs),
Form F (Hypothetical Events for SA & UA) (page 105)
Standard 5.3.4 (Construction and Codes) (page 15)

Audit: Be prepared to disclose adjustments made to account for future impacts on loss costs brought about by revisions due to building code changes or revised mold claim procedures. If loss costs are not adjusted following a revision in Florida building codes or for revised mold claim procedures, be prepared to provide the actuarial criteria indicating no adjustment is appropriate based on expected future insurance company claim payments.

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

Professional Team Comments:

Verified that ARA does not use modification factors to their actuarial functions.

5.4.3 Loss Cost Projections

Loss cost projections produced by hurricane loss projection models shall not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margin. Hurricane loss projection models shall not make a prospective provision for economic inflation.

Reference: *Module 1, Section I, B.4 (annual aggregate loss distributions),* (page 40)
C.1.a (socio-economic effects) (page 40)
Module 3, Section III, #2 (socio-economic effects) (page 73)
Module 3, Section V (Average Annual Loss Functions-Loss Costs) (page 82)
Module 3, Section VII (Baseline Tests) (page 97)

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

Professional Team Comments:

Verified that there were no changes made in the model. Reviewed color-coded maps reflecting the percentage changes in the ground-up weighted average loss costs by county for Owners-Frame, Mobile Homes, and Condos.

5.4.4 Insurer Inputs

The modeler shall disclose any assumptions, fixed and/or variable, that relate to insurer input. Such assumptions shall be demonstrated to be actuarially sound. Assumptions that can vary by specific insurer shall be disclosed in a model output report. Fixed assumptions, that do not vary, need to be disclosed to the Commission.

Reference: *Module 1, Section I, A.10 (modifications available for model user),* (page 39)
B.4 (annual aggregate loss distributions) (page 40)
Module 1, Section II, A.3 (damageability assumptions), (page 42)
A.4 (other assumptions) (page 43)
Module 3, Section III, #2 (socio-economic effects), (page 73)
#3 (building code enforcement), (page 73)
#4 (quality of construction type, materials and workmanship), (page 73)
#5 (hazard mitigation) (page 74)
Module 3, Section IV (Insurance Functions-Company Loss Estimates) (75)
Module 3, Section V, #4 (output ranges), (page 117)
#9 (distribution of hurricanes by size) (page 90)
Module 3, Section VII, Form B (30 Hypothetical Events),
Form C (One Hypothetical Event), (page 101)
Form D (Loss Costs),
Form E (PML), (page 104)
Form F (Hypothetical Events for SA & UA) (page 105)

Standard 5.4.11 (Comparison of Estimated Hurricane Loss Costs)(page 24)
Standard 5.4.12 (Output Ranges) (page 25)

Audit: Potential areas for assumptions may include, but are 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 expenses 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 will validate all zip code information received from insurance company clients to assure that valid zip codes are used.

All items included in the input and output forms submitted to the Commission shall be clearly labeled and clearly defined.

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

Professional Team Comments:

Verified no change to the model from last year.

5.4.5 Demand Surge

Loss cost projections shall not explicitly include demand surge. Any adjustment to the model or historical data to remove implicit demand surge, shall be disclosed and demonstrated to be reasonable.

Reference:
- *Module 1, Section I, C.1.a (socio-economic effects)* (page 40)
- *Module 1, Section II, A.3 (demand surge)* (page 42)
- *Module 3, Section III, #2 (socio-economic effects)* (page 73)
- *Module 3, Section V, #8 (Hurricane Andrew loss costs)* (page 88)
- *Module 3, Section VII (Baseline Tests)* (page 97)

Audit: Demonstrate how the presence of demand surge has been incorporated in any analysis where Hurricane Andrew losses are used for development or verification of the model or its output. Demonstrate how demand surge is incorporated in any other data used in the development or verification of the model.

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

Professional Team Comments:

Verified that demand surge was not used in preparation of loss cost projections.

5.4.6 Logical Relation to Risk

Loss costs shall not exhibit an illogical relation to risk, nor shall loss costs exhibit a significant change when the underlying risk does not change significantly.

