Professional Team Report to the
Florida Commission on Hurricane Loss Projection Methodology

AIR Worldwide Corporation
On-Site Review
November 3 & 4, 2010

On November 3 & 4, 2010, a subset of the Professional Team visited on-site at AIR Worldwide Corporation (AIR) in Boston, Massachusetts. The following individuals participated in the review:

AIR
Brandie Andrews, Risk Consultant
Tanya Bedore, Senior Technical Writer
Steve Dobro, Quality Assurance Manager
Tim Doggett, Ph.D., Principal Scientist Atmospheric Science, Research and Modeling
Jonathan Holden, Assistant Vice President
Vineet Jain, Ph.D., Principal Engineer, Research and Modeling
Shiraj Khan, Ph.D., Senior Engineer, Research and Modeling
Ellen Langhans, Communications Specialist
David Lalonde, FCAS, FCIA, MAAA, Senior Vice President
Stuart Miller, Ph.D., ARe, Senior Risk Consultant
Rob Newbold, Vice President, Consulting Services Group
Sudhir Potharaju, Software Engineering Director & Assistant Vice President
Ivelin Zverdov, Manager of Statistical Analysis/Numerical Models

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

On October 7, 2010, AIR Worldwide Corporation informed the Chair of the Florida Commission on Hurricane Loss Projection Methodology (Commission) that they had discovered a "software implementation issue… when using certain combinations of unknown construction, unknown height, and unknown occupancy." The letter also stated, "mobile homes are not impacted by this issue."

AIR described that when the "enhancement [to use region-specific building inventory weights] was introduced in CLASIC/2, the issue was inadvertently introduced in the coding that applied the region-specific weights," and that "specifically, an incorrect implementation in the code assigned incorrect weights to a few combinations of unknown construction, occupancy, and height, which caused differences in losses to exposures modeled with these combinations." AIR

asked "the Commission to consider and reaffirm certification of AIR's Atlantic Tropical Cyclone Model Version 12.0 as implemented in CLASIC/2 Version 12, which would include CLASIC/2 version 12.1 and subsequent releases of software CLASIC/2 Version 12, as meeting the standards of the FCHLPM."

AIR also stated, "the entirety of [the Florida Hurricane Catastrophe Fund] exposure data set was coded with unknown height." AIR stated its intent "to resubmit the output ranges utilizing a height category of low rise both for single family residential risks and apartments and condominiums," and that "the effect" would be an increase in "the output ranges by approximately 10%."

On October 18, 2010, the Chair of the Commission decided to call an emergency meeting of the Commission to determine whether to temporarily suspend the acceptability of Atlantic Tropical Cyclone Model Version 12.0, Program CLASIC/2 Version 12.0 as well as to determine if the Professional Team should review the corrective actions taken by AIR Worldwide Corporation resulting in the model version number changes to Atlantic Tropical Cyclone Model Version 12.0.1, Program CLASIC/2 Version 12.0.4.

On October 22, 2010, AIR submitted a revised Form A-6 using a height category of low rise for both single family residential risks and apartments and condominiums. The Professional Team determined the information submitted in Form A-6 alone was insufficient to providing information relative to the error.

On October 26, 2010, the Commission held an emergency conference call meeting. During this meeting, the Professional Team requested a revised Form A-7 which would expedite its analysis of the output ranges error. AIR then submitted a revised Form A-7 on October 26, 2010, indicating the changes in the output ranges from the submitted and accepted output ranges to the output ranges assuming the height category of low rise both for single family residential risks and apartments and condominiums. It was immediately evident there were increases in excess of the "approximately 10%" as stated by the modeler. The Professional Team determined that the increases greater than 10% were generally due to the effect of the error on the vulnerability curve for contents and additional living expense. The Professional Team also found changes in the output ranges for some categories (such as mobile homes) that appeared to be due to something other than the error being analyzed.

At this point during the Commission meeting, AIR described a minor error in addition to the error previously reported. Hence, at the completion of the Commission meeting, there were two separate and distinct errors requiring resolution.

The Commission voted to temporarily suspend the acceptability of Atlantic Tropical Cyclone Model Version 12.0, Program CLASIC/2 Version 12.0 and authorized a subset of the Professional Team to conduct an on-site review of the relevant documents and corrections implemented by AIR.

