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. Modeled results and historical 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 sufficiently rigorous 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, Historical Event Flood Extent and Depth Validation Maps
                            SF-1,   Distributions of Stochastic Flood Parameters (Coastal, Inland)
                            SF-2,   Probability and Frequency of Florida Flood Events per Year
                            SF-3,   Examples of Flood Loss Exceedance Estimates
                            SF-4,   Flood Validation Comparisons
                            SF-5,   Average Annual Zero Deductible Statewide Flood Loss Costs
                                             – Historical versus Modeled

Disclosures

1. Provide a completed Form SF-1, Distributions of Stochastic Flood Parameters (Coastal, Inland). Identify the form of the probability distributions used for each function or variable, if applicable. Identify statistical techniques used for estimation and the specific goodness-of-fit tests applied along with the corresponding *p*-values. Describe whether the fitted distributions provide a reasonable agreement with the historical data. 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 extent and depths 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 currently accepted scientific and statistical methods in the appropriate disciplines.

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

7. Provide a completed Form SF-2, 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-3, Examples of Flood Loss Exceedance Estimates. Provide a link to the location of the form [insert hyperlink here].

Audit

1. Forms SF-1, Distributions of Stochastic Flood Parameters (Coastal, Inland), SF-2, Probability and Frequency of Florida Flood Events per Year, and SF-3 Examples of Flood Loss Exceedance Estimates 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 extent and depths, 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 extent and depth, 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. Identify other input variables that impact the magnitude of the output when the input variables are varied simultaneously. Describe 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 will be reviewed. 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 extent and depths, 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 key 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 Convergence by Zone

At a modeling organization determined level of aggregation utilizing a minimum of 30 zones encompassing the entire state, the contribution to the error in flood loss cost estimates attributable to the sampling process shall be negligible for each of the modeled components (i.e., for each of coastal and inland flooding). However, the number of simulations to achieve negligible loss cost estimates may differ for the coastal and inland flooding components.

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 flood loss cost estimator within each identified zone is to be less than 5% of the flood loss cost estimate.

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 or other sampling scheme, describe the underpinnings of the design and how it achieves the required performance.

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, 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.

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 extent and depths. This standard applies to severity or the combined effects of flood extent and depths, flood vulnerability functions, and insurance flood loss limitations. To the extent possible, each of the three functions of flood extent and depths, flood vulnerability, and flood insurance are required to 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 is required 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 events indicated in Disclosure 1 of MHF-4.

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 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 extent and depths applied to a particular flood event for the purpose of validation and the flood extent and depths 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 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 were 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 extent and depths, 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: Distributions of Stochastic Flood Parameters
(Coastal, Inland)

Provide the probability distribution functional form used for each stochastic flood parameter in the flood model (one each for coastal and inland flooding). Provide a summary of the justification for each functional form selected for each general classification. Specify the relevant classification (coastal or inland) for each distribution.

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

Form SF-2: Probability and Frequency of Florida Flood Events per Year

Complete the table below showing the probability and frequency of Florida flood events per year. Modeled probabilities shall be rounded to four decimal places. The basis for the historical probabilities and frequencies are to be disclosed and should include the flooding events associated with hurricanes 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-2, 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	Modeled Probabilities	Historical Frequencies	Modeled Frequencies
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10 or more				

Form SF-3: Examples of Flood Loss Exceedance Estimates (Coastal and Inland Combined)

Provide projections of the aggregate personal residential insured flood losses for various probability levels using a dataset as specified and justified by the modeling organization as relevant for the purpose of comparing the modeled estimate of personal residential flood loss. 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 Modeling Organization Data Set
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-4: Flood Validation Comparisons

A. Provide five flood validation comparisons of actual personal residential exposures and flood loss to modeled exposures and flood loss. Provide these comparisons 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 versus 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 extent and depths, 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) _____
Type = Coastal, Inland, or Combination Coastal/Inland _____

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) _____
Type = Coastal, Inland, or Combination Coastal/Inland _____

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

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-4, Flood Characteristics, based on a dataset as specified and justified by the modeling organization as relevant for the purpose of comparing the modeled estimate of average annual zero deductible statewide personal residential flood loss costs.

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 a 95% confidence interval on the difference between the means of the historical and modeled personal residential flood losses and identify its basis.

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.