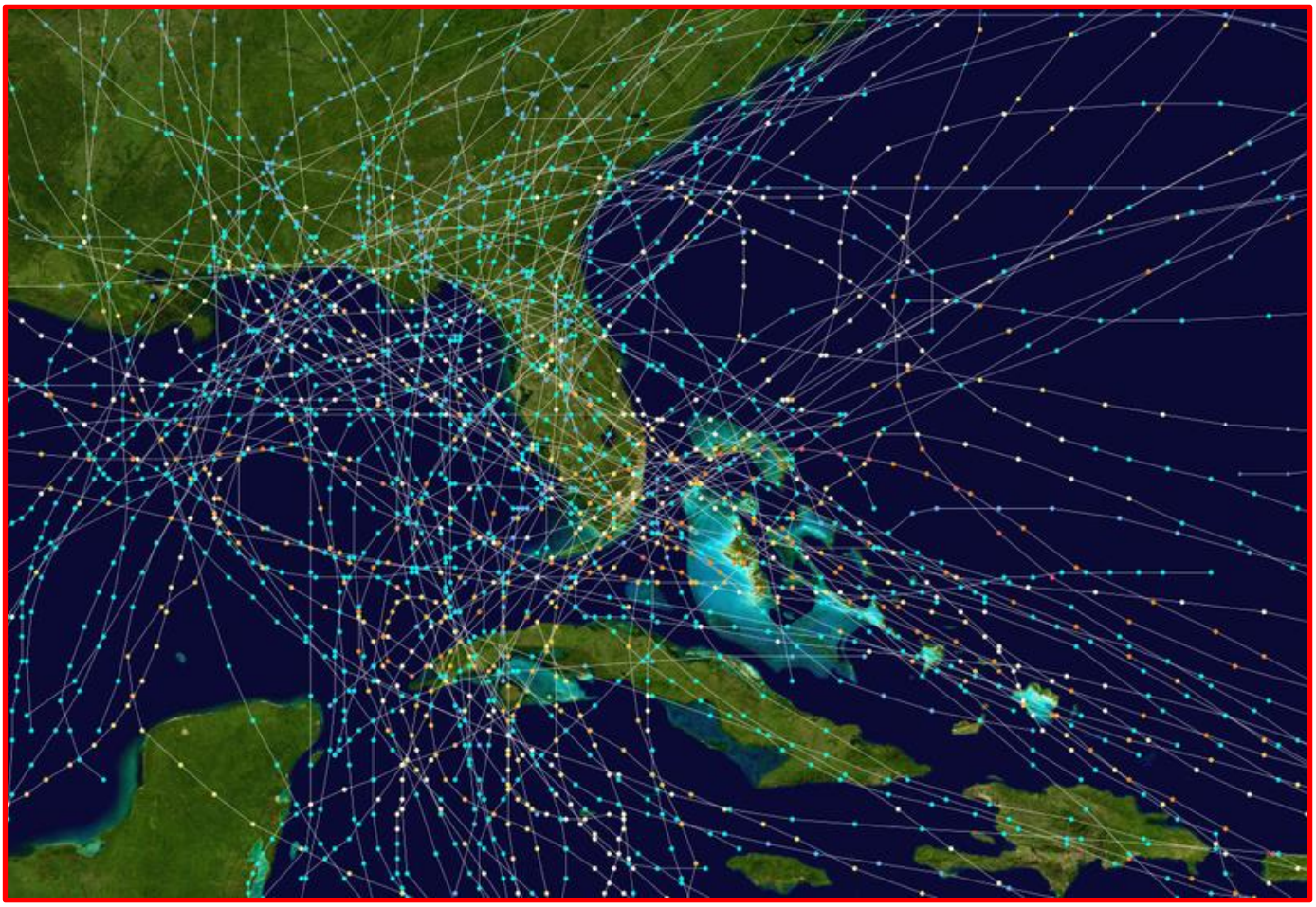
Florida Commission on Hurricane Loss Projection Methodology

Professional Team Report
2013 Standards



Florida Public Hurricane Loss Model
Florida International University

On-Site Review
February 2-4, 2015

Additional Verification Review
May 4, 2015

On February 2-4, 2015, the Professional Team conducted an audit on-site at Florida International University (FIU) in Miami, Florida of the Florida Public Hurricane Loss Model. The following individuals participated in the review:

FIU

Bachir Annane, Senior Research Associate III, CIMAS/HRD
Jing Chang, M.S. Information Technology student, Florida International University
Shu-Ching Chen, Ph.D., Professor, Director, Distributed Multimedia Information Systems Laboratory, School of Computing and Information Sciences, College of Engineering and Computing, Florida International University
Steve Cocke, Ph.D., Associate Scholar/Scientist, Department of Meteorology and COAPS, Florida State University
Xiaoyu Dong, M.S. Computer Science student, Florida International University
Gail Flannery, FCAS, MAAA, Consulting Actuary, AMI Risk Consultants, Inc., Miami, Florida
Raul Garcia, M.S. Computer Science student, Student Programmer, Florida International University
Sneh Gulati, Ph.D., Professor, Department of Statistics, Florida International University
Kurt Gurley, Ph.D., Associate Professor, Department of Civil and Coastal Engineering, College of Engineering, University of Florida
Hsin-Yu Ha, Ph.D. Computer Science Candidate, Florida International University
Tian Haiman, Ph.D. Computer Science Candidate, Florida International University
Shahid Hamid, Ph.D., CFA, Professor, Department of Finance, College of Business Administration, Florida International University
Junjie Hou, M.S. Computer Engineering student, Florida International University
Timothy Johnson, M.S. Civil Engineering student, Florida Institute of Technology
Golam Kibria, Ph.D., Professor, Mathematics and Statistics, College of Arts and Sciences, Florida International University
Qinghau Liang, M.S. Computer Engineering student, Florida International University
Yuexin Liu, M.S. Computer Engineering student, Florida International University
Diana Machado, M.S. Computer Science student, Student Programmer, Florida International University
Jean-Paul Pinelli, Ph.D., Professor, Civil Engineering Department, Florida Institute of Technology
Samira Pouyanfar, Ph.D. Computer Science Candidate, Florida International University
Mark Powell, Ph.D., Atmospheric Scientist, President, HWind Scientific
Wenbo Wang, M.S. Information Technology student, Florida International University
Johann Weekes, Ph.D. Civil Engineering, University of Florida
Yimin Yang, Ph.D. Computer Science Candidate, Florida International University

Professional Team

Paul Fishwick, Ph.D., Computer Scientist
Mark Johnson, Ph.D., Statistician, Team Leader
Tom Schroeder, Ph.D., Meteorologist
Del Schwalls, P.E., Hydrologist, observer
Marty Simons, ACAS, Actuary
Masoud Zadeh, Ph.D., P.E., Structural Engineer
Donna Sirmons, Staff

The review began with introductions and an overview of the audit process by the Professional Team. FIU then gave a presentation on the changes in the model from the previous submission and the revised percentage changes to the loss costs from those reported in the November 1, 2014 submission.

Changes to the meteorology component included:

1. Update to the recent version of HURDAT2 (April 1, 2014) including storms through the 2013 hurricane season,
2. Rmax dataset used for modeling the stochastic Rmax parameter revised to include recent storms and revisions to historical storms,
3. Update to the ZIP Code database to the December 2013 ZIP Code boundaries,
4. Update to the more recent Land Use/Land Cover dataset (National Land Cover Database 2011 and Florida Water Management District 2004-2011).

Changes to the vulnerability component included:

1. Projectile count increase in the debris impact model,
2. Interior pressure sharing between attic and top floor revised,
3. Interior pressure calculation in the attic space due to sheathing loss revised,
4. Soffit damage computation revised,
5. Pressure Coefficient multiplier reduced,
6. Masonry wall area failure function and its differentiation between unreinforced and reinforced masonry modified,
7. Rain Admittance Factor (RAF) values revised,
8. New surface run-off coefficient (SRC),
9. Directionality factor replaced with a more sophisticated directionality scheme,
10. Statistics used to weigh low-rise commercial residential matrices updated,
11. Additional volume of water penetration included for model of the upper story of mid/high-rise commercial residential model.

FIU explained further changes in the low-rise commercial residential model since the November 1, 2014 submission (from version 6.0 to version 6.1) attributable to error discoveries:

1. Modeling of gable end damage for masonry models,
2. Further modification of the masonry wall area failure function and its differentiation between unreinforced and reinforced masonry,
3. Rain penetration model.

FIU provided an explanation for the mistake in generating the commercial residential losses in Form A-4B submitted on November 1, 2014 as reported to the Commission on January 22, 2015. An outdated shell script was incorrectly used due to a human error, to select the losses of one output file to be added into a final loss file to generate the form. FIU discussed how the error was discovered and their confidence that Form A-4B was the only form affected.

FIU provided an overview of the new and extensively updated material in the vulnerability component changes in version 6.1 (January 22, 2015 submission):

1. Rain intrusion model to calculate interior damage,
2. Recent test data on the rain deposition and surface run-off characteristics incorporated into the interior damage model,
3. Directionality scheme adopted to account for local storm rotation.

In the previous two visits to verify the 2011 standards for the Florida Public Hurricane Loss Model on January 21-23, 2013, and on April 15, 2013, the Professional Team noted that there were significant inter-group communication issues. Dr. Hamid introduced a new written policy at that time to address future issues, and mitigate errors that might occur in the future. In particular, one of the goals was to ensure that all model teams would be using SVN (Source Versioning System) as a way of documenting source code in a central repository.

During this visit, the Professional Team determined that the policy put in place during the 2013 on-site reviews was being followed, and the code was being checked-in and out of the SVN repository.

Discussed the role of the Computer Science Team in preparing the forms provided in the submission. This role included emails from one team to another, especially during the detection of the problems with commercial residential loss costs, resulting in model version 6.1.

During the review of the procedure for processing the 2012 FHCF exposure data, it was discovered the modeler incorrectly changed all 0 risk counts to 1 in the exposure data. Consequently, all forms using the 2012 FHCF exposure data were completed inaccurately.

The Professional Team was unable to verify standards:

- G-1 pending verification of other standards
- G-2 pending signatories
- G-4 pending verification of other standards
- S-1 pending verification of revised Forms S-2B, S-4 and S-5
- S-5 pending verification of revised Form S-4, Table 16, and Table 17
- S-6 pending verification of revised Form S-5
- A-2 pending verification of revised Form A-2 (2012)
- A-6 pending verification of revised Forms A-2 (2012), A-3B, A-4B, A-8 (both A and B), S-2B and S-5
- C-2 pending a complete requirements document
- C-4 pending verification of other standards and elaboration of documentation related to equation/variable mapping covered during the audit
- C-5 pending verification of other standards

At the exit briefing, modeler options as given in the *Report of Activities* were presented to the modeler.

The Professional Team reviewed the following corrections to be included in the revised submission which is to be provided to the Commission no later than 10 days prior to the meetings for reviewing models for acceptability. Page numbers correspond to the January 5, 2015 submission in response to the deficiencies.