1. Loss costs produced by the model shall be positive and non-zero for all zip codes.
2. Modelers shall produce color-coded maps for the purpose of comparing loss costs by five-digit zip code within each county and on a statewide basis.
3. Loss costs cannot increase as friction or roughness increase, all other factors held constant.
4. Loss costs cannot increase as the quality of construction type, materials and workmanship increases, all other factors held constant.
5. Loss costs cannot increase with the presence of fixtures or construction techniques designed for hazard mitigation, all other factors held constant.
6. Loss costs shall decrease as deductibles increase, all other factors held constant.
7. Loss costs cannot increase as the quality of building codes and enforcement increases, all other factors held constant.
8. The relationship of loss costs for individual coverages (A, B, C, D) shall be consistent with the coverages provided.

The above tests are intended to apply in general. There may be certain anomalies that are insignificant or are explainable by special circumstances. This standard applies separately to each coverage.

Reference: *Module 1, Section 1, A.6 (actuarial functions modification factors),* (page 38)
B.1 (consistent loss costs produced), (page 39)
B.3 (deductibles, policy limits, replacement costs, insurance-to-value) (page 39)
C.1.b (building code and enforcement), (page 40)
C.1.c (construction characteristics) (page 40)
Module 3, Section III, #3 (building code enforcement), (page 73)
#4 (quality of construction type, materials and workmanship), (page 73)
#5 (hazard mitigation) (page 74)
Module 3, Section V, #2 (loss cost relationships by type of coverage and type of construction), (page 82)
#4 (output ranges), (page 117)
#5 (explanation of differences in output ranges from prior year), (page 85)
#9 (distribution of hurricanes by size) (page 90)
Module 3, Section VII (Baseline Tests) (page 97)
Standard 5.1.7 (Visual Presentation of Data) (page 6)
Standard 5.2.8 (Land Friction) (page 12)
Standard 5.3.4 (Construction and Codes) (page 15)
Standard 5.3.5 (Mitigation Measures) (page 16)
Standard 5.4.7 (Deductibles and Policy Limits) (page 21)

Audit:
A. Prepare graphic representation of loss costs by zip code. Provide statewide, by region, and major population centers.
B. For land friction, provide a color-coded map by zip code of friction for Florida and identify low, average, and high loss costs. Be prepared to call up loss costs for selected zip codes in Florida.
C. Form B will be used to assess coverage relationships.

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

Professional Team Comments:

Reviewed color-coded maps and plots showing the relationships between modeled and historical losses for buildings, contents, appurtenant structures, and ALE. Reviewed separate loss functions for different coverages. Verified no change in the model.

5.4.7 Deductibles and Policy Limits

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

The relationship among the modeled deductible loss costs shall be shown to be reasonable. Differences in these relationships from those previously found acceptable, if applicable, shall be explained and shown to be reasonable. If applicable, changes in the methods used to reflect the effects of policy limits shall be disclosed.

Reference: *Module 1, Section I, B.3 (deductibles, policy limits, replacement costs, insurance-to-value)* (page 39)
Module 3, Section IV, #1 (variety of damage produced by a given wind speed), (page 75)
#2 (insurer loss calculation), (page 75)
#8 (property value and replacement cost calculations) (page 77)
Module 3, Section V, #3 (maps of loss costs by zip code), (page 83)
#4 (output ranges), (page 117)
#9 (distribution of hurricanes by size) (page 90)
Module 3, Section VII, Form D (Loss Costs)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)

Audit: The company actuary will be asked to attest to the actuarial soundness of the procedure. To the extent that historical data are used to develop mathematical depictions of contents functions, be prepared to demonstrate the goodness-of-fit of the data to fitted models as per 5.6.2. Be prepared to discuss and justify changes from the prior submission in the relativities among corresponding deductible amounts for the same coverage.

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

Professional Team Comments:

ARA presented the methodology for handling deductibles including the derivation of insured loss functions. Reviewed data flow charts and associated calculations. Reviewed examples of distributions at a given wind speed, histograms of loss ratios by coverage type, and examples of losses for various deductibles at various peak gust wind speeds.

5.4.8 Contents

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

The relationship between the modeled building and contents loss costs shall be shown to be reasonable. If applicable, differences and the reasons for those differences from prior submissions in the relativities between loss costs for the building and the corresponding loss costs for contents shall be explained and shown to be reasonable.

