Flood Standards Development

Input to Draft Statistical Flood Standards Dated 12-22-14

April 15, 2015

AIR WORLDWIDE

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1 Introduction

AIR Worldwide (AIR) appreciates the opportunity to provide input into the development of the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM or Commission). This document contains AIR's input into the draft Statistical Flood Standards published on December 22, 2014. Due to the relatively short notice that the April 22, 2015 Committee meeting would deal with Stats rather than Vulnerability draft Standards, we decided to focus on the Stats *Standards* first and to provide input to the Stats Disclosures and Audit Items next month.

The remainder of this document presents AIR's suggestions for edits to the draft Statistical Standards using the required format.

2 Standard SF-1 Flood Flood Modeled Results and Goodness-of-Fit

The Problem Statement and Explanation sections below discuss suggested edits to the Standards.

2.1 SF-1 Standards

AIR's suggested edits to the SF-1 Disclosures are described, explained and justified below.

2.1.1 Standard SF-1.B

- Problem Statement: On the wind side, the Commission provides the list of historical hurricanes that, at minimum, should be included in the historical storm set. This forms the basis for the "historical results" referenced in this standard, as modelers create a small catalog of historical hurricanes and run the model on this catalog to produce historical results. There is no HURDAT equivalent on the flood side. In building the model AIR has used historical river flow data, but this river flow information is continuous and does not come with a label for a specific flood event.

  The basis for much of the statistical testing done on the wind side is the modeled (i.e. stochastic) results and the historical (i.e. based on the historical storm set) results. It becomes important for the Commission to define a set of historical events in the base historical storm set before the standards can require reporting on "historical results". Unless the Commission is prepared to do this, we suggest distinguishing between historical modeled results and historical data observations and requiring statistical testing on the latter.

- Explanation:
- Amendatory Language:

> ***B. ~~Flood m~~Modeled results and historical ~~results~~ observations shall reflect statistical agreement using currently accepted scientific and statistical methods for the academic disciplines appropriate for the various flood model components or characteristics.***

3 Standard SF- 4 Flood Model Loss Cost Estimates

The Problem Statement and Explanation sections below discuss suggested edits to the Standards.

3.1 SF-4 Standards

AIR's suggested edits to the SF-4 Standards are described, explained and justified below.

3.1.1 Standard SF-4

- Problem Statement: We see a problem with measuring the error in loss costs coming from sampling process at the 10 x 10 meter resolution. Why has the Commission selected 10 x 10 meter for the standard? As a starting point the same convergence standards should be applied to the flood model as are applied to the wind model. The use of the flood model for ratemaking can be managed with the convergence limitations in mind, not the other way around.
- Explanation: This edit will lessen the required convergence standard to be on par with what is required for the wind model.
- Amendatory Language:

> **SF-4 Flood Model Loss Cost Estimates**
>
> ***At ~~a~~ the ~~ten meter by ten meter~~county level of resolution, the contribution to the error in flood loss cost estimates attributable to the sampling process shall be negligible for each of the modeled components (coastal flooding associated with storm surge, fluvial flooding, and pluvial flooding). However, the number of simulations to achieve negligible loss cost estimates may differ for each modeled component.***

4 Standard SF- 5 Replication of Known Flood Losses

The Problem Statement and Explanation sections below discuss suggested edits to the Standards.

4.1 SF-5 Standards

AIR's suggested edits to the SF-5 Standards are described, explained and justified below.

4.1.1 Standard SF-5

- Problem Statement: Given the fact that the government insures flood risk and the data is protected by privacy laws, we should remove the requirement about more than one company and multiple years of loss data. To produce true comparisons of modeled and historical losses, detailed exposures at the time of the event are needed, as well as a thorough understanding of the policy conditions and loss settlement. None of these are currently available. As the private flood market evolves over time, we can improve the standards, but we should start simple with what we have.
- Explanation:
- Amendatory Language:

SF-5 Replication of Known Flood Losses

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

5 Attachment with Track Changes

The attached document called AIR_Statistical Flood Standards 12-22-14-TrackChgs.docx contains all of AIR's suggested edits in track-changes format. If there is any disagreement between the appendix and the content in the report, the report edits take precedence.