- Page 2, Model Identification – updated to reflect current model name and version
- Page 38, G-1 Disclosure 2 – updated for Florida Building Code Wind-Borne Debris Region and High Velocity Hurricane Zone
- Page 47, G-1 Disclosure 2 – updated for vintage of RSMeans data
- Page 50, G-1 Disclosure 2 – Figure 12 legend updated to reflect current model version, text revised to correctly reflect the process for unknown characteristics
- Page 55, G-1 Disclosure 2 – updated for Florida Building Code Wind-Borne Debris Region and High Velocity Hurricane Zone
- Page 102, G-1 Disclosure 4 – updated to include RSMeans references

- Page 123, G-1 Disclosure 5.D – Figure 22 revised
- Pages 167-168, M-5 Disclosure 2 – Captions for Figure 30 and Figure 31 revised
- Page 242, V-1 Disclosure 3 – updated to reflect new claims data received
- Page 274, V-1 Disclosure 8 – updated for Florida Building Code Wind-Borne Debris Region and High Velocity Hurricane Zone
- Page 275, V-1 Disclosure 12 – revised to correctly reflect the process for unknown characteristics

Additional Verification Review – May 4, 2015

FIU submitted revisions to the revised January 5, 2015 model submission (FPHLM 6.0) under the 2013 Standards dated April 8, 2015. The Professional Team completed an additional verification review of FPHLM 6.1 on May 4, 2015 in Miami.

The following individuals participated in the additional verification review.

FIU

Jing Chang, M.S. Information Technology student, Florida International University
Shu-Ching Chen, Ph.D., Professor, Director, Distributed Multimedia Information Systems Laboratory, School of Computing and Information Sciences, College of Engineering and Computing, Florida International University
Steve Cocke, Ph.D., Associate Scholar/Scientist, Department of Meteorology and COAPS, Florida State University
Xiaoyu Dong, M.S. Computer Science student, Florida International University
Gail Flannery, FCAS, MAAA, Consulting Actuary, AMI Risk Consultants, Inc., Miami, Florida
Raul Garcia, M.S. Computer Science student, Student Programmer, Florida International University
Sneh Gulati, Ph.D., Professor, Department of Statistics, Florida International University
Kurt Gurley, Ph.D., Associate Professor, Department of Civil and Coastal Engineering, College of Engineering, University of Florida
Hsin-Yu Ha, Ph.D. Computer Science Candidate, Florida International University
Tian Haiman, Ph.D. Computer Science Candidate, Florida International University
Shahid Hamid, Ph.D., CFA, Professor, Department of Finance, College of Business Administration, Florida International University
Junjie Hou, M.S. Computer Engineering student, Florida International University
Golam Kibria, Ph.D., Professor, Mathematics and Statistics, College of Arts and Sciences, Florida International University
Qinghau Liang, M.S. Computer Engineering student, Florida International University
Yuexin Liu, M.S. Computer Engineering student, Florida International University
Diana Machado, M.S. Computer Science student, Student Programmer, Florida International University
Samira Pouyanfar, Ph.D. Computer Science Candidate, Florida International University
Mark Powell, Ph.D., Atmospheric Scientist, President, HWind Scientific
Wenbo Wang, M.S. Information Technology student, Florida International University
Yimin Yang, Ph.D. Computer Science Candidate, Florida International University

Professional Team
Paul Fishwick, Ph.D., Computer Scientist
Mark Johnson, Ph.D., Statistician, Team Leader
Michael Smith, FCAS, MAAA, Actuary, observer
Masoud Zadeh, Ph.D., P.E., Structural Engineer
Donna Sirmons, Staff

The additional verification review began with a discussion of the outstanding issues from the initial on-site review in February. FIU confirmed no additional changes were discovered or made since the revised submission dated April 8, 2015.

FIU provided an overview of the change in procedures for processing the FHCF exposure data and the resulting percentage changes in loss costs and the revised actuarial forms. FIU informed the Professional Team of an error in Form A-3B due to incorrect demand surge factors applied for Form A-3B losses. FIU confirmed no other forms were affected by the error. FIU addressed how the error occurred and the approach to preventing a recurrence.

During the review of the validation analyses, FIU informed the Professional Team of errors in the final submission for version 5.0 under the 2011 Standards for Tables 29 & 30 under Standard S-5, Disclosure 1. The Professional Team informed FIU that these corrections with a letter of explanation should be provided to the Commission along with the corrected Form V-1 discovered during the February on-site review.

The Professional Team reviewed all revised forms and materials in the April 8, 2015 re-submission. The Professional Team also reviewed the following additional corrections to be included in the final revised submission which is to be provided to the Commission no later than May 22, 2015.

- G-1 Disclosure 5.B – overall statewide percentage change in loss cost corrected
- S-4 Disclosure 1 – minimum number of years required corrected
- Form S-2B – revised to correct the interquartile range in Part B
- Form S-5 – revised to correct the historical losses and confidence intervals in Part A and Part B and to correct the title of Part A to reflect personal and commercial residential loss costs

All standards are now verified by the Professional Team.

Report on Deficiencies

The Professional Team reviewed the following deficiencies cited by the Commission at the December 16, 2014 meeting. The deficiencies were eliminated by the established time frame, and the modifications have been verified.

1. Figure numbering is non-responsive to Acceptability Process II.A.5.c requirement (page 47) in the *Report of Activities.*

2. Standard G-1, Disclosure 4 (pages 71-104)
   Response is incomplete as the Statewide 2004-2011 Florida Water Management District data set provided in response to Standard G-1, Disclosure 5.A.1 (page 105) is not included in the List of References.

3. Standard G-1, Disclosure 5.A.1 (page 105)
   Response is unclear as the reformatted NOAA historical database was renamed to HURDAT2 in 2012.

4. Standard G-1, Disclosure 5.A.3 (page 106)
   Response is unclear as the latest version of HURDAT2 was released in May 2014.

5. Standard G-1, Disclosure 5.C (pages 109-111)
   Maps in Figures 20-22 are non-responsive to the Acceptability Process II.A.5.e.2 requirements (page 47) in the *Report of Activities*.

6. Standard G-2, Disclosure 1.B (page 113)
   Response is unclear as Figure 23 is unreadable in the printed version.

7. Standard G-2, Disclosure 2.C (page 117)
   Response is unclear as Figure 24 is unreadable in the printed version.

8. Form G-2 (page 125)
   Response is incomplete as the Name of Model and Mark Powell's professional credentials are not included.

9. Form G-3 (page 126)
   Response is incomplete as Sneh Gulati's professional credentials are not included.

10. Form G-6 (page 129)
    Response is incomplete as Shu-Ching Chen's professional credentials are not included.

11. Standard M-4, Disclosure 9 (page 145)
    Response is non-responsive as it does not describe and justify the appropriateness of the databases used in the windfield validations.

12. Standard S-1, Disclosure 1 (page 171)
    Response is incomplete as specific goodness-of-fit tests are not included for hurricane landfalling frequencies.

13. Form S-4.C (pages 202-205)
    Response is unclear as Figures 48-53 use of common axis scales does not present a meaningful graphical representation.

Report on Issues

The Professional Team discussed the following issues identified by the Commission at the December 16, 2014 meeting. The modeler is to address these issues with the Commission during the meeting to review the model for acceptability.

1. How Florida Building Code enforcement of reinforced and unreinforced masonry is handled in the model. What is the default condition in the model post 2002? If the data is available, does the model take this into account, and if so, how?

2. How screen enclosures for both attached and unattached are handled in the model.

Professional Team Pre-Visit Letter

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

Pre-Visit Letter

The purpose of the pre-visit letter is to outline specific issues unique to the modeler's submission, and to identify lines of inquiry to be followed during the on-site review to allow adequate preparation by the modeler. Aside from due diligence with respect to the full submission, various questions that the Professional Team is certain to ask the modeler during the on-site review are provided in this letter. This letter does not preclude the Professional Team from asking for additional information during the on-site review that is not given below or discussed during an upcoming conference call that will be held if requested by the modeler. One goal of the potential conference call is to address modeler questions related to this letter or other matters pertaining to the on-site review. The overall intent is to expedite the on-site review and to avoid last minute preparations that could just as easily have been handled earlier.

Some of this material may have been shown or may have been available on a previous visit by the Professional Team. The Professional Team will also be considering material in response to deficiencies and issues designated by the Florida Commission on Hurricane Loss Projection Methodology (Commission).
The goal of the Professional Team on-site review is to provide the Commission with a clear and thorough report of the model, subject to non-disclosure restrictions on proprietary information. All modifications, adjustments, assumptions, or other criteria that were included in producing the information requested by the Commission 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 Professional Team simultaneously. The Professional Team will review selected computer code in conjunction with the reviews performed for each section. Computer code should be readily available in a format that will allow simultaneous visualization by the entire Professional Team. Access to critical articles or materials referenced in the submission or during the on-site review should be available on-site for the Professional Team. The Professional Team

should be provided access to internet connections through the Professional Team members' laptops for reference work that may be required while on-site.

The on-site schedule is tentatively planned to proceed in the following sequence: (1) presentation by the modeler of new or extensively updated material related to the model; (2) section by section review commencing within each section with pre-visit letter responses; (3) responses to new or significantly changed standards in the 2013 Report of Activities, and (4) responses to the audit items for each standard in the Report of Activities.

We note that the submission document does not include a date and time in the footnote which could be construed as non-responsive to the requirements in the Acceptability Process (II.A.5.b, page 47). In lieu of reprinting the entire document to abide by this requirement, we will accept page changes that do abide by the requirement during the on-site review. Likewise, the submission is deficient by not placing the forms in an Appendix.

Be prepared to have available for the Professional Team's consideration, all insurance company claims data received or newly processed since the previous submission. Be prepared to describe any processes used to amend or validate the model that incorporates this data.

Provide an explanation for each loss cost change of more than 5% from the loss costs produced in the previous submission using the 2007 Florida Hurricane Catastrophe Fund (FHCF) exposure data to the corresponding loss costs produced in the current submission using the 2007 FHCF exposure data.

When the Professional Team arrives on-site, provide five (5) printed copies of all figures with scales for the *X* and *Y* axes labeled that are not so labeled in the submission. Label the figures with the same figure number as given in the submission. Also, provide five (5) printed copies of Form V-3 and the electronic file used to complete Form V-3 on a removable drive medium. This material will be used during the on-site review and will be returned when the on-site review is complete. Additionally, provide five (5) printed copies of Form A-6 (all 8 worksheets) and the electronic file(s) used to complete Form A-6 and Form A-7. The electronic files will be examined only on-site and will be deleted from the Professional Team member's laptop at the conclusion of the review.
Be prepared to provide for the Professional Team's review all engineering data (post event surveys, tests, etc.) received since the previous review by the Professional Team. Be prepared to describe any processes used to amend or validate the model that incorporates this data.