Reference: *Module 1, Section I, B.6 (distinction for different policy types)* (page 40)
Module 3, Section IV, #5 (contents vulnerability function), (page 76)
#7 (depreciation assumptions) (page 77)
Module 3, Section V, #2 (loss cost relationships by type of coverage and type of construction), (page 82)
#4 (output ranges) (page 117)
Module 3, Section VII, Form B (30 Hypothetical Events), Form C (One Hypothetical Event), Form D (Loss Costs) (page 101)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)

Audit: The company actuary will be asked to attest to the actuarial soundness of the procedure. To the extent that historical data are used to develop mathematical depictions of contents functions, be prepared to demonstrate the goodness-of-fit of the data to fitted models as per 5.6.2. Be prepared to discuss and justify changes from the prior submission in the relativities between loss costs for buildings and the corresponding loss costs for contents.

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

Professional Team Comments:

Performed a detailed review of the insurance company experience used to develop and validate the model as summarized in Figure 6 (page 24) of ARA's submission. Verified no change in the model.

5.4.9 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.

The relationship between the modeled building and ALE loss costs shall be shown to be reasonable. If applicable, differences and the reasons for those differences from prior

submissions in the relativities between loss costs for the building and the corresponding loss costs for ALE shall be explained and shown to be reasonable.

The modeler shall disclose the methods used in the model to incorporate ALE losses from damage to the infrastructure and the methods shall be shown to be reasonable.

Reference: *Module 1, Section 1, C.1.d (storm surge and flood damage to the infrastructure)* (page 41)
Module 3, Section IV, #6 (ALE vulnerability function) (page 76)
Module 3, Section V, #4 (output ranges) (page 117)
Module 3, Section VII, Form B (30 Hypothetical Events), Form C (One Hypothetical Event), Form D (Loss Costs) (page 101)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)

Audit: The company actuary will be asked to attest to the actuarial soundness of the procedure. Also, be prepared to document, discuss, and justify the following during the on-site review:

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. For Hurricane Andrew, be prepared to quantify and discuss the effects of demand surge on ALE;
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 condominium exposure;
H. Logical relation to contents, especially contents versus ALE for condominiums; and
I. ALE resulting from damage to the infrastructure.

To the extent that historical data are used to develop mathematical depictions of ALE functions, be prepared to demonstrate the goodness-of-fit of the data to fitted models as per 5.6.2.

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

Professional Team Comments:

Reviewed methodology used in development of ALE loss costs. Verified no change in the model.

5.4.10 Replication of Known Hurricane Losses

The model shall be shown to reasonably replicate incurred losses on a sufficient body of past hurricane events, including the most current data available to the modeler. This standard applies separately to personal residential and mobile homes to the extent data are available. Personal residential experience may be used to replicate building-only and contents-only losses. The modeler shall demonstrate that the replications were produced on an objective body of loss data by county or an appropriate level of geographic detail.

Reference: *Module 1, Section II, A.5 (claims data used in development of vulnerability functions),* (page 43)
C.3 (damage estimates validation tests) (page 50)
Module 3, Section IV, #9 (validation comparisons of actual exposures and loss to modeled exposures and loss) (page 77)
Module 3, Section V, #2 (loss costs relationships by type of coverage and type of construction), (page 82)
#8 (Hurricane Andrew loss costs) (page 88)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)
Standard 5.6.3 (Uncertainty Characterization) (page 30)

Audit: A. Provide the following for each insurer and hurricane:

1. The version of the model used to calculate modeled losses for each storm provided;
2. For each storm, a general description of the data and its source;
3. A disclosure of any material mismatch of exposure and loss data problems, or other material consideration. For each storm, the date of the exposures used for modeling and the date of the hurricane;
4. An explanation of differences in the actual and modeled storm parameters;
5. 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;
6. The type of property used in each storm to address:
   a. Personal versus commercial
   b. Residential structures
   c. Mobile homes
   d. Condominiums
   e. Buildings only
   f. Contents only
7. For each example, the inclusion of demand surge, storm surge, loss adjustment expenses, or law and ordinance coverage in the actual losses, or the modeled losses.