STATISTICAL FLOOD STANDARDS

SF-1 Flood Modeled Results and Goodness-of-Fit

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

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

Purpose: Many aspects of flood model development and implementation involve fitting a probability distribution to historical data for use in generating stochastic floods. Such fitted models shall be checked to ensure that the distributions are reasonable. The chi-square goodness-of-fit test may not be a rigorous methodology for demonstrating the reasonableness of models of historical data.

This standard explicitly requires the modeling organization to have the results of data fitting with probability distributions available for the flood model assessments. Also, this standard requires the production of graphical and numerical statistical summaries by the modeling organization in advance of an audit (which could have the desirable effect in a self-audit of identifying potential problem areas).

Relevant Forms:

GF-3,	Statistical Flood Standards Expert Certification
MHF-1,	Annual Flood Occurrence Rates
SF-1,	Probability and Frequency of Florida Flood Events per Year
SF-2,	Examples of Flood Loss Exceedance Estimates
SF-3,	Distributions of Stochastic Flood Parameters (Coastal, Fluvial, Pluvial)
SF-4,	Flood Validation Comparisons
SF-5,	Average Annual Zero Deductible Statewide Flood Loss Costs – Historical versus Modeled

Disclosures

1. Identify the form of the probability distributions used for each function or variable, if applicable. Identify statistical techniques used for the estimates and the specific goodness-of-fit tests applied. Describe whether the *p*-values associated with the fitted distributions provide a reasonable agreement with the historical data. Provide a completed Form SF-3, Distributions of Stochastic Flood Parameters (Coastal, Fluvial, Pluvial). Provide a link to the location of the form [insert hyperlink here].

2. Describe the nature and results of the tests performed to validate the flood footprints generated.

3. Provide the date of loss of the insurance company data available for validation and verification of the flood model.

4. Provide an assessment of uncertainty in flood loss costs for output ranges using confidence intervals or other accepted scientific characterizations of uncertainty.

5. Justify any differences between the historical and modeled results using current accepted scientific and statistical methods in the appropriate disciplines.

6. Provide graphical comparisons of modeled and historical data and goodness-of-fit tests. Examples include flood frequencies, footprints, and physical damage.

7. Provide a completed Form SF-1, Probability and Frequency of Florida Flood Events per Year. Provide a link to the location of the form [insert hyperlink here].

8. Provide a completed Form SF-2, Examples of Flood Loss Exceedance Estimates. Provide a link to the location of the form [insert hyperlink here].

Audit

1. Forms SF-1 (Probability and Frequency of Florida Flood Events per Year), SF-2 (Examples of Flood Loss Exceedance Estimates), and SF-3 (Distributions of Stochastic Flood Parameters – Coastal, Fluvial, Pluvial) 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 flood footprints, damage estimates, annual flood loss, and flood loss costs will be reviewed.

SF-2 Sensitivity Analysis for Flood 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.

Purpose: Sensitivity analysis goes beyond mere quantification of the magnitude of the output (e.g., flood footprint, flood loss cost, etc.) by identifying and quantifying the input variables that impact the magnitude of the output when the input variables are varied simultaneously. The simultaneous variation of all input variables enables the modeling organization to detect interactions and to properly account for correlations among the input variables. Neither of these goals can be achieved by using one-factor-at-a-time variation, hence such an approach to sensitivity analysis does not lead to an understanding of how the input variables jointly affect the flood model output. The simultaneous variation of the input variables is an important diagnostic tool and provides needed assurance of the robustness and viability of the flood model output.