Be prepared to demonstrate how the modeler is consistently using the Source Versioning System implemented as there appears to still be a systemic problem. Discuss any changes made to improve the correspondence and communications between modeling teams as described in the Professional Team Report, 2011 Standards, On-Site Review January 21-23, 2013 and Additional Verification Review April 15, 2013, with excerpts below:

January 21-23, 2013:
In 2011, the Professional Team performed two reviews of the Florida Public Model. The first review was on-site and conducted March 14-17, 2011. The second, additional verification, review was held on June 6 and 7, 2011. During these reviews, the Professional Team emphasized existing poor correspondence and connections between, and among, different model teams. These teams include experts in meteorology, actuarial science, structural engineering, statistics, and computer science. The modeler produced measures designed to mitigate problems occurring as a result of the problems in correspondence and communication. These measures were discussed on Page 4 (Preamble) and Page 61 (Standard C-1) of the Professional Team's 2011 report.

During the current audit, it became clear that many of the same substantial issues raised during the 2011 audit remained. In particular, inter-group communications remain problematic. The Professional Team emphasized the importance of improving these issues. Dr. Shahid Hamid (signatory on Form G-1) recognized that problems continue to exist. Dr. Hamid introduced a new written policy designed to further mitigate errors that appear to result from lack of coordination and communication. The Professional Team remains concerned about the recent history (2011-2013) of the coordination and communication problems. If the recent policy is successfully implemented, these problems should be mitigated.

In auditing the model, the Professional Team identified discrepancies in version dates between the model in the Source Versioning System and the submission timeline. The Source Versioning System has not been adopted by all modeler groups. Although evidence was provided to indicate that the model being reviewed and the model submission were concurrent, the system in place is not adequate.

A fully operational Source Versioning System needs to be implemented and then demonstrated with a re-run of the output ranges to assure that the current version of the model concurs with what was submitted. If these output ranges agree with those in the November 2012 submission, no further forms need to be completed.

April 15, 2013:
FIU began with a presentation on a version control system used by all model components to track all modifications to the code, model input data, and documentation. FIU stated project meetings were held to review SVN functionality, to discuss the repository structure, and to set up SVN clients. Individual meetings were also held to reinforce SVN knowledge. FIU demonstrated that SVN is now consistently used by all model components.

If any changes have been made in any part of the model or the modeling process from the descriptions provided in the original 2013 submission, provide the Professional Team with a complete and detailed description of those changes, the reasons for the changes

(e.g., an error was discovered), and all revised Forms where any output of the form changed.

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

The pre-visit comments are grouped by standards sections.

GENERAL STANDARDS – Mark Johnson, Leader

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

*(*Significant Revision)*

A. The computer model shall project loss costs and probable maximum loss levels for residential property insured damage from hurricane events.

B. The modeling organization shall maintain a documented process to assure continual agreement and correct correspondence of databases, data files, and computer source code to slides, technical papers, and modeling organization documents.

Audit

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

2. The process defined in Standard G-1.B will be: (1) reviewed for its inclusion of all stages of the modeling process, and (2) traced using the Computer Standards for one or more items listed in the response to Disclosure 5.

3. All software and data (1) located within the model, (2) used to validate the model, (3) used to project model loss costs and probable maximum loss levels, and (4) used to create forms required by the *Report of Activities*:
    a. Shall fall within the scope of the Computer Standards,
    b. Shall be located in centralized, model-level file areas, and
    c. Shall be reviewable interactively (viewed simultaneously by all Professional Team members in conjunction with the review of each standard).

4. Modeling organization specific publications cited must be available in hard or soft copy or via a web link.

5. Maps, databases, or data files relevant to the modeling organization's submission will be reviewed.

6. Provide the following information related to changes in the model from the initial submission this year to each subsequent revision.

    A. Model changes:
        1. A summary description of changes that affect, or believe to affect, the personal or commercial residential loss costs or probable maximum loss levels,
        2. A list of all other changes, and
        3. The rationale for each change.

B. Percentage difference in average annual zero deductible statewide loss costs based on the 2007 Florida Hurricane Catastrophe Fund's aggregate personal and commercial residential exposure data found in the file named *"hlpm2007c.exe"* for:
   1. All changes combined, and
   2. Each individual model component and subcomponent change.

C. For any modifications to Form A-4A (Output Ranges, 2007 FHCF Exposure Data) since the initial submission, additional versions of Form A-5 (Percentage Change in Output Ranges, 2007 FHCF Exposure Data):
   1. With the initial submission as the baseline for computing the percentage changes, and
   2. With any intermediate revisions as the baseline for computing the percentage changes.

D. Color-coded maps by county reflecting the percentage difference in average annual zero deductible statewide loss costs based on the 2007 Florida Hurricane Catastrophe Fund's aggregate personal and commercial residential exposure data found in the file named *"hlpm2007c.exe"* for each model component change:
   1. Between the previously accepted submission and the revised submission,
   2. Between the initial submission and the revised submission, and
   3. Between any intermediate revisions and the revised submission.

Pre-Visit Letter

1. G-1, Disclosure 2, page 39: Explain the use of RSMeans Residential Cost Data and Construction Estimating Institute (Langedyk & Ticola, 2002) to estimate cost of repair.

2. G-1, Disclosure 5.B, Vulnerability Component, page 107: Provide a sense of the impact of the various vulnerability changes.

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

Professional Team Comments:

This standard cannot be verified pending verification of other standards.

Reviewed changes to the meteorology and vulnerability components and the resulting impact of the changes to modeled loss costs.

Discussed the use of RSMeans Residential Cost Data and Construction Estimating Institute as the main source to estimate cost of repair. Discussed the RSMeans vintage being 2008. References listed under Disclosure 4 will be updated to include the 2008a and 2008b RSMeans references.

Discussed the process to assure agreement between databases, data files, and computer source code to modeling documents. Reviewed the flowchart for incorporating new research into the model. Reviewed inter-team communication document: Florida Public Hurricane Loss Model: Engineering Team Report of Activities, submitted to Dr. Shahid Hamid, Director, Laboratory for Insurance, Financial, and Economic Research, International Hurricane Research Center, Florida International University, Maintenance and Development of the Florida Public Loss Model: 2013-2014 Cycle, June 6, 2014.

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

Reviewed the revised percentage changes in average annual zero deductible statewide loss costs.

Verified after resolution of outstanding issues with other standards.

Reviewed the definition of Wind Borne Debris Regions (WBDRs) which depend on the Florida Building Code (FBC).

Reviewed the definition of High Velocity Hurricane Zone (HVHZ).

G-2 Qualifications of Modeling Organization Personnel and Consultants

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

B. The model and model submission documentation shall be reviewed by either modeling organization personnel or consultants in the following professional disciplines: structural/wind engineering (licensed Professional Engineer), statistics (advanced degree), actuarial science (Associate or Fellow of Casualty Actuarial Society), meteorology (advanced degree), and computer/information science (advanced degree). These individuals shall certify Forms G-1 through G-6 as applicable.

Audit

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

2. Forms G-1 (General Standards Expert Certification), G-2 (Meteorological Standards Expert Certification), G-3 (Statistical Standards Expert Certification), G-4 (Vulnerability Standards Expert Certification), G-5 (Actuarial Standards Expert Certification), G-6 (Computer Standards Expert Certification), and all independent peer reviews of the model under consideration will be reviewed. Signatories on the individual forms will be required to provide a description of their review process.

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

Pre-Visit Letter

3. G-2, Disclosure 2.B, page 116: Provide resumes of the personnel identified.

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

Professional Team Comments:

This standard cannot be verified pending verification of revised Forms G-1, G-3, G-5, G-6, and G-7.

Reviewed resumes of new personnel:

- Jing Chang, student, Computer Science, Florida International University; B.S. Software Engineering, Hebei University of Technology, Hebei, China

- Xiaoyu Dong, M.S. student, Computer Engineering, Florida International University, Miami, FL; B.S. Mathematics and Apply Mathematics, Hebei Science and Technology University, Hebei, China
- Tian Haiman, Ph.D. candidate, Computer Science, Florida International University, Miami, FL; M.S. Computer Engineering, Florida International University; B.S. Computer Science, Sun Yat-Sen University, Guangdong, China
- Junjie Hou, M.S. student, Computer Engineering, Florida International University, Miami, FL; B.S. Electronic and Information Engineering, China University of Geosciences, Beijing, China
- Qinghua Liang, M.S. student, Computer Engineering, Florida International University, Miami, FL; M.S. Interaction Design, Beihang University, Beijing, China; B.S. Math and Applied Math, Ningbo University, Zhejiang, China
- Yuexin Liu, M.S. student, Computer Engineering, Florida International University, Miami, FL; M.S. Cloud Computing, Beihang University, Beijing, China; B.S. Electrical Engineering, Northeast Dianli University, Jilin, China; B.S. Math, Northeast Dianli University
- Daniel Lopez, undergraduate student, Computer Science, Florida International University
- Samira Pouyanfar, Ph.D. candidate, Computer Science, Florida International University, Miami, FL; M.S. Artificial Intelligence, Sharif University of Technology, Tehran, Iran; B.S. Software Engineering, University of Isfahan, Isfahan, Iran
- Wenbo Wang, M.S. student, Information Technology, Florida International University, Miami, FL; B.S. Computer Science and Technology, North China University of Technology, Beijing, China
- Yilin Yan, Ph.D. candidate, Electrical and Computer Engineering, University of Miami, Coral Gables, FL; M.S. Computer Science and Engineering, National Taiwan Ocean University, Keelung, Taiwan; B.S. Computer Science and Technology, Beihang University, Beijing, China

Discussed that there were no departures of personnel attributable to violations of professional standards.

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

Verified after review of revised Forms G-1, G-3, G-5, G-6, and G-7.

G-3 Risk Location*

*(*Significant Revision)*

A. ZIP Codes used in the model shall not differ from the United States Postal Service publication date by more than 24 months at the date of submission of the model. ZIP Code information shall originate from the United States Postal Service.

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

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

D. If any hazard or any model vulnerability components are dependent on ZIP Code databases, the modeling organization shall maintain a logical process for ensuring these components are consistent with the recent ZIP Code database updates.

E. Geocoding methodology shall be consistent and justifiable.

Audit

1. Provide geographic displays for all ZIP Codes.
2. Provide geographic comparisons of previous to current locations of ZIP Code centroids.
3. Provide the third party vendor, if applicable, and a complete description of the process used to validate ZIP Code information.
4. The treatment of ZIP Code centroids over water or other uninhabitable terrain will be reviewed.
5. Examples of geocoding for complete and incomplete street addresses will be reviewed.
6. Examples of latitude-longitude to ZIP Code conversions will be reviewed.
7. Model ZIP Code-based databases will be reviewed.

Pre-Visit Letter

4. G-3.C, page 120: Provide maps of previous and current ZIP Code centroid locations (as has been done in previous reviews).
5. G-3, Disclosure 1, page 121: Explain the use of ZIP Code centroids to correct windspeeds.

6. G-3, Disclosure 3, page 121: Explain the methodology and process for conversion from latitude and longitude to street address or Zip Code.

Verified: YES

Professional Team Comments:

Reviewed geographic displays of ZIP Codes and comparisons of new centroid locations to previous locations for the entire state.

Discussed the methodology for using distance to coast in the windspeed correction module. Discussed for windspeed that the location is the only requirement and it is not necessary to have the ZIP Code. Discussed no reverse geo-coding utilized.

