

Recommended Edits to the 2-20-15 Draft Meteorological/Hydrological Flood Standards

Flood Standards Development Committee Meeting

March 31, 2015

MHF-1, Flood Event Data Sources

Purpose

Professional Team: **Editorial**

Explanation: These are editorial changes to remove the use of “shall” in the Purpose statements and to rename Form MHF-1 to align with the Professional Team’s recommendations for the form.

Amendatory Language:

~~As a minimum, This standard requires that~~ the flood model ~~shall~~ include coastal and inland flooding as a minimum. Coastal flooding includes storm surge, and inland flooding includes riverine, lacustrine, and surface water flooding.

This standard requires that ~~U~~utilized data sources associated with each type of flooding ~~shall~~ be documented, and the stochastic flood event data sources ~~shall~~ be scientifically defensible. If other flood sub-perils are included, they ~~shall~~ are to be identified.

Relevant Forms: GF-2A, Meteorological/Hydrological Flood Standards
Meteorologist Expert Certification
GF-2B, Meteorological/Hydrological Flood Standards
Hydrologist Expert Certification
~~MHF-12, Annual Coastal Flood Occurrence Rates Return Periods~~
MHF-3, Inland Flood Return Periods
AF-2, Flood Event Data Sources Statewide Losses
SF-1, Probability and Frequency of Florida Flood Events per Year
SF-5, Average Annual Zero Deductible Statewide Flood Loss Costs –
Historical versus Modeled

AIR: **Editorial**

Explanation: The Commission requested input from the modelers about Form MHF-1; AIR’s suggested edits in MHF-1 respond to this request.

Amendatory Language:

Relevant Forms: GF-2A, Meteorological/Hydrological Flood Standards
Meteorologist Expert Certification
GF-2B, Meteorological/Hydrological Flood Standards
Hydrologist Expert Certification
MHF-1, ~~Annual Flood Occurrence Rates~~ Flood Severity Quantile Estimates

AF-2,	Flood Event Data Sources Statewide Losses
SF-1,	Probability and Frequency <u>Severity</u> of Florida Flood Events per Year <u>for Specified Probabilities and Frequencies</u>
SF-5,	Average Annual Zero Deductible Statewide Flood Loss Costs – Historical versus Modeled

Disclosures

Professional Team: **Technical/Editorial**

Explanation: Disclosure 4 is reworded and Disclosure 5 is added to be consistent with the Professional Team’s recommendations for Form MHF-1.

Amendatory Language:

4. Provide a completed Form MHF-~~12~~, (Annual Coastal Flood Occurrence Rates Return Periods) for coastal ~~and inland~~ flooding, which includes data for ~~various~~ flood extent and depth corresponding to 5, 10, 25, 50, 100, 200, 500, and 1,000 year return periods. ~~Provide a separate form for coastal and inland flooding~~ subdivided for each specific location ~~chosen~~. Provide a link to the location of the form [insert hyperlink here].
- 4.5. Provide a completed Form MHF-3 (Inland Flood Return Periods) for inland flooding which includes data for flood extent and depth corresponding to 10, 25, 50, 100, 200, 500, and 1,000 year return periods, subdivided for each specific location. Provide a link to the location of the form [insert hyperlink here].

AIR: **Technical/Editorial**

Problem Statement: We have provided suggested edits to Form MHF-1. The wording in Disclosure 4 is edited to be consistent.

Explanation: This is technical edit to bring the language in the disclosure in line with Form MHF-1.

Amendatory Language:

4. Provide a completed Form MHF-1, (~~Annual Flood Occurrence Rates~~ Flood Severity Quantile Estimates) for coastal and inland flooding, which includes data for ~~various~~ flood extents s and depths s corresponding to 5, ~~25~~ 20, 50, 100, 200, 500, and 1,000 year return periods. Provide a separate form for coastal and inland flooding subdivided for each specific location chosen. Provide a link to the location of the form [insert hyperlink here].

Audit

Professional Team: **Technical/Editorial**

Explanation: Audits 3 and 4 are reworded to be consistent with the Professional Team's recommendations for Form MHF-1. Audit 5 is reworded for consistency with usual audit wording.