B. Have the following documentation available for on-site review:

1. Provide a copy of the publicly available documentation that you plan to provide to the Commission;

2. A listing of all data sources excluded from validation and the reasons for excluding the data from review by the Commission (if any);
3. An analysis that identifies and explains anomalies observed in the validation data;
4. For Hurricane Andrew, be prepared to quantify and discuss the effects of demand surge; and
5. User input sheets for each insurer and hurricane detailing specific assumptions made with regard to exposed property.

C. Use confidence intervals per 5.6.3 to gauge the comparison between historical and modeled losses.

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

Professional Team Comments:

Reviewed details of actual and modeled Zip Code level losses. Reviewed scatter plots of actual loss versus modeled loss ratios.

Discussed results of validation and testing provided in ARA's Florida Hurricane Model, Vol. I-B/C.

5.4.11 Comparison of Estimated Hurricane Loss Costs

The model shall provide the annual average zero deductible statewide loss costs produced using the list of hurricanes in 5.2.3 historical hurricanes in Florida based on the 1998 Florida Hurricane Catastrophe Fund's (FHCF) aggregate personal residential exposure data, as of November 1, 1999. These will be compared to the statewide loss costs produced by the model on an average industry basis. The difference, due to uncertainty, between historical and modeled annual average statewide loss costs shall be demonstrated to be statistically reasonable.

Reference: *Module 1, Section II, C.2 (expected loss estimates validation tests),* (page 48)
C.3 (damage estimates validation tests) (page 50)
Module 3, Section I, #7 (decay rate compared to Kaplan-DeMaria), (page 65)
#11 (frequency and annual occurrence rates) (page 69)
Module 3, Section V, #2 (loss cost relationships by type of coverage and type of construction), (page 82)
#4 (output ranges), (page 117)
#5 (explanation of differences in output ranges from prior year), (page 85)
#9 (distribution of hurricanes by size) (page 90)
Standard 5.6.2 (Comparison of Historical and Modeled Results) (page 29)
Standard 5.6.3 (Uncertainty Characterization) (page 30)

Audit: Be prepared to discuss and justify the following during the on-site review:

A. Meteorological parameters;
B. The effect of by-passing storms;
C. The effect of actual storms that have 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;
E. Exposure assumptions;
F. Identify and explain any unusual results;
G. Use confidence intervals per 5.6.3 to gauge the comparison between historical and modeled losses;
H. The zero deductible statewide loss for each hurricane in the Official Storm Set; and
I. The zero deductible loss by zip code for Hurricane Andrew.

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

Professional Team Comments:

Reviewed scatter plot comparisons of actual to modeled losses and plots showing the terrain effects. Verified that results between historical and simulated are unchanged from last year.

5.4.12 Output Ranges

Any model previously found acceptable by the Commission shall provide an explanation suitable to the Commission concerning the differences in the updated output ranges. Differences between the prior year submission and the current submission shall be explained in the submission including, but not limited to:

1. Differences and the reasons for those differences from the prior submission of greater than ten percent in the weighted average loss costs for any county shall be specifically listed and explained in the modeler's submission to the Commission. The submission shall include a specific listing of each affected county.
2. Differences and the reasons for those differences from the prior submission of ten percent or less in the weighted average loss costs for any county shall be explained in the aggregate in the modeler's submission to the Commission.

Reference: *Module 1, Section I, B.2 (resolution used for output ranges)* (page 39)
Module 3, Section V, #4 (output ranges), (page 117)
#5 (explanation of differences in output ranges from prior year), (page 85)
#6 (output ranges % change by county), (page 86)
#7 (maps of output ranges % change by county) (page 87)

Audit: Be prepared to discuss and justify the following during the on-site review:

1. Changes from the prior submission of greater than ten percent in weighted average loss costs for any county.
2. Changes from the prior submission of ten percent or less in weighted average loss costs for any county.

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

Professional Team Comments:

Discussed in detail the changes by county in the Output Ranges. ARA disclosed errors were made in their previous Output Ranges submission due to incorrectly filling out the form. Verified that all changes in the Output Ranges were attributable to human error in filling out the form, and that there was no change in the model. Verified that no insurance company used the model Output Ranges in the state of Florida.

Discussed in detail the differences in relativities among building type, contents, mobile homes, deductibles, ALE, and appurtenant structures.

Reviewed ARA's internal comparisons on the changes in loss costs produced in the Output Ranges.

Discussed the relationship among deductibles and verified that ARA uses the same loss curve for primary and appurtenant structures.