Discussed there is no conversion from latitude and longitude to street address required in the model as the input specification is provided separately by street address, ZIP Code, city, and county.

Reviewed ZIP Code centroid movements in several counties.

G-4 Independence of Model Components

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

Audit

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

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

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

Professional Team Comments:

This standard cannot be verified pending verification of other standards.

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

There was no evidence to suggest that one component of the model was artificially adjusted to compensate for another component.

Verified after resolution of outstanding issues with other standards.

G-5 Editorial Compliance

The submission and any revisions provided to the Commission throughout the review process shall be reviewed and edited by a person or persons with experience in reviewing technical documents who shall certify on Form G-7, Editorial Certification that the submission has been personally reviewed and is editorially correct.

Audit

1. Demonstrate that the person or persons who have reviewed the submission has had experience in reviewing technical documentation and such person or persons is familiar with the submission requirements as set forth in the Commission's *Report of Activities as of November 1, 2013*.

2. Describe all changes to the submission document since the previously accepted submission that might impact the final document submission.

3. Demonstrate that the submission has been reviewed for grammatical correctness, typographical accuracy, completeness, and inclusion of extraneous data or materials.

4. Demonstrate that the submission has been reviewed by the signatories on Forms G-1 through G-6 (Standards Expert Certification forms) for accuracy and completeness.

5. The modification history for submission documentation will be reviewed.

6. A flowchart defining the process for form creation will be reviewed.

7. Form G-7 (Editorial Certification) will be reviewed.

Verified: YES

Professional Team Comments:

Editorial items noted by the Professional Team were satisfactorily addressed during the audit. The Professional Team has reviewed the submission per Audit item 3, but cannot guarantee that all editorial difficulties have been identified. The modeler is responsible for eliminating such errors.

Discussed the change in the editorial review process since the previous submission.

Meteorological Standards – Tom Schroeder, Leader

M-1 Base Hurricane Storm Set*

*(*Significant Revision)*

A. Annual frequencies used in both model calibration and model validation shall be based upon the National Hurricane Center HURDAT2 starting at 1900 as of August 15, 2013 (or later). Complete additional season increments based on updates to HURDAT2 approved by the Tropical Prediction Center/National Hurricane Center are acceptable modifications to these storm sets. Peer reviewed atmospheric science literature can be used to justify modifications to the Base Hurricane Storm Set.

B. Any trends, weighting, or partitioning shall be justified and consistent with currently accepted scientific literature and statistical techniques. Calibration and validation shall encompass the complete Base Hurricane Storm Set as well as any partitions.

Audit

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

2. Provide a flowchart illustrating how changes in the HURDAT2 database are used in the calculation of landfall distribution.

3. Changes to the modeling organization Base Hurricane Storm Set from the previously accepted submission will be reviewed. Any modification by the modeling organization to the information contained in HURDAT2 will be reviewed.

4. Reasoning and justification underlying any short-term and long-term variations in annual hurricane frequencies incorporated in the model will be reviewed.

5. Modeled probabilities will be compared with observed hurricane frequency using methods documented in currently accepted scientific literature. The goodness-of-fit of modeled to historical statewide and regional hurricane frequencies as provided in Form M-1 (Annual Occurrence Rates) will be reviewed.

6. Form M-1 (Annual Occurrence Rates) will be reviewed for consistency with Form S-1 (Probability and Frequency of Florida Landfalling Hurricanes per Year).

7. Comparisons of modeled probabilities and characteristics from the complete historical record will be reviewed. Modeled probabilities from any subset, trend, or fitted function will be reviewed, compared, and justified against the complete historical record. In the case of partitioning, modeled probabilities from the partition and its complement will be reviewed and compared with the complete historical record.

Pre-Visit Letter

7. Form M-1.E, page 160: Describe how changes in HURDAT2 due to the re-analyses and additions of new hurricane seasons are incorporated into the Base Hurricane Storm Set. Individual cases may be reviewed.

Verified: YES

Professional Team Comments:

Reviewed the update to HURDAT2 as of April, 2014 which includes revisions from the reanalysis project for the period 1936-1950, and includes storms through the 2013 hurricane season. Discussed the impact of the significant changes to storms in the 1936-1950 reanalysis for NoName09 (1945), NoName04 (1947), NoName02 (1949), and Hurricane King (1950).

Discussed the revisions to the Rmax winds at landfall for NoName04 (1912).

Discussed the process for updating the historical storm set. Changes were primarily to storm intensity and dimensions.

Reviewed the storm track change for NoName02 (1949) and the potential significant increase in losses due to the more southerly track.

Reviewed Form M-1.

M-2 Hurricane Parameters and Characteristics

Methods for depicting all modeled hurricane parameters and characteristics, including but not limited to windspeed, radial distributions of wind and pressure, minimum central pressure, radius of maximum winds, landfall frequency, tracks, spatial and time variant windfields, and conversion factors, shall be based on information documented in currently accepted scientific literature.

Audit

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

2. Prepare graphical depictions of hurricane parameters as used in the model. Describe and justify:
   a. The data set basis for the fitted distributions,
   b. The modeled dependencies among correlated parameters in the windfield component and how they are represented,
   c. The asymmetric nature of hurricanes,
   d. The fitting methods used and any smoothing techniques employed.

3. The treatment of the inherent uncertainty in the conversion factor used to convert the modeled vortex winds to surface winds will be reviewed and compared with currently accepted scientific literature. Treatment of conversion factor uncertainty at a fixed time and location within the windfield for a given hurricane intensity will be reviewed.

4. Scientific literature cited in Standard G-1 (Scope of the Computer Model and Its Implementation) may be reviewed to determine applicability.

5. All external data sources that affect model generated windfields will be identified and their appropriateness will be reviewed.

6. Describe and justify the value(s) of the far-field pressure used in the model.

Pre-Visit Letter

8. M-2, Disclosure 1, pages 133-134: Provide the new data on Rmax and the fit that is now being used. Identify which data were removed from the previous Rmax database used in the fitting and explain why.

9. M-2, Disclosure 1, pages 133-134: Discuss how the new Rmax data is impacting B estimation.

10. M-2, Disclosure 1, pages 133-134: The use of NCEP data in the calculation of PI (and range of years included) will be reviewed.

Verified: YES

Professional Team Comments:

Reviewed revisions to the Rmax historical dataset used for modeling the stochastic Rmax parameter. Discussed the Rmax criteria and the domain for being included in the Rmax landfall dataset. Reviewed the Rmax change statistics with a total of 106 Rmax values in the current dataset compared to 115 previously. Reviewed the changes from the previously accepted model for the Rmax gamma distribution including mean, standard error, new shape and scale parameters, and parameter uncertainty.

Discussed the use of the landfall Rmax dataset in the stochastic model and the use of all available Rmax data for modeling historical storms.

Discussed the impact on Holland B estimation with the new Rmax data. Verified no change in the methodology with the B value developed from Willoughby and Rahn (2004). Discussed that for some historical storms, the B value may have changed if Rmax was revised.

Discussed NCEP databases used in potential intensity (PI) calculations.

Reviewed grid used to identify historical storms.

Reviewed changes in the Rmax database for historical storms NoName08 (1906), NoName05 (1910), NoName04 (1912), NoName05 (1924), NoName10 (1926) and Hurricane Georges (1998) and the impact on loss costs.

Discussed changes in the intensity and track for NoName10 (1926) due to the HURDAT reanalysis changing from a category 2 to a category 3. These changes should have been included in the previous submission.

M-3 Hurricane Probabilities*

*(*Significant Revision)*

A. Modeled probability distributions of hurricane parameters and characteristics shall be consistent with historical hurricanes in the Atlantic basin.

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

C. Models shall use maximum one-minute sustained 10-meter windspeed when defining hurricane landfall intensity. This applies both to the Base Hurricane Storm Set used to develop landfall frequency distributions 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 windspeed shall be within the range of windspeeds (in statute miles per hour) categorized by the Saffir-Simpson Scale.

Saffir-Simpson Hurricane Scale:

Category	Winds (mph)	Damage
1	74 – 95	Minimal
2	96 – 110	Moderate
3	111 – 129	Extensive
4	130 – 156	Extreme
5	157 or higher	Catastrophic

Audit

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

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

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

4. Provide any modeling organization specific research performed to develop the functions used for simulating model variables or to develop databases.

5. Form S-3 (Distributions of Stochastic Hurricane Parameters) will be reviewed for the probability distributions and data sources.

Verified: YES

Professional Team Comments:

Verified no change in modeled probability distributions of hurricane parameters and characteristics. Reviewed Form M-1 to verify compliance with M-3B.

M-4 Hurricane Windfield Structure*

*(*Significant Revision)*

A. Windfields generated by the model shall be consistent with observed historical storms affecting Florida.

B. The land use and land cover database shall be consistent with National Land Cover Database (NLCD) 2006 or later. Use of alternate data sets shall be justified.

C. The translation of land use and land cover or other source information into a surface roughness distribution shall be consistent with current state-of-the-science and shall be implemented with appropriate geographic information system data.

D. With respect to multi-story buildings, the model windfield shall account for the effects of the vertical variation of winds if not accounted for in the vulnerability functions.

Audit

1. Provide any modeling organization-specific research performed to develop the windfield functions used in the model. Identify the databases used.

2. Provide any modeling organization-specific research performed to derive the roughness distributions for Florida and adjacent states.

3. The spatial distribution of surface roughness used in the model will be reviewed.

4. Provide the previous and current hurricane parameters used in calculating the loss costs for the LaborDay03 (1935) and NoName09 (1945) landfalls, and justify the choices used. Provide the resulting spatial distribution of winds. These will be reviewed with Form A-2 (Base Hurricane Storm Set Statewide Losses).

5. For windfields not previously reviewed, provide detailed comparisons of the model windfield with Hurricane Charley (2004), Hurricane Jeanne (2004), and Hurricane Wilma (2005).

6. For windfield and pressure distributions not previously reviewed, present time-based contour animations (capable of being paused) to demonstrate scientifically reasonable windfield characteristics.

7. The effects of vertical variation of winds as used in the model where applicable will be reviewed.

8. Form M-2 (Maps of Maximum Winds) will be reviewed.

Pre-Visit Letter

11. M-4.D, page 143: Discuss how the coastal transition function explicitly takes into account the vertical variation of the horizontal winds.

12. M-4, Disclosure 2, page 144: Discuss how the new Rmax data affect the distributional fits.

13. M-4, Disclosure 8, page 145: Demonstrate how the new LULC database has been incorporated into the model. Individual cases may be reviewed.

14. M-4, Disclosure 10, page 146: The method for updating the historical windfield footprints will be examined. Updates to Hurricane NoName09 from 1945 (AL091945) will be compared with the same hurricane as presented in the previous submission.

15. Form M-2, pages 161-165: Discuss the relative variation of windspeed minima versus maxima between the three temporal sampling periods.

Verified: YES

Professional Team Comments:

Discussed the coastal transition model for converting marine winds to over-land winds, the boundary layer growth over land, and vertical variation of the winds over land.

Discussed the new Rmax data. These data only affect the stochastic Rmax gamma distribution.