Amendatory Language:

3. Modeled frequencies will be compared with the observed spatial distribution of flood frequencies across Florida using methods documented in currently accepted scientific literature. The goodness-of-fit of modeled to historical statewide and regional coastal and inland flooding flood frequencies as provided in Form MHF-~~1-2~~ (Annual Coastal Flood Occurrence Rates Return Periods) and Form MHF-3 (Inland Flood Return Periods) will be reviewed.
4. Form MHF-~~1-2~~ (Annual Coastal Flood Occurrence Rates Return Periods) and Form MHF-3 (Inland Flood Return Periods) will be reviewed for consistency with Form SF-1 (Probability and Frequency of Florida Flood Events per Year).
5. ~~Describe the h~~Historical data used as the basis for the model's flood extent and depth will be reviewed. ~~Discuss t~~The appropriateness of the model's stochastic flood extent and depth with reference to the historical flood databases will be reviewed.

AIR: **Technical/Editorial**

Problem Statement: We have suggested a change in the name of Form MHF-1; this name needs to be updated throughout the document. We also suggest the name of Form SF-1 be changed to be consistent with the name Form MHF-1 name change.

Explanation: This is a technical edit.

Amendatory Language:

3. Modeled frequencies will be compared with the observed spatial distribution of flood frequencies across Florida using methods documented in currently accepted scientific literature. The goodness-of-fit of modeled to historical statewide and regional coastal and inland flooding flood frequencies as provided in Form MHF-1 (Flood Severity Quantile Estimates Annual Flood Occurrence Rates) will be reviewed.
4. Form MHF-1 (Flood Severity Quantile Estimates Annual Flood Occurrence Rates) will be reviewed for consistency with Form SF-1 (~~Probability and Frequency~~Severity of Florida Flood Events ~~per Year~~for Specified Probabilities and Frequencies).

MHF-2, Flood Parameters (Inputs)

Standard

Professional Team: **Technical**

Amendatory Language:

D. The grid cell size used in the model shall be scientifically justified.

Disclosures:

Professional Team: **Technical/Editorial**

Amendatory Language:

6. For coastal flood analyses, describe how the coastline is segmented (or partitioned) in determining the parameters for ~~coastal~~ flood frequency used in the flood model.
13. Provide the source, resolution, and accuracy of the topography and bathymetry throughout the flood model domain. Provide the grid cell size(s) used in the model.
15. As applicable, describe the methods used to account for soil infiltration rates and saturation in the flood model. Provide citations to ~~published papers, if any,~~ all data sources used to develop and support the soil infiltration rate or soil saturation methodology, including publicly developed or peer reviewed information.
16. Describe the methods used to account for land-use conditions and future changes in land-use, if any, in the flood model. Provide citations to ~~published papers, if any,~~ all data sources used to develop and support the land-use evaluation methodology, including publicly developed or peer reviewed information.
17. Provide the collection and publication dates of the soil and LULC data used in the flood model, and justify ~~their~~ the data's applicability and timeliness for Florida.

Audit

Professional Team: **Technical/Editorial**

5. ~~Provide a~~ Any modeling organization specific research performed to develop the soil infiltration rates or soil saturation used in the flood model will be reviewed. ~~Identify t~~ he databases used. ~~This material~~ will be reviewed in the context of the cited scientific literature.
6. ~~Provide a~~ Any modeling organization specific research performed to develop soil saturation land-use evaluation methodology in the flood model will be reviewed. ~~Identify t~~ he databases used. ~~This material~~ will be reviewed in the context of the cited scientific literature.

MHF-3, Wind and Pressure Field Structures for Storm Surge

Standard

Professional Team: **Technical**

- A. ~~Representations of the spatial and temporal structures~~ Modeling of wind and pressure fields shall be employed to drive storm surge models due to tropical cyclones. Modeling of wind and pressure fields shall be employed to drive storm surge models due to extra-tropical cyclones, unless extra-tropical storm surge is otherwise incorporated into the flood elevation results.
- B. The wind and pressure fields shall be based on contemporary scientific literature or developed using scientifically defensible methods.
- ~~C. Wind and pressure fields for coastal flood modeling shall be employed for at least two classes of storms: tropical cyclones and extra-tropical cyclones.~~
- ~~1.~~C. Wind and pressure fields that drive coastal flood models shall be modeled for a time period that extends from at least before the storm's passage over the continental shelf waters of Florida and neighboring states to at least the time the storm no longer affects flooding in Florida.
- ~~2.~~D. The features of modeled wind and pressure fields shall be consistent with those of historical storms affecting Florida.