The Professional Team informed ARA that the Commission will be updating the FHCF exposure database provided next year, and that they will be required to run both the old and new exposure data sets.

5.5 Computer Standards – *Paul Fishwick, Leader*

5.5.1 Primary Document Binder

A primary document binder, in either electronic or physical form, shall be created, and shall contain fully documented sections for each subsequent Computer Standard. Development of each section shall be indicative of accepted software engineering practices. All computer software (i.e., user interface, scientific, engineering, actuarial) relevant to the modeler's submission must be consistently documented.

Reference: *Module 1, Section I (General Description of the Model)* (page 32)
Module 1, Section II (Specific Description of the Model) (page 41)

Audit: The Professional Team will audit all aspects of the submission. Modeler personnel, or their designated proxies, responsible for each aspect of the software (i.e. user interface, quality assurance, engineering, actuarial) shall be present at the break-out meeting when the computer standards are being audited.

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

Professional Team Comments:

Reviewed: (1) component designs and implementation provided in binders and source code; (2) the input file that controls the building stock mappings for each county; and (3) the source code that controls the coverage limits, deductibles, and ZIP Code weights used in the Output Ranges. Verified that all computer software relevant to ARA's submission was consistently documented. Reviewed the primary document binder, which references and organizes the following document binders:

HURLOSS RISK ANALYSIS SUITE documentation

Volume	Binder	Section	Title
0			Primary Documents Binder
	0-A		**Primary Documents Binder**
I			Hurricane Simulation Model
	I-A		**LIFESIMi Model**
	I-B &C		**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-A		**Building Component Load Models**
	II-B		**Individual Building Damage Model Part 1**
	II-C		**Individual Building Damage Model Part 2**
	II-D		**Building Damage Comparisons FHC99 vs. FHC00**
	II-E		**Individual Ground-Up Building Loss**
	II-F		**Individual Risk Analysis Building Database**
	II-G1		**Individual Risk Sensitivity Study (Primary)**
	II-G2		**Individual Risk Sensitivity Study (Secondary)**
	II-H		**HurReport Utility**
	II-R		**Regression Test Results**

III	Portfolio Analysis Model
III-A	**Actuarial and Aggregation Models**
III-A2	**Florida Building Construction Characteristics**
III-A3	**Analysis of FL Building Stock**
III-B	**Terrain Database (by Zip Code)**
III-C	**DOQQ's**
III-D	**HurLoss Portfolio Analysis Application**
III-E	**Historical Storm Validation**

5.5.2 Requirements

The modeler shall document all requirements specifications of the software, such as interface, human factors, functionality, documentation, data, human and material resources, security, and quality assurance.

Reference: *Module 1, Section I (General Description of the Model)* (page 32)
Module 1, Section II (Specific Description of the Model) (page 41)
Module 3, Section VI, #2 (computer code tampering) (page 96)

Audit: The Professional Team will ask modelers for the requirements specifications documentation and review onsite.

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

Professional Team Comments:

Refer to comments under Standard 5.5.1.

5.5.3 Model Architecture and Component Design

The modeler shall document detailed control and data flow diagrams, interface specifications, and a schema for all data files along with field type definitions. Each network diagram shall contain components (including referenced sub-component diagrams), arcs, and labels. A model component custodian shall be identified and documented.

Reference: *Module 1, Section I (General Description of the Model)* (page 32)
Module 1, Section II (Specific Description of the Model) (page 41)

Audit: All codes will be designed in diagrams that depict the flow of data and control. Other synonyms for "component" are module, function, plug-in, or object. In all cases, a component has a clear input/output interface. The idea of interacting components with flows extending from one component to another came about in systems theory and engineering and was extended to

software engineering. While the standards do not dictate programming paradigm, they require that the top-level design of the code is in an aggregate form that references common components such as STORMS, WIND FIELD, DAMAGE, and COST.

All model component custodians or their designated proxies must be available at the time of audit.

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

Professional Team Comments:

Reviewed component designs, data flow diagrams, and implementation provided in binders and source code. Reviewed the Model Custodian Primary and Secondary Reviewer chart.

5.5.4 Implementation

The software shall be traceable from the flow diagrams and their components down to the code level. All documentation, including document binder identification, shall be indicated in the relevant component. The highest design level components shall incrementally be translated into a larger number of components until the code level is reached.