Reviewed update of the Land Use/Land Cover (LULC) roughness. Discussed the methodology for merging the National Land Cover Dataset (NLCD) 2011 and State of Florida Water Management District datasets (2004-2011).

Reviewed geographic roughness maps comparing version 5.0 to version 6.0. Reviewed test results indicating the change in roughness factors resulted in an approximate 0.8% increase in statewide losses.

Reviewed changes to Hurricane NoName09 (1945) windfield and windfield footprint comparisons of the updates.

Discussed the relative variation in windspeed minima and maxima for the 100-year and 250-year return period maps in Form M-2. Discussed the historical windspeed maxima is larger than those in the return period maps. Return period values are based on rank sorting and are associated with a given exceedance probability. Discussed historical maxima are extreme events with an unknown return period.

M-5 Landfall and Over-Land Weakening Methodologies*

*(*Significant Revision)*

A. The hurricane over-land weakening rate methodology used by the model shall be consistent with historical records and with current state-of-the-science.

B. The transition of winds from over-water to over-land within the model shall be consistent with current state-of-the-science.

Audit

1. Describe the variation in over-land decay rates used in the model.

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

3. The detailed transition of winds from over-water to over-land (i.e., landfall, boundary layer) will be reviewed. The region within 5 miles of the coast will be emphasized. Provide color-coded snapshot maps of roughness length and spatial distribution of over-land and over-water windspeeds for Hurricane Jeanne (2004), Hurricane Dennis (2005), and Hurricane Andrew (1992) at the closest time after landfall.

Pre-Visit Letter

16. M-5, Disclosure 2, pages 150-151: Explain why the simulated winds in Figures 30 and 31 remain unchanged from the previous submission when the roughness database used in the model has been updated based on two LULC databases.

Verified: YES

Professional Team Comments:

Discussed the simulated winds in Figures 30 and 31 represent open and marine exposure terrain and therefore are not impacted by the roughness changes in the updated Land Use/Land Cover databases. Captions for Figures 30 and 31 were revised for clarification.

Discussed over-water to over-land transition of winds in the context of Form M-2.

M-6 Logical Relationships of Hurricane Characteristics

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

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

Audit

1. Form M-3 (Radius of Maximum Winds and Radii of Standard Wind Thresholds) and the modeling organization's sensitivity analyses provide the information used in auditing this standard.

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

3. Justify the variation of the asymmetry with the translation speed.

Pre-Visit Letter

17. M-6, Disclosure 3, page 155: Discuss the source of the model large bias when measured by the 110 mph wind radius compared to observations.

Verified: YES

Professional Team Comments:

Discussed the model large bias in Rmax for 110 mph wind radii. Bias appears to be an artifact of a limited sample of storms within the 110 mph range.

Reviewed Form M-3.

STATISTICAL STANDARDS – Mark Johnson, Leader

S-1 Modeled Results and Goodness-of-Fit

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

B. Modeled and historical results shall reflect statistical agreement using currently accepted scientific and statistical methods for the academic disciplines appropriate for the various model components or characteristics.

Audit

1. Forms S-1 (Probability and Frequency of Florida Landfalling Hurricanes per Year), S-2A (Examples of Loss Exceedance Estimates, 2007 FHCF Exposure Data), S-2B (Examples of Loss Exceedance Estimates, 2012 FHCF Exposure Data), and S-3 (Distributions of Stochastic Hurricane Parameters) will be reviewed. Provide justification for the distributions selected including, for example, citations to published literature or analyses of specific historical data.

2. The modeling organization's characterization of uncertainty for windspeed, damage estimates, annual loss, and loss costs will be reviewed.

Pre-Visit Letter

18. S-1, Disclosure 1, page 173: Provide further details on the MLE gamma distribution fit to Rmax. Provide an electronic version of the data underlying the fit.

Additional Verification Review Questions

7. Form S-2B (2012 FHCF exposure data) values changed from version 6.0 to version 6.1 as expected. However, Form S-2A (2007 FHCF exposure data) had values changed from version 6.0 to version 6.1 which was unexpected. If correct, does the same problem exist with the previously accepted version of the model?

8. Demonstrate that Forms S-2B, S-4, S-5, and Tables 16 and 17 have been completed correctly and consistently.

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

Professional Team Comments:

This standard cannot be verified pending verification of revised Forms S-2B, S-4, and S-5.

Reviewed the new maximum likelihood estimation of the gamma distribution to a revised data set of landfall Rmax values.

Reviewed the truncated gamma inverse distribution function implementation for generating Rmax variates.

Discussed Forms S-2B and S-5 were not correct in the initial November 1, 2014 submission, the January 5, 2015 submission, and the January 22, 2015 submission due to an error in completing the forms.

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

Verified after review of revised Forms S-2B, S-4, and S-5.

Discussed no change in Form S-2A results for the 2007 FHCF exposure data since the January 22, 2015 correction to the commercial residential losses.

Reviewed Form S-2B revised on-site to correct the Interquartile Range value.

S-2 Sensitivity Analysis for Model Output

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

Audit

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

2. Form S-6 (Hypothetical Events for Sensitivity and Uncertainty Analysis) will be reviewed, if applicable.

Verified: YES

Professional Team Comments:

Verified no changes in model methodology from the previous submission and no new sensitivity tests were required.

S-3 Uncertainty Analysis for Model Output

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

Audit

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

2. Form S-6 (Hypothetical Events for Sensitivity and Uncertainty Analysis) will be reviewed, if applicable.

Verified: YES

Professional Team Comments:

Verified no changes in model methodology from the previous submission and no new uncertainty tests were required or performed.

S-4 County Level Aggregation

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

Audit

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

Verified: YES

Professional Team Comments:

Reviewed the county level uncertainties to verify that the 2.5% threshold was met.

S-5 Replication of Known Hurricane Losses

The model shall estimate incurred losses in an unbiased manner on a sufficient body of past hurricane events from more than one company, including the most current data available to the modeling organization. This standard applies separately to personal residential and, to the extent data are available, to commercial residential. Personal residential experience may be used to replicate structure-only and contents-only losses. The replications shall be produced on an objective body of loss data by county or an appropriate level of geographic detail and shall include loss data from both 2004 and 2005.

Audit

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

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

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

4. Form S-4 (Validation Comparisons) will be reviewed.

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

Additional Verification Review Question

8. Demonstrate that Forms S-2B, S-4, S-5, and Tables 16 and 17 have been completed correctly and consistently.

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

Professional Team Comments:

This standard cannot be verified pending verification of revised Form S-4, Table 16, and Table 17.

Reviewed the tables and forms which required numerous revisions and corrections. Determined that the actual versus modeled commercial data agreement was overstated owing to one large event.

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

Verified after review of revised Form S-4 and revised validation analyses provided in Table 15 for commercial residential losses.

Discussed the analyses performed to validate the total modeled losses in Tables 14 and 15. Discussed modeled losses were greater for some companies and unchanged for others due to demand surge applied to the claims data used in the validation analyses under the 2013 standards, but was not applied to the claims data used in the validation analyses under the 2011 standards. The correction of applying demand surge to the claims data resulted in higher losses for those data points. These tables are in error in the final submission for version 5.0 under the 2011 standards and will be revised.

It was also discovered in processing the claims data for Hurricane Charley (2004), a data set was missed for one insurance company. Table 30 results for Hurricane Charley (2004), Company D in the final submission for version 5.0 under the 2011 standards is incorrect and will be revised.

S-6 Comparison of Projected Hurricane Loss Costs

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

Audit

1. Form S-5 (Average Annual Zero Deductible Statewide Loss Costs – Historical versus Modeled) will be reviewed for consistency with Standard G-1 (Scope of the Computer Model and Its Implementation), Disclosure 5.

2. Justify the following:
   a. Meteorological parameters,
   b. The effect of by-passing hurricanes,
   c. The effect of actual hurricanes that had two landfalls impacting Florida,
   d. The departures, if any, from the windfield, 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.

Additional Verification Review Question

8. Demonstrate that Forms S-2B, S-4, S-5, and Tables 16 and 17 have been completed correctly and consistently.

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

Professional Team Comments:

This standard cannot be verified pending verification of revised Form S-5.

Reviewed revisions to Form S-5. Determined that the updates to the model as described in Standard G-1, Disclosure 5 provided plausible adjustments from the previous forms in version 5.0.

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

Verified after review of revised Form S-5.

Reviewed Form S-5 revised on-site to correct the historical losses and confidence intervals in Part A and Part B and to correct the title of Part A to include both personal and commercial residential loss costs.

VULNERABILITY STANDARDS – Masoud Zadeh, Leader

V-1 Derivation of Vulnerability Functions*

*(*Significant Revision)*

A. Development of the building vulnerability functions shall be based on at least one of the following: (1) historical data, (2) tests, (3) rational structural analysis, and (4) site inspections. Any development of the building vulnerability functions based on rational structural analysis, site inspections, and tests shall be supported by historical data.

B. The method of derivation of the building vulnerability functions and their associated uncertainties shall be theoretically sound and consistent with fundamental engineering principles.

C. Residential building stock classification shall be representative of Florida construction for personal and commercial residential properties.

D. Building height/number of stories, primary construction material, year of construction, location, building code, and other construction characteristics, as applicable, shall be used in the derivation and application of building vulnerability functions.

E. Vulnerability functions shall be separately derived for commercial residential building structures, personal residential building structures, mobile homes, and appurtenant structures.

F. The minimum windspeed that generates damage shall be consistent with fundamental engineering principles.

G. Building vulnerability functions shall include damage as attributable to windspeed and wind pressure, water infiltration, and missile impact associated with hurricanes. Building vulnerability functions shall not include explicit damage to the building due to flood, storm surge, or wave action.

Audit

1. Modifications to the building vulnerability component in the model since the previously accepted model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications and their impacts on the building vulnerability component. Comparisons with the previously accepted model will be reviewed.

2. 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. For historical data used to develop building vulnerability functions, demonstrate the goodness-of-fit of the data. Complete reports detailing loading conditions and damage suffered are required for any test data used. Complete

rational structural analyses shall be presented so that a variety of different building types and construction characteristics may be selected for review. Tests and original site inspection reports shall be available for review.

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

4. Multiple samples of building vulnerability functions for commercial residential building structures, personal residential building structures, mobile homes, and appurtenant structures shall be available. The magnitude of logical changes among these items for a given windspeed shall be explained and validation materials shall be available.

5. Justify the construction types and characteristics used.

6. Provide validation of the mean building vulnerability functions and associated uncertainties.

7. Document and justify all modifications to the building vulnerability functions due to building codes and their enforcement. If age of building is used as a surrogate for building code and code enforcement, provide complete supporting information for the number of age groups used as well as the year(s) of construction that separates particular group(s).

8. Provide validation material for the disclosed minimum windspeed. Provide the computer code showing the inclusion of the minimum windspeed at which damage occurs.

9. The effects on building vulnerability from local and regional construction characteristics and building codes will be reviewed.