On October 29, 2010, AIR submitted revised Forms A-3, A-4, and A-5 "regenerated in the updated software." On November 1, 2010, AIR submitted revised Forms A-6, A-7, A-8, and S-5 "based on Atlantic Tropical Cyclone Model Version 12.0.1, Program CLASIC/2 Version 12.0.4. Revised Forms A-9 and S-2 were received on November 2, 2010, and revised Forms S-4 and S-6 were provided on-site on November 3, 2010.

The Professional Team began the on-site review on November 3, 2010 asking if any other errors had been discovered. AIR stated there were no additional errors to report and provided an overview of the source of the known errors and their solutions within the source code that resulted in the release of CLASIC/2 Version 12.0.4.

Review and Discussion of Error #1

Error #1 is the result of applying an incorrect regional modifier in the vulnerability module. The regional modifiers were a new enhancement in model Version 12.0. The error consisted of an incorrect initialization of the variable 'nRow' that is used as an index value in an array. When certain combinations of unknown occupancy, unknown construction, and unknown height were used, the code returned the first row of the array rather than assigning the expected default value of 1.0. An incorrect assumption of the array index range was also made resulting in the use of incorrect factors.

The following summarizes the activities of the on-site review:

Discussed when the error was discovered internally by the Consulting and Client Services Group, and then subsequently reported as a problem by a client. Discussed the losses misstated, and their impact on all coverages.

Reviewed AIR's internal procedure that is followed when a software/model error is identified by a client. AIR notified companies licensing CLASIC/2 to alert them of the impact on loss estimates for locations modeled using certain combinations of unknown height, occupancy, and construction.

Reviewed the solutions and corrective actions implemented in the source code. The solution for the first issue was to initialize the array index to a value other than "0" so that an entry from the array itself would not be returned when primary vulnerability characteristics are unknown. The solution for the second issue was to subtract "one" from the row index.

Reviewed the requirements, implementation, and testing of the unknown regional modifiers in the source code. Discussed the three types of testing performed to test the implementation of the unknown regional modifiers – positive, negative, and system.

Reviewed the test results from Version 12.0. Discussed why the error was not discovered during the original testing and the assumptions made when reviewing the test cases. AIR stated it was not obvious from the tests results to isolate the effect of regional modifiers. A

custom build was needed for those test cases. Hence, the right test cases were not originally identified.

Reviewed the modified test coverage for the vulnerability module.

Reviewed AIR's software development and software testing processes.

Reviewed AIR's plan for process improvement to prevent similar mistakes from occurring in future releases including improvements to employee training, more in-depth peer code reviews for high risk areas of code, and requiring "stakeholders" from the various departments to identify test cases and to review the test results for software and model features.

Discussed gaps identified in AIR's training process. In an effort to prevent similar mistakes from occurring in future releases, AIR will implement or improve upon three business practices that are designed to aid AIR employees who are involved in software engineering development, validation, and testing. These business practices include:

1) Creating a software engineering development, implementation, and validation checklist designed to ensure that development, validation, and testing efforts are aligned with the standards set forth by the Florida Commission on Hurricane Loss Projection Methodology;
2) Company-wide communication sessions committed to improving the communication between offices by implementing "structured" communication sessions to encourage involvement from all AIR employees; and
3) Employee training for all AIR employees who are involved in software engineering development, validation, and testing. AIR will implement a training program that all software developers and testers are expected to participate in every 6 months. This training will focus on coding and testing best practices standards, including the development of effective test plans, reviewing test plans, and understanding coding best practices/standards.

Additional process improvement initiatives include enhancing the software impact template, a review of test results, and the process for the development of requirements.

The Professional Team informed AIR that the process improvements will be reviewed during our next on-site review.

Reviewed the software test plans and results for 5 basic test cases for CLASIC/2 Version 12.0.4 performed by the Quality Assurance group to validate the numbers generated by the model.

Reviewed technical document CLASIC/2 Version 12.0.4 Update, November 2010, and revisions made during the on-site review for further details and clarification.

Reviewed C++ Coding Guidelines technical documentation revised during the on-site review for documenting the programming style change in assigning default values.

Review and Discussion of Error #2

Error #2 is the result of improper options used in the import of the exposure file with some ZIP Codes being ignored for the 1% deductible column in the output ranges.