Reference: *Module 1, Section I (General Description of the Model)* (page 32)
Module 1, Section II (Specific Description of the Model) (page 41)

Audit: Each of the components in 5.5.3 is refined into subcomponents, and at the end of the component "tree" there are blocks of code. All documentation and binder identifications will be referenced within this tree. This creates a traceable design from aggregate components down to the code level.

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

Professional Team Comments:

Reviewed component designs and implementations documented in the source code, and the binders listed under Standard 5.5.1.

5.5.5 Verification

1. General

The modeler shall employ and document procedures employed, such as code inspections, reviews, calculation crosschecks, and walkthroughs, sufficient to demonstrate code correctness. The code shall contain sufficient logical assertions, exception-handling mechanisms, and flag-triggered output statements to test the correct values for key variables that might be subject to modification.

2. Testing

Tests shall be documented for each software component, independent of all other components, to ensure that each component provides the correct response to inputs. The test specifications, procedures, and results shall also be documented to establish that the integration of all components produces model behavior that functions correctly.

Reference: *Module 1, Section I (General Description of the Model)* (page 32)
Module 1, Section II (Specific Description of the Model) (page 41)
Standard 5.1.4 (Independence of Model Components) (page 2)
Standard 5.6.4 (Sensitivity Analysis for Model Output) (page 30)
Standard 5.6.5 (Uncertainty Analysis for Model Output) (page 30)

Audit: Some compilers will contain the ability to declare logical assertions. For those compilers without this capability, one can create "if-statements" with the appropriate flag. Assertions as to "what should be true" at specific points in the code aids in producing correct code.

To test the whole, unit testing is required on each of the parts. When each part is verified as working on an independent basis, then the parts can be combined together to create the final program. Tests should be run by varying component inputs to ensure correct output. To the extent that component inputs are varied according to sensitivity and uncertainty analyses, provide this material to the Professional Team for review.

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

Professional Team Comments:

Discussed ARA's computer verification methods documented in the HurLoss Model Revision Policy. Reviewed the policy and ARA's methods for inspecting internal variables in a debugging environment, independent code reviews, and code walkthroughs. Spot checked examples of logical assertions and error checking in Fortran, and exception handling in C++ source.

Verified that errors associated with county-based building stock mappings (reference Standard 5.5.1) data sections were corrected.

5.5.6 Model Maintenance and Revision

The modeler shall specify all policies and procedures used to maintain the code, data, and documentation. For each component in the system decomposition, the modeler shall list the installation date under configuration control, the current version number, and the date of the most recent change(s). The modeler shall use tracking software to identify all errors, as well as modifications to the code, data, and documentation.

Reference: *Module 1, Section I (General Description of the Model)* (page 32)
Module 1, Section II (Specific Description of the Model) (page 41)

Audit: Software maintenance includes a written and implemented policy for backup procedures. There are numerous software applications that aid the programming in source revision and control. Even if there are very few programmers, such an approach is necessary to track changes and ensure a quality software engineering process.

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

Professional Team Comments:

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

5.5.7 User Documentation

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

Reference: *Module 1, Section I (General Description of the Model)* (page 32)
Module 1, Section II (Specific Description of the Model) (page 41)

Audit: The Professional Team will talk to users of the software, including those familiar with the code as well as those who use the code without any knowledge of its components or their internal interfaces.

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

Professional Team Comments:

Reviewed user documentation listed under Standard 5.5.1.

5.6 Statistical Standards – *Mark Johnson, Leader*

5.6.1 Use of Historical Data

The use of historical data in developing the model shall be demonstrated to be reasonable using rigorous methods published in the scientific literature.

Reference: *Module 1, Section II, B.12 (statistical techniques used for probability distribution estimates)* (page 46)
Module 3, Section I, #8 (source of historical data set) (page 66)

Audit: Although the chi-square goodness-of-fit test is a commonly used procedure, there are more powerful (rigorous) tests available. Either the Kolmogorov-Smirnov (with relevant adjustments for parameter estimation) or Cramer-von Mises tests should be applied using a reasonable significance level. The Commission does not consider the chi-square goodness-of-fit test to be a rigorous methodology for demonstrating the reasonableness of models of historical data.