10. Describe how the claim practices of insurance companies are accounted for when claims data for those insurance companies are used to develop or to verify building vulnerability functions. Examples include the level of damage the insurer considers a loss to be a total loss, claim practices of insurers with respect to concurrent causation, or the impact of public adjusting.

11. Provide the percentage of damage at or above which the model assumes a total loss.

12. Form V-1 (One Hypothetical Event) will be reviewed.

Pre-Visit Letter

19. V-1, Disclosure 11, page 256: Explain how the approach outlined applies to unknown construction type.

20. V-1, Disclosure 15, pages 257-259: Plot the ratio of actual appurtenant structure loss to building loss versus the ratio of modeled appurtenant structure loss to building loss.

21. Form V-1, pages 289-293: Compare the results in Form V-1 with the previous submission.

Verified: YES

Professional Team Comments:

Discussed the changes in version 6.1 to the horizontal rain accumulation with the consideration of storm rotation using a probabilistic treatment of the direction and fraction of impinging rain for each wind direction as a function of windspeed.

Discussed the link between the rain model and the vulnerability model being the maximum windspeeds. Damage is assumed to occur at the maximum 3-second gust. The horizontal rain impinging on the building surface results in two categories of water accumulation being treated separately in the model – direct impinging rain and indirect surface runoff. The metrics used to quantify the direct impinging rain and the surface run-off are Rain Admittance Factor (RAF) and the Surface Run-off Coefficient (SRC).

Reviewed the change in the RAF application in version 6.1. RAF values are mapped to the building envelop for a given wind direction. RAF is the fraction of the approaching horizontal rain that strikes the building. It accounts for the effect of a large portion of the rain moving around the structure with the wind rather than striking the building surface and is dependent on the building shape.

Reviewed the change in the SRC application in version 6.1. SRC estimates accumulated run-off rain on building surface. SRC values are mapped to the building envelop for a given wind direction. It accounts for upstream run-off area and for various wind directions.

Reviewed RAF and SRC equations for estimating the volume of water entering the building from both direct impinging rain and surface run-off and for storm rotation.

Reviewed Wall of Wind test parameters and results for modeling RAF and SRC.

Reviewed the mean RAF and SRC values that are taken for each component and applied to the breaches and defects.

Reviewed graphical comparisons of changes to the vulnerability curves from version 5.0 to version 6.1.

Reviewed changes to the vulnerability component for exterior damage for low rise commercial residential in version 6.0 (November 1, 2014 submission) and version 6.1 (January 22, 2015 submission).

1. Projectile count increase in debris impact model based on trajectory simulations conducted in Laboy et al. (2013) resulting in an increased damage to openings from debris impact.
2. Interior pressure sharing mechanism between attic and top floor modified to reflect the change in internal pressure sharing due to top floor breaches.
3. Interior pressure calculation in the attic space changed to delineate internal pressure contributions from the flow regimes associated with windward and leeward roof sheathing damage resulting in increased damage to roof components.

4. Modifications to loadings on the soffits to better reflect current state-of-knowledge which results in change to soffit damage as a function of windspeed.
5. Modifications to the pressure coefficients to reduce an overly-conservative extreme load assumption and to bring the low-rise commercial residential model into compliance with the personal residential model resulting in reduced pressure coefficients, resultant loads, and damage.

Reviewed the change in the vulnerability component from version 6.0 (November 1, 2014 submission) to version 6.1 (January 22, 2015 submission) due to an error discovered in the gable end damages not recorded for masonry models. Discussed how the error was discovered, the root cause of the error, and the proposed solution for eliminating this type of error in the future.

Reviewed change in methodology for modeling of gable end damage for masonry models in version 6.0.

Reviewed modification to masonry functions from version 6.0 (November 1, 2014 submission) to version 6.1 (January 22, 2015 submission) for load/capacity ratio for unreinforced and reinforced masonry.

Reviewed graphical comparison of the change in vulnerability functions in version 6.1 due to the modification to the masonry wall functions for modeling gable end damage.

Reviewed modifications of the masonry wall area failure function by reducing heuristic functions that relate load/capacity ratio to equivalent breached area for strong and medium models and reducing the slope on post failure flexural failure heuristic equations.

Reviewed an additional error discovered in the rain penetration model in version 6.0 (November 1, 2014 submission) and the correction in version 6.1 (January 22, 2015 submission) to the dimension of the gable end upstream run-off area. Discussed the correction in the gable end dimension calculation for 2 and 3 story heights in version 6.1.

Discussed the change in statistics to account for the latest information from tax appraiser databases and the revised weighting scheme applied to the vulnerability matrices.

Reviewed graphical comparison of the changes in the low rise commercial residential vulnerability curves due to the change in statistics in version 6.1.

Reviewed the alternative soffit model included in the revisions to version 6.1 (January 22, 2015 submission) which was not included in version 6.0 (January 5, 2015 submission). Discussed the improvement to the soffit model by reducing the influence of soffits as the adjacent roof panels become damaged. The breach case was updated to reflect test data from IBHS. An edge survival function was added to reduce the influence of soffits when adjacent roof sheathing is lost. Discussed the negligible consequences on loss costs due to this update.

Reviewed comparisons of the soffit vulnerability curve changes in version 6.0 to version 6.1.

Reviewed the methodology for assigning a vulnerability matrix for unknown building classifications based on statistics of the building population for that location and data availability in insurance portfolios. The response to Disclosure 12 was revised to correctly reflect the process.

Discussed that the model does not explicitly model screen enclosures. In the case of unattached or appurtenant structures, the model considers vulnerability levels to capture the high variability of model strength (including screen enclosures). Reviewed the methodology for modeling appurtenant structures based on three classifications – high vulnerability (e.g., fence), medium vulnerability (e.g., gazebo), and low vulnerability (e.g., pools). Reviewed a plot of the low, medium and high appurtenant structure damage versus windspeed.

Reviewed Form V-1 results compared with the previous submission noting differences in Part A are attributed to updates to the meteorology component and the differences in Part B are attributed to a combination of change in exposure and the change in the high-rise commercial residential model. In discussing the anomalies between the current Form V-1 with the previous Form V-1, it was discovered that Form V-1 in the final submission for version 5.0 was incorrect and will be revised.

Reviewed changes in the source code for the pressure coefficient change from version 5.0 to version 6.1.

Reviewed changes in the source code for implementing the correction for calculating gable end height in version 6.1.

Discussed the increase in damage relative to building height due to the increase in windspeeds with building height. Reviewed the breach area vulnerability curves for openings for 10-meter height versus 18^{th} floor in condo-units.

Discussed the different ratios in Form A-6 for building code, frame owners versus commercial residential in Broward County.

V-2 Derivation of Contents and Time Element Vulnerability Functions*

*(*Significant Revision)*

A. Development of the contents and time element vulnerability functions shall be based on at least one of the following: (1) historical data, (2) tests, (3) rational structural analysis, and (4) site inspections. Any development of the contents and time element vulnerability functions based on rational structural analysis, site inspections, and tests shall be supported by historical data.

B. The relationship between the modeled building and contents vulnerability functions and historical building and contents losses shall be reasonable.

C. Time element vulnerability function derivations shall consider the estimated time required to repair or replace the property.

D. The relationship between the modeled building and time element vulnerability functions and historical building and time element losses shall be reasonable.

E. Time element vulnerability functions used by the model shall include time element coverage claims associated with wind, flood, and storm surge damage to the infrastructure caused by a hurricane.

Audit

1. Modifications to the contents and time element vulnerability component in the model since the previously accepted model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications and their impact on the contents and time element vulnerability component. Comparisons with the previously accepted model will be reviewed.

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

3. Justify changes from the previously accepted submission in the relativities between vulnerability functions for building and the corresponding vulnerability functions for contents.

4. Documentation and justification of the following will be reviewed:
   a. The method of derivation and data on which the time element vulnerability functions are based;
   b. Validation data specifically applicable to time element coverages;
   c. Assumptions regarding the coding of time element losses by insurers;
   d. The effects of demand surge on time element for the 2004 and 2005 hurricane seasons;
   e. Assumptions regarding the variability of time element losses by size of property;
   f. Statewide application of time element coverage assumptions;
   g. Assumptions regarding time element coverage for mobile homes, tenants, and condo unit

owners exposure;

h. The methods used to incorporate the estimated time required to repair or replace the property;

i. The methodology and available validation for determining the extent of infrastructure damage and its effect on time element costs.

5. Justify changes from the previously accepted submission in the relativities between vulnerability functions for building and the corresponding vulnerability functions for time element.

6. To the extent that historical data are used to develop mathematical depictions of time element vulnerability functions, demonstrate the goodness-of-fit of the data to fitted models.

Verified: YES

Professional Team Comments:

Discussed contents and time element losses in Form A-6.

Reviewed the time element formulation as a function of interior damage and the associated flowchart.

Verified no change in the vulnerability functions for contents and time element losses.

V-3 Mitigation Measures*

*(*Significant Revision)*

A. Modeling of mitigation measures to improve a building's wind resistance and the corresponding effects on vulnerability shall be theoretically sound and consistent with fundamental engineering principles. These measures shall include fixtures or construction techniques that enhance the performance of the building and its contents and shall consider:

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

B. Application of mitigation measures that enhance the performance of the building and its contents shall be justified as to the impact on reducing damage whether done individually or in combination.

Audit

1. Modifications to mitigation measures in the model since the previously accepted model will be reviewed in detail, including the rationale for the modifications, the scope of the modifications, the process, the resulting modifications, and their impacts on the vulnerability component. Comparisons with the previously accepted model will be reviewed.

2. Form V-2 (Mitigation Measures – Range of Changes in Damage) and Form V-3 (Mitigation Measures – Mean Damage Ratios and Loss Costs, Trade Secret item) provide the information used in auditing this standard.

3. Individual mitigation measures as well as their effect on damage due to use of multiple mitigation measures will be reviewed. Any variation in the change over the range of windspeeds for individual and multiple mitigation measures will be reviewed.

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

Pre-Visit Letter

22. Form V-2, page 296: Compare the results in Form V-2 with the previous submission.

23. Form V-3, pages 299-303: Compare the results in Form V-3 with the previous submission.

Verified: YES

Professional Team Comments:

Reviewed the results in Form V-2 with the previous submission. Discussed the changes relative to the previous submission due to modification to the base case by weakening the base front door for the reference structures.

Reviewed the results in Form V-3 with the previous submission. Discussed the changes relative to the previous submission are the same as those in Form V-2. Reviewed plots of vulnerability curves for the reference frame and masonry structures in mitigation sets 1, 2, 3 and 4.

Reviewed Form V-3 and confirmed consistency with Form V-2.

ACTUARIAL STANDARDS – Marty Simons, Leader

A-1 Modeling Input Data

A. When used in the modeling process or for verification purposes, adjustments, edits, inclusions, or deletions to insurance company input data used by the modeling organization shall be based upon accepted actuarial, underwriting, and statistical procedures.

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

Audit

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

2. All model inputs and assumptions will be reviewed to determine that the model output report appropriately discloses all modifications, adjustments, assumptions, and defaults used to produce the loss costs.