Discussed the process for producing the output ranges and the absence of checks in the business workflow system for these types of errors. Reviewed modified guidelines for preparing the output ranges report including language to specifically check options when the import begins and once completed.

Reviewed technical document Output Range Report – Guidelines for Preparation, November 2010.

Reviewed several counties where the difference from Version 12.0 to Version 12.0.4 was greater than 11.11%. These increases were attributable to rounding and to the effects of demand surge and other criteria on the higher losses.

Reviewed software code for the mean damage ratio calculation for additional living expense coverage.

Reviewed apparent anomalies related to output range effects by deductible.

Discussed the change in Form A-6 for mobile homes in Clay County from Version 12.0 to Version 12.0.1 which was a result of rounding.

Professional Team Conclusion

After a thorough and comprehensive review of the errors and corrective actions implemented, as well as relevant documents, the Professional Team verifies that Atlantic Tropical Cyclone Model Version 12.0.1, Program CLASIC/2 Version 12.0.4 meets the 2009 standards.

The Professional Team reviewed the following revised pages from the May 21, 2010, final revised submission which will be provided electronically by November 5, 2010, with hard copies to follow no later than November 10, 2010.

1. Model Submission Checklist
2. Model Identification
3. Standard G-1, Disclosure 1
4. Form G-1
5. Form G-3
6. Form G-4
7. Form G-5
8. Form G-6
9. Form G-7
10. Standard V-1, Disclosure 2, Figures 23, 24, 25, 26, 27, 28

11. Standard A-6.G, Table 12
12. Standard A-6, Disclosure 1, Figures 30, 31, 32
13. Standard A-6, Disclosure 2, Figures 33, 34, 35
14. Standard A-8.B, Figure 38
15. Standard A-8, Disclosure 1, Figure 39
16. Standard A-9.C, Figure 41
17. Standard A-9, Disclosure 2, Figure 42
18. Form A-3
19. Form A-4
20. Form A-5
21. Form A-6
22. Form A-7
23. Form A-8
24. Form A-9
25. Standard S-1, Disclosure 6, Figure 77
26. Standard S-5, Disclosure 1, Tables 19, 20, 21, 22
27. Standard S-6 response
28. Form S-2
29. Form S-4
30. Form S-5
31. Form S-6
32. Standard C-1.A and C
33. Standard C-4, Disclosure 1 and Table 25
34. Attachment A, Project Information Assumption Form

Response to Commission Query Concerning All Modeling Organizations

MITIGATION OF FUTURE ERRORS:

The models found acceptable by the Commission represent very large and complex software engineering products. These products contain on the order of 10^4 to 10^5 lines of code. This corresponds to at least order 10^5 machine code operations (e.g., half a million). For a language such as C++, these operations are native to the architecture (x86, x86-64), and for some other languages (Java), a virtual machine is employed. Errors in software construction, like in house construction, can easily result in massive failure. Think of a house as being constructed from Jenga but with pieces drawn from a variety of shapes and sizes, and that is a reasonable physical analogy. Removing a piece or changing its shape or size may leave the structure intact, may cause a slight failure, or may cause total

failure. Jenga captures the interaction effects similar to those in software, whereas for a house, there are few such effects. Mitigation of errors and failure is achieved through a thorough and complete Q&A process, such as the use of exception (try/catch) and event handling (e.g., assert, verify) as well as software testing, with special emphasis on boundary conditions. The best approach is to ensure a complete process of writing and testing quality code. Bug fixing should always reflect back on the process rather than to trigger simple fixes. The simple fix may solve the immediate problem with one software component, when a more serious problem may be present within the software engineering process being used.

PROPOSED ACTIONS BY ALL MODELING ORGANIZATIONS FOR MITIGATION OF FUTURE ERRORS:

1. Analyze and improve Q&A procedures corresponding with Standard C-5, specifically.
2. Improve, or institute, in-house training for all model-specific personnel on Computer Standards.

PROPOSED PROFESSIONAL TEAM ACTIONS FOR MITIGATION OF FUTURE ERRORS:

1. Increase the time of audit, especially during review of changes triggered by: (a) significant change in the Report of Activities, (b) significant change by the modeler.
2. Create a standard requiring modelers to use only personnel with the appropriate computer science or computer engineering background (modeler qualification) when programming for the model version that is used to determine loss costs. Other programming activities (preliminary, exploratory, research, pre-model-deployment) need not have this requirement.