Relevant Forms: GF-3, Statistical Flood Standards Expert Certification

Disclosures

1. Identify the most sensitive aspect of the flood model and the basis for making this determination. Provide a full discussion of the degree to which these sensitivities affect output results and illustrate with an example.

2. Describe how other aspects of the flood model may have a significant impact on the sensitivities in output results and the basis for making this determination.

3. Describe and justify action or inaction as a result of the sensitivity analyses performed.

Audit

1. The modeling organization's sensitivity analysis for the flood model 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.

SF-3 Uncertainty Analysis for Flood Model Output

The modeling organization shall have performed an uncertainty analysis on the temporal and spatial outputs of the flood 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.

Purpose: Modeling organizations have traditionally quantified the magnitude of the uncertainty in the output (e.g., flood footprint, flood loss cost, etc.) through a variance calculation or by use of confidence intervals. While these statistics provide useful information, uncertainty analysis goes beyond a mere quantification of these statistics by quantifying the expected percentage reduction in the variance of the output that is attributable to each of the input variables. Identification of those variables that contribute to the uncertainty is the first step that can lead to a reduction in the uncertainty in the output. It is important to note that the input variables identified in an uncertainty analysis are not necessarily the same as those in a sensitivity analysis nor are they necessarily in the same relative order. As with sensitivity analysis, uncertainty analysis is an important diagnostic tool and provides needed assurance of the robustness and viability of the flood model output.

Relevant Forms: GF-3, Statistical Flood Standards Expert Certification

Disclosures

1. Identify the major contributors to the uncertainty in flood model outputs and the basis for making this determination. Provide a full discussion of the degree to which these uncertainties affect output results and illustrate with an example.

2. Describe how other aspects of the flood model may have a significant impact on the uncertainties in output results and the basis for making this determination.

3. Describe and justify action or inaction as a result of the uncertainty analyses performed.

Audit

1. The modeling organization's uncertainty analysis for the flood model 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.

SF-4 Flood Model Loss Cost Estimates

At ~~a~~ the ~~ten meter by ten meter~~county level of resolution, the contribution to the error in flood loss cost estimates attributable to the sampling process shall be negligible for each of the modeled components (coastal flooding associated with storm surge, fluvial flooding, and pluvial flooding). However, the number of simulations to achieve negligible loss cost estimates may differ for each modeled component.

Purpose: The intent of this standard is to ensure that sufficient runs of the simulation have been made or a suitable sampling design invoked so that the contribution to the error of the flood loss cost estimates due to its probabilistic nature is negligible. To be negligible, the standard error of each output range shall be less than 5% of the flood loss cost estimate. [Review for resolution size and standard error percentage amount]

Relevant Form: GF-3, Statistical Flood Standards Expert Certification

Disclosure

1. Describe the sampling plan used to obtain the average annual flood loss costs and output ranges. For a direct Monte Carlo simulation, indicate steps taken to determine sample size. For an importance sampling design, describe the underpinnings of the design.

Audit

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

SF-5 Replication of Known Flood Losses

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

Purpose: Each flood model shall reasonably replicate past known events for flood frequency and severity. The Meteorological/Hydrological Flood Standards assess the flood model's flood event frequency projections and flood footprints. This standard applies to severity or the combined effects of flood footprint, flood vulnerability functions, and insurance flood loss limitations. To the extent possible, each of the three functions of flood footprint, flood vulnerability, and flood insurance shall be separately tested and verified.

Given a past flood event and a book of insured properties at the time of the flood event, the flood model shall be able to provide expected flood losses.

Relevant Forms: GF-3, Statistical Flood Standards Expert Certification
SF-4, Flood Validation Comparisons

Disclosures

1. Describe the nature and results of the analyses performed to validate the flood loss projections generated for personal residential losses. Include analyses for the latest five years.

2. Provide a completed Form SF-4, Flood Validation Comparisons. Provide a link to the location of the form [insert hyperlink here].