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

Professional Team Comments:

Reviewed storm validations provided in ARA's Florida Hurricane Model, Vol. I-B/C, Validation and Testing Results.

5.6.2 Comparison of Historical and Modeled Results

The modeler shall demonstrate the agreement between historical and modeled results using accepted scientific and statistical methods.

Reference: *Module 1, Section II, A.1 (deviation from official hurricane set),* (page 41)
B.7 (parameters for hurricane frequency), (page 45)
C.1 (wind speed validation tests), (page 47)
C.3 (damage estimates validation tests), (page 50)
C.5 (other validation tests), (page 52)
C.6 (validation tests documentation) (page 52)
Module 3, Section I, #12 (number of events, relative frequency and annual occurrence rate by category), (page 70)
#13 (probability of hurricanes by year) (page 71)

Module 3, Section III, #3 (building code enforcement), (page 73)
#4 (quality of construction type, materials and workmanship), (page 73)
#5 (hazard mitigation) (page 74)
Module 3, Section IV, #3 (appurtenant structures vulnerability function), (page 75)
#4 (mobile home vulnerability function), (page 76)
#5 (contents vulnerability function), (page 76)
#6 (ALE vulnerability function) (page 76)

Audit: Examples include hurricane frequencies, tracks, intensities and physical damage.

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

Professional Team Comments:

Reviewed storm validations provided in ARA's Florida Hurricane Model, Vol. I-B/C, Validation and Testing Results including examples of goodness-of-fit tests using Chi-squared, K-S, t-tests, and F-tests performed for historical data versus modeled.

Reviewed revised tests with the change in the wind speeds of Hurricane Andrew. Verified no change was made in the model.

5.6.3 Uncertainty Characterization

The modeler shall provide an assessment of uncertainty using confidence intervals or other accepted scientific characterizations of uncertainty.

Reference: Module 1, Section II, B.9 (confidence intervals produced) (page 45)

Audit: Note that confidence limits could be used for distribution parameter limits and prediction limits could be used for situations in which future values are envisaged.

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

Professional Team Comments:

Reviewed ARA's uncertainty studies performed on wind climate, terrain error, building stock, and AAL. Verified that there was no change made to the model.

5.6.4 Sensitivity Analysis for Model Output

The modeler shall demonstrate that the model has been assessed with respect to sensitivity of temporal and spatial outputs to the simultaneous variation of input variables using accepted scientific and statistical methods. Statistical techniques used to perform sensitivity analysis shall be explicitly stated and the results of the analysis shall be presented in graphical format.

Reference: *Module 1, Section I, A.5 (critical variables determined from SA)* (page 37)
Module 1, Section II, B.13 (model sensitivity), (page 47)
B.14 (sensitivity in output results), (page 47)
B.15 (SA & UA performed on model) (page 47)
Module 3, Section VII, Form F (Hypothetical Events for SA & UA) (page 105)
Standard 5.2.10 (Temporal and Spatial Wind Field Characteristics) (page 13)

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

Professional Team Comments:

Reviewed results of ARA's sensitivity studies on simultaneous variations of input parameters. Reviewed examples of the impact on loss cost estimates of the different parameters used in the model.

Reviewed ARA's building stock sensitivity analysis study.

Reference: Individual Risk Sensitivity Study (Primary), Vol. II-G1
Individual Risk Sensitivity Study (Secondary), Vol. II-G2
Analysis of Florida Building Stock, Hurloss 3.0, Vol. III-A3

Reviewed details on the sensitivity studies performed on the Form F data. ARA's results were consistent with those expected by the Professional Team.

5.6.5 Uncertainty Analysis for Model Output

The modeler shall demonstrate that the temporal and spatial outputs of the model have been subjected to an uncertainty analysis using accepted scientific and statistical methods. The analysis shall identify and quantify the extent that input variables impact the uncertainty in model output as the input variables are simultaneously varied. Statistical techniques used to perform uncertainty analysis shall be explicitly stated and results of the analysis shall be presented in graphical format.