AIR: **Editorial**

Problem Statement: New Standard MHF-3.D. requires that wind and pressure fields that drive coastal flood models shall be modeled for an appropriate length of time. Since this standard is specific to storm surge, we think an additional clarifying word should be added in the second to last line of this standard. Adding the word "coastal" will clarify that the standard is not also talking about an inland flood event.

Explanation: This is a general edit to clarify the intent of the standard

Amendatory Language:

- D. Wind and pressure fields that drive coastal flood models shall be modeled for a time period that extends from at least before the storm's passage over the continental shelf waters of Florida and neighboring states to at least the time the storm no longer affects coastal flooding in Florida.

Purpose

Professional Team: **Technical/Editorial**

Amendatory Language:

Wind is the dominant feature of tropical cyclones that drives storm surge and Storm-storm surge is frequently the dominant component of the associated flooding~~due to cyclonic storms, and wind is the dominant feature of cyclonic storms that drives surge.~~ The representation of the windfield and related pressure field is, therefore, crucial to storm surge modeling. This standard ~~ensures~~requires that the wind and pressure fields used to drive storm surge as part of flood models are scientifically sound and have been evaluated by using comparison to historical storms affecting Florida. ~~Modeling organizations have leeway in their methods of representing wind and pressure fields, and different storm classes may well require different approaches.~~Extra-tropical cyclones need not be explicitly modeled with wind and pressure fields but are not exempt from consideration in the flood elevation results.

Disclosures

Professional Team: **Technical**

Amendatory Language:

1. Describe the nature modeling of the wind and pressure fields ~~representation (e.g., parametric or resampled reanalysis of historical storms)~~for tropical cyclones. State and justify the choice of the parametric forms and the parameter values.
2. Describe the modeling of the wind and pressure fields for extra-tropical cyclones, if implemented.
- ~~2.3.~~ Provide the historical data used to estimate parameters and to develop stochastic storm sets from reanalysis.
- ~~3. If parametric gradient wind and pressure fields are employed, state and justify the choice of the parametric forms and the parameter values.~~
4. Provide a rotational (y-axis) versus radial (x-axis) plot of the average or default wind and pressure profiles ~~for parametric, symmetric fields or a latitude-longitude map of typical reanalysis-based wind and pressure fields.~~
5. ~~If parametric gradient wind and pressure fields are employed, d~~Describe how these parametric wind~~fields~~ are translated to surface wind~~fields~~ (e.g., numerically via planetary boundary layer models or parametrically via empirical surface wind reduction factors and inflow angles). Discuss the associated uncertainties.
6. ~~If parametric gradient wind and pressure fields are employed, d~~Describe how storm translation is accounted for when computing surface wind~~fields.~~

Audit

Professional Team: **Technical/Editorial**

Amendatory Language:

1. All external data sources that affect the model-generated wind and pressure fields associated with storm surge will be identified and their appropriateness reviewed.
3. The sensitivity of final-flood extent and depth results to ~~the nature~~changes in the representation of ~~the~~ wind and pressure fields representations will be reviewed.
5. The treatment of ~~the inherent~~ uncertainty in the factor used to convert from a reference windfield to a geographic distribution of surface winds and the impact of the resulting winds upon the storm surge will be reviewed and compared with currently accepted scientific literature. ~~Treatment of conversion factor uncertainty at a fixed time and location will be reviewed.~~

MHF-4, Flood Characteristics (Outputs)

Purpose

Professional Team: **Editorial**

Explanation: Editorial changes to remove the use of “shall” in the Purpose statements and to rename Form MHF-2 to align with the Professional Team’s recommendations for the form.

Amendatory Language:

This standard requires that the modeling organization use ~~only~~ scientifically sound information for determining inland and coastal flooding characteristics.

This standard requires that ~~The~~ resulting surface flood extent, depth, and other characteristics ~~shall~~ be representative of historical floods in Florida.