Audit

1. The following information for each insurer and flood event will be reviewed:
    a. The validity of the flood model assessed by comparing expected flood losses produced by the flood model to actual observed flood losses incurred by insurers at both the state and county level,
    b. The version of the flood model used to calculate modeled flood losses for each flood event provided,
    c. A general description of the data and its source,
    d. A disclosure of any material mismatch of exposure and flood loss data problems, or other material consideration,

e. The date of the exposures used for modeling and the date of the flood event,
f. An explanation of differences in the actual and modeled flood parameters,
g. A listing of the departures, if any, in the flood footprint applied to a particular flood event for the purpose of validation and the flood footprint used in the flood model under consideration,
h. The type of property used in each flood event to address:
   (1) Personal Residential structures
   (2) Mobile homes
   (3) Condominiums
   (4) Structures only
   (5) Contents only,
i. The inclusion of demand surge, wind losses, loss adjustment expenses, or law and ordinance coverage in the actual flood losses or the modeled flood 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 flood event detailing specific assumptions made with regard to exposed property.

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

4. Form SF-4 (Flood Validation Comparisons) will be reviewed.

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

SF-6 Comparison of Projected Flood Loss Costs

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

Purpose: This standard requires various demonstrations that the differences between historical and modeled annual average statewide flood loss costs are plausible from a statistical perspective.

Relevant Forms: GF-3, Statistical Flood Standards Expert Certification
SF-5, Average Annual Zero Deductible Statewide Flood Loss Costs – Historical versus Modeled

Disclosures

1. Describe the nature and results of the tests performed to validate the expected flood loss projections generated. If a set of simulated flood events or simulation trials was used to determine these flood loss projections, specify the convergence tests that were used and the results. Specify the number of flood events or trials that were used.

2. Identify and justify differences, if any, in how the flood model produces flood loss costs for specific historical events versus flood loss costs for events in the stochastic flood event data sources.

3. Provide a completed Form SF-5, Average Annual Zero Deductible Statewide Flood Loss Costs – Historical versus Modeled. Provide a link to the location of the form [insert hyperlink here].

Audit

1. Justify the following:
    a. Meteorological/Hydrological parameters,
    b. The departures, if any, from the flood footprint, flood vulnerability functions, or flood insurance functions applied to the actual flood events for the purposes of this test and those used in the flood model under consideration,
    c. Exposure assumptions.

Form SF-1: Probability and Frequency of Florida Flood Events per Year

[Review and revise form as appropriate for flood – seeking public input]

Complete the table below showing the probability and modeled frequency of Florida flood events per year. Modeled probability shall be rounded to four decimal places. The historical probabilities and frequencies below have been derived from the Flood Event Data Sources for the xxx year period [add dates] (as given in Form AF-2, Flood Event Data Sources Statewide Losses). Exclusion of flood events that caused zero modeled Florida flood damage or additional Florida flood events included in the modeling organization flood data sources as identified in their response to Standard MHF-1 (Flood Event Data Sources) should be used to adjust the historical flood probabilities and frequencies provided here.

If the data are partitioned or modified, provide the historical flood probabilities and frequencies for the applicable partition (and its complement) or modification as well as the modeled flood probabilities and frequencies in additional copies of Form SF-1 (Probability and Frequency of Florida Flood Events per Year).

Flood Model Results
Probability and Frequency of Florida Flood Events per Year

Number Of Flood Events Per Year	Historical Probabilities[AB1]	Modeled Probabilities	Historical Frequencies	Modeled Frequencies
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10 or more				

Form SF-2: Examples of Flood Loss Exceedance Estimates

[Review and revise form as appropriate for flood – seeking public input]

Provide projections of the aggregate personal residential insured flood losses for various probability levels using the notional risk data set specified in Form AF-1 (Zero Deductible Personal Residential Flood Loss Costs) and [data set to be determined]. Provide the total average annual flood loss for the loss exceedance distribution. If the modeling methodology does not allow the flood model to produce a viable answer, please state so and why.