Reference: *Module 1, Section I, A.5 (assessment of uncertainty in loss costs produced by variables)* (page 37)
Module 1, Section II, B.9 (confidence intervals produced), (page 45)

B.13 (model sensitivity), (page 47)
B.14 (sensitivity in output results), (page 47)
B.15 (SA & UA performed on model) (page 47)
Module 3, Section VII, Form F (Hypothetical Events for SA & UA) (page 105)
Standard 5.2.10 (Temporal and Spatial Wind Field Characteristics) (page 13)

Audit: Although some modelers may use parameters as synonyms for input variables, the latter terminology is preferred here.

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

Professional Team Comments:

Reviewed details on the uncertainty studies performed on the Form F data. ARA's results were consistent with those expected by the Professional Team.

Reviewed graphical representations on the coefficient of variation in wind speeds.

5.6.6 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 using accepted scientific and statistical methods.

Reference: *Module 1, Section II, C.2 (expected loss estimates validation tests)* (page 48)
Module 3, Section V, #4 (output ranges), (page 117)
#5 (explanation of differences in output ranges from prior year), (page 85)
#6 (output ranges % change by county) (page 86)
#7 (maps of output ranges % change by county) (page 87)
Module 3, Section VII, Form D (Loss Costs)
Standard 5.6.3 (Uncertainty Characterization) (page 30)

Audit: Provide a graph assessing the accuracy associated with low impact areas such as Nassau County. Assess where appropriate, the contribution of simulation uncertainty via confidence intervals per 5.6.3.

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

Professional Team Comments:

Verified no changes to the model.

Modules Verification:

Module 1

Reviewed various flow-charts for the model components. Several questions addressed satisfactorily.

Module 2

Reviewed ARA's list of current clients and verified there was no change in the list of clients for ratemaking. Several questions addressed satisfactorily.

Module 3

Several questions addressed satisfactorily.

Form A

Verified no change in the model. ARA updates their ZIP Code database every 2 years. The next update will be completed by or before October 2003.

Form B

ARA response:

We determined that the Form B results provided in our original submission were incorrect. In the 2001 Standards year, the units of Rmax in the Form B input file changed from nautical miles to statute miles. We did not catch this change in our initial 2001 submission and subsequently revised our submission in May 2002. This year, because our hurricane model did not change, we simply re-used our Form B wind speeds from our 2001 submission. Our error was that we re-used our initial wind speeds from 2001 rather than our revised wind speeds. Revised copies of Form B are provided in XLS and PDF formats on the enclosed CDs.

Verified corrected Form B results using statute miles. Verified that the differences from last year's form were a result of changes made in the building stock.

Form C

Verified results of Form C and discussed the differences from last year's form.

Form D

A revised Form D adjusted through 2001 will be submitted.

Form E

Reviewed results in Form E and confirmed the changes in Part B were attributable to the changes made in the model. A revised Form E adjusted through 2001 will be submitted.

Form F

ARA presented their sensitivity and uncertainty analyses performed on the Form F data.

Reviewed contour plots of Cat 5 wind fields in Open Terrain and Real Terrain. Performed a detailed discussion of the differences in wind speed and changes in the wind speed.

Reviewed contour plots of ARA's sensitivity analysis runs for Cat 1, Cat 3, and Cat 5 hurricane Maximum Wind Speed in steps of time showing the standardized regression coefficients (SRC) for Central Pressure, Radius to Maximum Winds, Forward Translation Speed, and the Holland B parameter.

Reviewed contour plots of ARA's uncertainty analysis runs for Cat 1, Cat 3, and Cat 5 hurricane Maximum Wind Speed showing the expected percentage reductions (EPR) for Central Pressure, Radius to Maximum Winds, Forward Translation Speed, and the Holland B parameter.

Performed a detailed discussion of ARA's analysis on average loss cost percentage (total ground-up loss/total exposure). Reviewed contour plots of the sensitivity analysis for Cat 1, Cat 3, and Cat 5 hurricane ground-up loss percentage showing the standardized regression coefficients (SRC) for Central Pressure, Radius to Maximum Winds, Forward Translation Speed, and the Holland B parameter.

Reviewed contour plots of the uncertainty analysis for Cat 1, Cat 3, and Cat 5 hurricane ground-up loss percentage showing the expected percentage reductions (EPR) for Central Pressure, Radius to Maximum Winds, Forward Translation Speed, and the Holland B parameter.

Discussed ARA's conclusions drawn from the SA/UA studies with Form F. ARA's results matched those prepared by the Professional Team.