Verified: YES

Professional Team Comments:

Discussed the pre-processing checklist and procedures for assuring the accuracy of claims data. Discussed the procedure for going through the Office of Insurance Regulation for obtaining clarification on claims data from the insurance companies.

Discussed the adjustments and assumptions disclosed on the model output report.

A-2 Event Definition

A. Modeled loss costs and probable maximum loss levels shall reflect all insured wind related damages from storms that reach hurricane strength and produce minimum damaging windspeeds or greater on land in Florida.

B. Time element loss costs shall reflect losses due to infrastructure damage caused by a hurricane.

Audit

1. The model will be reviewed to determine that the definition of an event in the model is consistent with this standard.
2. The model will be reviewed to determine that by-passing storms and their effects are considered in a manner that is consistent with this standard.
3. The model will be reviewed to determine whether (if so, how) the model takes into account flood or hurricane storm surge.

Additional Verification Review Question

4. Form A-2 values changed slightly for the 2012 FHCF exposure data, as expected. Why did the 2007 FHCF exposure data values change as well?

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

Professional Team Comments:

This standard cannot be verified pending verification of revised Form A-2 (2012).

Discussed no change in the definition of an event in the stochastic storm set.

Discussed the methodology for inclusion or exclusion of by-passing storms.

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

Verified after review of revised Form A-2 with appropriate processing of policies with zero number of risks.

Verified no change in Form A-2 results for the 2007 FHCF exposure data since the January 22, 2015 correction to the commercial residential losses.

A-3 Coverages*

*(*Significant Revision)*

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

B. The methods used in the development of appurtenant structure loss costs shall be actuarially sound.

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

D. The methods used in the development of time element coverage loss costs shall be actuarially sound.

Audit

1. The methods used to produce building, appurtenant structure, contents and time element loss costs and probable maximum loss levels will be reviewed.

Verified: YES

Professional Team Comments:

Discussed the methodology for building, appurtenant structure, contents, and time element losses.

A-4 Modeled Loss Cost and Probable Maximum Loss Considerations

A. Loss cost projections and probable maximum loss levels shall not include expenses, risk load, investment income, premium reserves, taxes, assessments, or profit margin.

B. Loss cost projections and probable maximum loss levels shall not make a prospective provision for economic inflation.

C. Loss cost projections and probable maximum loss levels shall not include any explicit provision for direct hurricane storm surge losses.

D. Loss cost projections and probable maximum loss levels shall be capable of being calculated from exposures at a geocode (latitude-longitude) level of resolution.

E. Demand surge shall be included in the model's calculation of loss costs and probable maximum loss levels using relevant data.

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

Audit

1. Describe how the model handles expenses, risk load, investment income, premium reserves, taxes, assessments, profit margin, economic inflation, and any criteria other than direct property insurance claim payments.

2. The method of inclusion of secondary uncertainty in the probable maximum loss levels will be examined.

3. Provide the data and methods used to incorporate individual aspects of demand surge on personal and commercial residential coverages, inclusive of the effects from building material costs, labor costs, contents costs, repair time, etc.

4. Provide a detailed description of how the model accounts for hurricane storm surge losses.

5. All referenced literature will be reviewed to determine applicability.

Pre-Visit Letter

24. A-4.C, page 323: Describe the process used to ensure that storm surge losses are excluded from the model's loss cost outputs.

Verified: YES

Professional Team Comments:

Discussed the only way that a provision for storm surge could have entered the model is through the calibration of the vulnerability matrices and curves using actual claim data. Losses from Hurricane Ivan (2004) were excluded from the calibration process due to suspicion of contamination with storm surge damage.

Discussed no change in the methodology for accounting for demand surge in the calculation of loss costs.

A-5 Policy Conditions

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

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

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

Audit

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

2. To the extent that historical data are used to develop mathematical depictions of deductibles and policy limits, demonstrate the goodness-of-fit of the data to fitted models.

3. To the extent that historical data are used to validate the model results, the treatment of the effects of deductibles, policy limits, and coinsurance in the data will be reviewed.

4. Justify changes from the previously accepted submission in the relativities among corresponding deductible amounts for the same coverage.

Verified: YES

Professional Team Comments:

Discussed the process used for determining accuracy of the insurance value in exposure data.

Discussed there are no data or fits used for development of deductibles and policy limits.

A-6 Loss Output*

*(*Significant Revision)*

A. The methods, data, and assumptions used in the estimation of probable maximum loss levels shall be actuarially sound.

B. 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.

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

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

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

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

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

H. The relationship of loss costs for individual coverages, (e.g., buildings and appurtenant structures, contents, and time element) shall be consistent with the coverages provided.

I. Output ranges shall be logical for the type of risk being modeled and deviations supported.

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

1. masonry construction versus frame construction,

2. personal residential risk exposure versus mobile home risk exposure,

3. inland counties versus coastal counties, and

4. northern counties versus southern counties.

A-6 Loss Output (Continued)

K. For loss cost and probable maximum loss level estimates derived from or validated with historical insured hurricane losses, the assumptions in the derivations concerning (1) construction characteristics, (2) policy provisions, (3) coinsurance, (4) contractual provisions, and (5) relevant underwriting practices underlying those losses, as well as any actuarial modifications, shall be appropriate based on the type of risk being modeled.

Audit

1. Provide the data and methods used for probable maximum loss levels for Form A-8 (Probable Maximum Loss for Florida). Describe the hurricane associated with the Top Event.

2. All referenced literature will be reviewed to determine applicability.

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

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

5. The procedures used by the modeling organization to verify the individual loss cost relationships will be reviewed. Forms A-1 (Zero Deductible Personal Residential Loss Costs by ZIP Code), A-2 (Base Hurricane Storm Set Statewide Losses), A-3A (2004 Hurricane Season Losses, 2007 FHCF Exposure Data), A-3B (2004 Hurricane Season Losses, 2012 FHCF Exposure Data), A-6 (Logical Relationship to Risk, Trade Secret item), and A-7 (Percentage Change in Logical Relationship to Risk) will be used to assess coverage relationships.

6. Demonstrate that loss cost relationships among deductible, construction type, policy form, coverage, building code/enforcement, building strength, condo unit floor, number of stories, territory, and region are consistent and reasonable.

7. The total personal and commercial residential insured losses provided in Forms A-2 (Base Hurricane Storm Set Statewide Losses), A-3A (2004 Hurricane Season Losses, 2007 FHCF Exposure Data), and A-3B (2004 Hurricane Season Losses, 2012 FHCF Exposure Data) will be reviewed individually for total personal residential and total commercial residential insured losses.

8. Forms A-4A (Output Ranges, 2007 FHCF Exposure Data), A-4B (Output Ranges, 2012 FHCF Exposure Data), and A-5 (Percentage Change in Output Ranges, 2007 FHCF Exposure Data) will be reviewed, including geographical representations of the data when applicable.

9. Justify all changes in loss costs from the previously accepted submission.

10. Forms A-4A (Output Ranges, 2007 FHCF Exposure Data) and A-4B (Output Ranges, 2012 FHCF Exposure Data) will be reviewed to ensure appropriate differentials among deductibles, coverage, and construction types.

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

Pre-Visit Letter

25. Form A-4B, page 453: Describe how the file hlpm2012c.txt was processed for use in completing Form A-4B.

26. Form A-5, page 354: Explain the percentage change in output ranges for Palm Beach and Broward Counties in Figure 97.

27. Form A-5, page 357: Explain the percentage change in output ranges for Monroe and Indian River Counties in Figure 100.

28. Form A-5, page 359: Explain the percentage change in output ranges for Levy County (low) and Manatee County (high) in Figure 102.

29. Form A-5, page 361: Explain the 9071.96% increase for Calhoun County in Figure 104.

30. Form A-5, page 472: Explain commercial residential inland percentage changes.

Additional Verification Review Questions

1. A key finding at the original review was that the 0 Total Insured Risks entries in the 2012 FHCF exposure data were not being processed appropriately. Explain how this issue was addressed for all relevant forms.

2. In the 2012 FHCF exposure data there were 2,514 rows having 0 Total Insured Risks that occur in all but 10 counties. These 10 counties (Baker, Bradford, Calhoun, Glades, Hamilton, Holmes, Lafayette, Madison, Monroe, and Union) exhibit, as expected, no change from the previous Form A-4B Output Ranges for 0% deductible. However, for the specified deductibles, this is not the case as some values change in these 10 counties. Explain.

3. What other changes, if any, were made in version 6.1? For example, why are the Form A-4A Output Ranges values changed from version 6.0 to version 6.1?

5. Why is Form A-3A changed from version 6.0?

6. Form A-3B values changed in ZIP Codes which did not have any of the 2,514 rows noted above. Why did these values change?

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

Professional Team Comments:

This standard cannot be verified pending verification of revised Forms A-2 (2012), A-3B, A-4B, A-8 (both A and B), S-2B, and S-5.

Reviewed the process for processing the FHCF exposure data used in completing Form A-4B. The modeler incorrectly changed all 0 risk counts to 1 in the exposure data.

Reviewed percentage changes in output ranges for Palm Beach and Broward Counties due to changes in the meteorology component.

Reviewed percentage changes in output ranges for Monroe and Indian River Counties due to ZIP Code centroid and roughness changes.

Reviewed spreadsheet of the breakdown of percentage changes in the output ranges due to each model change (ZIP Code centroid and roughness updates, HURDAT and Rmax database updates, and vulnerability updates) and the overall percentage changes.

Reviewed percentage changes in output ranges for Levy and Manatee Counties due to ZIP Code centroid and roughness changes.

Discussed the extreme percentage change in Calhoun County for commercial residential 3% deductible due to a single exposure, low rise frame structure affected by the vulnerability model changes. The value in the previously accepted model, version 5.0 was $0.002, and in the model version 6.1 is $0.215.

Discussed commercial residential inland percentage changes due to the vulnerability component changes.

Discussed the process for completing the actuarial forms for the submission and resolution of anomalies identified.

Discussed the apparent anomalies in Form A-6.

Reviewed results in Form A-1 for ZIP Codes 33036, 33109, 33070, 33154, 33140, 33402, and 33480 for frame owners, masonry, and mobile homes relativities.

Discussed process for completing the actuarial forms.

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

Verified after review of revised Forms A-2 (2012), A-3B, A-4B, A-8 (both A and B), S-2B, and S-5.

Discussed the revised procedures for processing the FHCF exposure data. Reviewed revised actuarial forms after appropriate processing of the 2012 FHCF exposure data.

Verified no change in Form A-3A and Form A-4A results for the 2007 FHCF exposure data since the January 22, 2015 correction to the commercial residential losses.
Discussed the error in applying demand surge factors in Form A-3B. Reviewed a corrected Form A-3B.

COMPUTER STANDARDS – Paul Fishwick, Leader

C-1 Documentation

A. Model functionality and technical descriptions shall be documented formally in an archival format separate from the use of letters, slides, and unformatted text files.

B. The modeling organization shall maintain a primary document repository, containing or referencing a complete set of documentation specifying the model structure, detailed software description, and functionality. Development of the documentation shall be indicative of accepted software engineering practices.