Part A

Return Period (years)	Probability of Exceedance	Estimated Flood Loss Notional Risk Data Set	Estimated Personal Residential Flood Loss
Top Event	N/A		
10,000	0.01%		
5,000	0.02%		
2,000	0.05%		
1,000	0.10%		
500	0.20%		
250	0.40%		
100	1.00%		
50	2.00%		
20	5.00%		
10	10.00%		
5	20.00%		

Part B

Mean (Total Average Annual Flood Loss)		
Median		
Standard Deviation		
Interquartile Range		
Sample Size		

Form SF-3: Distributions of Stochastic Flood Parameters (Coastal, Fluvial, Pluvial)

Provide the probability distribution functional form used for each stochastic flood parameter in the flood model (one each for coastal flooding associated with storm surge, fluvial flooding, and pluvial flooding). Provide a summary of the justification for each functional form selected for each general classification. Specify the relevant classification for each distribution.

Justification for Functional Form										
Year Range Used										
Data Source										
Functional Form of Distribution										
Stochastic Flood Parameter (Function or Variable)										

Form SF-4: Flood Validation Comparisons

[Flood form to be developed – seeking public input]

A. Provide five flood validation comparisons of actual personal residential exposures and flood loss to modeled exposures and flood loss. These comparisons must be provided by line of insurance, construction type, policy coverage, county or other level of similar detail in addition to total flood losses. Include flood loss as a percent of total exposure. Total exposure represents the total amount of insured values (all coverages combined) in the area affected by the flood. This would include exposures for policies that did not have a flood loss. If this is not available, use exposures for only those policies that had a flood loss. Specify which was used. Also, specify the name of the flood event compared.

B. Provide a scatter plot of modeled vs. historical flood losses for each of the required flood validation comparisons. (Plot the historical flood losses on the *x*-axis and the modeled flood losses on the *y*-axis.)

Rather than using directly a specific published flood footprint, the water height, the duration of the flood event (time needed for flood waters to recede), water flows including wave action, rate of water flow along banks and structures, and the weight, pressure and energy generated by moving water and its volume underlying the modeled flood loss cost calculations must be produced by the flood model being evaluated and should be the same flood parameters as used in completing Form AF-2 (Flood Event Data Sources Statewide Losses).

Example Formats for Personal Residential Flood Loss:

Flood Event Description (location, date and duration of event) = _____

_____

Exposure = Total exposure or flood loss only (please specify) _____

Construction	Company Actual Flood Loss / Exposure	Modeled Flood Loss / Exposure	Difference
Wood Frame			
Masonry			
Other (specify)			
Total			

Flood Event Description (location, date and duration of event) = _____

_____

Exposure = Total exposure or flood loss only (please specify) _____

Coverage	Company Actual Flood Loss / Exposure	Modeled Flood Loss / Exposure	Difference
A			
B			
C			
D			
Total			

Form SF-5: Average Annual Zero Deductible Statewide Flood Loss Costs – Historical versus Modeled

[Review and revise form as appropriate for flood – seeking public input]

A. Provide the average annual zero deductible statewide personal residential flood loss costs produced using the list of floods in the flood data sources as defined in Standard MHF-1 (Flood Event Data Sources) based on the [data set to be determined]

Average Annual Zero Deductible Statewide Personal Residential Flood Loss Costs

Time Period –	Historical Floods	Produced by Flood Model
Current Submission		

B. Provide a comparison with the statewide personal residential flood loss costs produced by the flood model on an average industry basis.

C. Provide the 95% confidence interval on the differences between the mean of the historical and modeled personal residential flood loss.

D. If the data are partitioned or modified, provide the average annual zero deductible statewide personal residential flood loss costs for the applicable partition (and its complement) or modification, as well as the modeled average annual zero deductible statewide personal residential flood loss costs in additional copies of Form SF-5 (Average Annual Zero Deductible Statewide Flood Loss Costs – Historical versus Modeled).