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

D. The modeling organization shall maintain (1) a table of all changes in the model from the previously accepted submission to the initial submission this year and (2) a table of all substantive changes since this year's initial submission.

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

Audit

1. The primary document repository, in either electronic or physical form, and its maintenance process will be reviewed. The repository shall contain or reference full documentation of the software.

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

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

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

5. Provide verification that documentation is created separately from and is maintained consistently with the source code.

6. The tables specified in C-1.D that contain the items listed in Standard G-1(Scope of the Computer Model and Its Implementation), Disclosure 5 will be reviewed. The tables shall contain the item number in the first column. The remaining five columns shall contain specific document or file references for affected components or data relating to the following Computer Standards: C-2 (Requirements), C-3 (Model Architecture and Component Design), C-4 (Implementation), C-5 (Verification), and C-6 (Model Maintenance and Revision).

7. Trace the model changes specified in Standard G-1 (Scope of the Computer Model and Its Implementation), Disclosure 5 through all Computer Standards.

Pre-Visit Letter

31. C-1.B, page 370: Relate the primary binder table of contents with the response to Standard G-1, Disclosure 5 by demonstrating individual table item compliance with Computer Standards C-1 through C-7.

Verified: YES

Professional Team Comments:

Reviewed the primary document binder and associated sub-documents relating to Standards C-1 through C-7 as required by Audit items 1 through 6.

Reviewed the two tables required by Standard C-1.D for model versions 6.0 and 6.1. Verified the addition of the model version numbers, and added descriptions in table cells that were initially empty.

Discussed the need for the modeler to maintain consistently dated documents throughout the submission. Verified compliance with revised submission pages to reflect the most recent model version 6.1.

Reviewed documentation on model version 6.0 and its evolution from the previously accepted model 5.0.

Reviewed documentation on model version 6.1 which replaced version 6.0 as a result of errors encountered during testing of the model. These errors were reported to the Florida Commission in a letter dated January 22, 2015 from Dr. Hamid to Dr. Lorilee Medders, Chair of the Florida Commission.

Verified that the modeler was working closely with inter-team communication by reviewing the document: Florida Public Hurricane Loss Model: Engineering Team Report of Activities, submitted to Dr. Shahid Hamid, Director, Laboratory for Insurance, Financial, and Economic Research, International Hurricane Research Center, Florida International University, Maintenance and Development of the Florida Public Loss Model: 2013-2014 Cycle, June 6, 2014.

Reviewed two tables as required in Standard C-1, Audit item 6. The first table documented changes from version 5.0 to version 6.0 of the model, and the second table documented changes from version 6.0 to version 6.1.

Traced model changes from Standard G-1, Disclosure 5 through the Computer Standards as required in Standard C-1, Audit item 7.

C-2 Requirements

The modeling organization shall maintain a complete set of requirements for each software component as well as for each database or data file accessed by a component. Requirements shall be updated whenever changes are made to the model.

Audit

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

Pre-Visit Letter

32. C-2, page 372: Provide requirements documentation that specifically relates to each model change identified in Standard G-1, Disclosure 5.

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

Professional Team Comments:

This standard cannot be verified pending a complete requirements document.

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

Reviewed the updated requirements document of model changes from FPHLM version 5.0. Requirements included changes from version 5.0 to version 6.0, and changes from version 6.0 to version 6.1.

C-3 Model Architecture and Component Design*

*(*Significant Revision)*

The modeling organization shall maintain and document (1) detailed control and data flow diagrams and interface specifications for each software component, (2) schema definitions for each database and data file, and (3) diagrams illustrating model-related flow of information and its processing by modeling organization personnel or team. Documentation shall be to the level of components that make significant contributions to the model output.

Audit

1. The following will be reviewed:
    a. Detailed control and data flow diagrams, completely and sufficiently labeled for each component,
    b. Interface specifications for all components in the model,
    c. Documentation for schemas for all data files, along with field type definitions,
    d. Each network diagram including components, sub-component diagrams, arcs, and labels, and
    e. Diagrams illustrating model-related information flow among modeling organization personnel or team (e.g., using Unified Modeling Language (UML), Business Process Model and Notation (BPMN), or equivalent technique including a modeling organization internal standard).

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

Verified: YES

Professional Team Comments:

Reviewed the flowchart for calculating roof water penetration as a result of leaks in commercial residential properties.

Reviewed the modeler's procedural approach to geographic coding.

Verified that the process for maintaining correspondence among media for the model (as required in Standard G-1.B) had not changed since the previously accepted model.

Verified the new flowcharts being used by the Vulnerability Team as a result of the new flowchart guidelines.

Discussed the importance of the human workflow process, and the need to document this process in a manner similar to documenting source code design.

Reviewed a new flow diagram defining the human business workflow process involved in producing the Actuarial forms in the modeler's submission.

C-4 Implementation

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

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

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

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

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

F. The modeling organization shall maintain the following documentation for all components or data modified by items identified in Standard G-1 (Scope of the Computer Model and Its Implementation), Disclosure 5:

1. A list of all equations and formulas used in documentation of the model with definitions of all terms and variables.

2. A cross-referenced list of implementation source code terms and variable names corresponding to items within F.1.

Audit

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

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

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

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

5. The following information shall be available and will be reviewed for each component, either in a header comment block, source control database, or the documentation:
    a. Component name,
    b. Date created,

c. Dates modified and by whom,
d. Purpose or function of the component,
e. Input and output parameter definitions.

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

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

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

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

Professional Team Comments:

This standard cannot be verified for two reasons: (1) the modeler's response to Standard C-4.F was insufficient as the provided documents did not clearly relate equation terms to source code implementation variable names, and (2) pending verification of other standards.

Discussed with the modeler the first error reported in the January 22, 2015, letter from Dr. Hamid to the Florida Commission. During the process of automating the preparation of Form A-4B, there were two Unix scripts employed: one that was used for the previously accepted model (version 5.0) and one that had been updated for version 6.0. The modeler detailed how the old script was accidentally used, and how the error was determined. The error was found through a cross-checking procedure where the wrong script had been used. This error was corrected in version 6.1.

Discussed with the modeler how the second error described in the January 22, 2015, letter dealt with the necessary updating of the soffit model. Originally, the masonry model was an integral part of the timber (i.e., wood frame) model. During the evolution of model version 6.0, the modeler had separated these two models to achieve modular independence. After this separation of the masonry and timber models, an error was introduced that created an inaccurate rain penetration for low-rise commercial residential buildings. This error was found by the engineering team and corrected in version 6.1.

Reviewed the two versions of the shell script (original and corrected) for creating Form A-4B, with highlighting of the corrected part of the original script.

Reviewed the algorithm used to process the FHCF aggregate exposure data file hlpm2012c.txt for completing Form A-4B. The approach specifies an initial step for pre-processing the file data consisting of SQL queries, and involves a total of 16 steps.

Discussed the role of the actuary in hand-calculating the ratios in Form A-6 (Logical Relationship to Risk).

Discussed the modeler's implementation of the inverse method for sampling from a gamma distribution for radius of maximum (Rmax) winds.

Reviewed adherence to the consistent use of Apache Subversion (SVN) by all modelers and all teams.

Reviewed the minutes of the February 22, 2014 meeting at the Florida Institute of Technology regarding training for the use of SVN.

Reviewed several MATLAB source code implementations of calculations related to the rain penetration model.

Reviewed the C++ code to ensure correspondence with a flowchart describing the logic for rain penetration.

Verified the coordination of SVN usage through coordination by the Computer Science Team.

Discovered that the estimated damage/subject exposure in the currently accepted model (version 5.0 from 2013) had incorrect values for Form V-1. The values used a mitigated structure rather than a base structure.

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

Reviewed strategy and planned SQL script for handling future zero insured risks.

Reviewed SQL script for fixing the previously incorrect handling of zero insured risks.

Verified the documentation required by Standard C-4.F.

C-5 Verification*

*(*Significant Revision)*

A. General

For each component, the modeling organization shall maintain procedures for verification, such as code inspections, reviews, calculation crosschecks, and walkthroughs, sufficient to demonstrate code correctness. Verification procedures shall include tests performed by modeling organization personnel other than the original component developers.

B. Component Testing

1. ***The modeling organization shall use testing software to assist in documenting and analyzing all components.***

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

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

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

C. Data Testing

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

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

Audit

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

2. The testing software used by the modeling organization will be reviewed.

3. The component (unit, regression, aggregation) and data test processes and documentation will be reviewed including compliance with independence of the verification procedures.

4. Fully time-stamped, documented cross-checking procedures and results for verifying equations, including tester identification, will be reviewed. Examples include mathematical calculations versus source code implementation, or the use of multiple implementations using different languages.

5. Flowcharts defining the processes used for manual and automatic verification will be reviewed.

6. The response to Disclosure 1 will be reviewed.

7. Verification approaches used for externally acquired data, software, and models will be reviewed.

Pre-Visit Letter

33. C-5, pages 376-378: Provide complete and thorough verification procedures and output from the model changes identified in Standard G-1, Disclosure 5.

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

Professional Team Comments:

This standard cannot be verified pending verification of other standards.

Discussed the practice of pair programming, and its role in cross-verification, employed by the Computer Science Team.

Reviewed software test cases for the Insurance Loss Model and submission forms, Medium-High Rise units.

Reviewed the implementation and data employed to fit the gamma distribution for Rmax.

Discussed the visual methods used in verifying the new ZIP Code data.

Discussed the visual methods used in verifying the new Land Use Land Cover database dated 2011.

Discussed with the modeler a verification approach suggested by the Engineering Team to mitigate future errors in the vulnerability standards. The modeler recommended the future use of logical assertions as a means to semi-automate checking of variables to ensure that variable values fell within acceptable bounds.

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

Discussed approach for verifying the correct handling of zero insured risks.

Reviewed a revised method for mitigating errors associated with applying an incorrect demand surge factors file.

C-6 Model Maintenance and Revision*

*(*Significant Revision)*

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

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

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

D. The modeling organization shall maintain a list of all model versions since the initial submission for this year. Each model description shall have a unique version identification, and a list of additions, deletions, and changes that define that version.

Audit

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

2. The policy for model revision will be reviewed.

3. The tracking software will be reviewed and checked for the ability to track date and time.

4. The list of all model revisions as specified in C-6.D will be reviewed.

Pre-Visit Letter

34. C-6.D, page 379: Provide the model version history over the past 5 years, leading up to the version identified in the submission.

Verified: YES

Professional Team Comments:

Reviewed the model version history over the past 5 years culminating in the most recent version, 6.1.

Verified that the model revision procedures from version 5.0 to 6.0 and then to 6.1 were consistent with the defined procedure identified in Standard C-6.D in the modeler submission.

Reviewed the Apache Subversion Tutorial for Standard C-6.C developed by Diana Machada, Raul Garcia, and Dr. Shu-Ching Chen, Florida International University, February 22, 2014.

Reviewed version history update during the audit, based on the changes from version 6.0 to 6.1.

C-7 Security

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

Audit

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

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

Verified: YES

Professional Team Comments:

Verified that there were no security breaches related to the model since the previously accepted model version.

Verified that the policy for security has not changed since the previously accepted model version.