This standard requires that ~~C~~comparison of ~~the~~ flood characteristics produced by the stochastic flood events and historical flood events ~~shall~~ be documented, and variations ~~between them shall be~~ justified.

Relevant Forms: GF-2A, Meteorological/Hydrological Flood Standards
Meteorologist Expert Certification
GF-2B, Meteorological/Hydrological Flood Standards
Hydrologist Expert Certification
MHF-~~21~~, Historical Event Maps of Flood Extent and Depth
Validation Maps by Return Period
AF-2, Flood Event Data Sources Statewide Losses

Disclosures

Professional Team: **Technical/Editorial**

Amendatory Language:

1. Provide comparisons of the modeled ~~calculated~~ and historical flood extents and depths for ~~a minimum of XX events. The minimum number will include Y number of storms as provided in Table MHF-1~~ the following events: Hurricane Ivan (2004), Hurricane Jeanne (2004), Hurricane Wilma (2005), Tropical Storm Fay (2008), Unnamed storm on east central Florida (May 2009), Unnamed storm on Florida panhandle (July 2013), and one additional Florida storm of the modeling organization’s choosing. The comparisons must demonstrate that ~~the events selected are of sufficient variety, and~~ each model component (~~storm surge, riverine/lacustrine flooding, and surface water~~ coastal and inland flooding) is sufficiently robust, to incorporate important flood parameters, replicate historical flood characteristics, and accommodate the varied geographic, geologic, hydraulic, and LULC conditions in Florida. Provide justification for validation using any historical events not specified ~~in Table MHF-1~~ above.
2. For each of the coastal storm events in Disclosure ~~8~~ 1, provide a comparison of the modeled ~~calculated~~ flood extents and water surface elevations with either the NOAA Maximum Envelope of Water (MEOW) or NOAA validation case studies using Sea, Lake, and Overland Surges from

Hurricanes (SLOSH) data, if applicable. The modeling organization should use the most reasonable vintage of the ~~MEOW-MOM~~ data for this exercise.

3. Provide ~~visual descriptions (sufficient to illustrate various regions in Florida) illustrating the flood characteristics for coastal and inland flooding~~ a map comparing simulated water elevations to observed water elevations for each validation storm in Disclosure 1.
9. Demonstrate the consistency of the model-generated flood extent and depth with observed floods affecting Florida. Describe and justify the appropriateness of the databases used in the flood extent and depth validations.
12. Provide a completed Form MHF-~~21~~, Maps of Historical Event Flood Extent and Depth Validation Maps by Return Period. Explain any differences between modeled flood extent and depth and historical flood extent and depth. Provide a link to the location of the form [insert hyperlink here].

Audit

Professional Team: **Technical/Editorial**

Amendatory Language:

1. ~~Provide a~~Any modeling organization specific research performed to develop the flood extent and depth functions used in the flood model will be reviewed along with. ~~Identify~~ the associated databases ~~used~~.
2. ~~Provide a~~Any modeling organization specific research performed to derive the hydrological characteristics associated with the topography, soil type, and LULC distributions for the flood extent and depth will be reviewed.
3. Provide the ~~current~~ flood parameters used in calculating the flood loss costs for **X** historical flood events. Calculations based on flood model results for coastal and inland flooding will be reviewed. Specification of flood parameters used in the model for all storm events will be reviewed. Provide the resulting temporal and spatial distributions of any flood characteristics contributing to flood damage. These will be reviewed with Form AF-2 (Flood Event Data Sources Statewide Losses). [consider deletion of this sentence if Form AF-2 is not going to specify a list]
5. Form MHF-~~21~~ (Maps of Historical Event Flood Extent and Depth Validation Maps by Return Period) will be reviewed.
8. The comparison of the calculated characteristics with historical flood events will be reviewed. The selected locations and corresponding storm events will be reviewed to verify sufficient representation of the ~~variety of varied~~ geographic areas. If a single storm is used for both coastal and inland flooding validation, then its appropriateness will be reviewed.
9. The comparison of the flood extents and water surface elevations calculated in the model with the NOAA Maximum of MEOW (MOM) or NOAA validation studies using SLOSH data for each location will be reviewed, if applicable. The reasonableness of the ~~MEOW-MOM~~ data vintage used will be reviewed.

MHF-5, Flood Probabilities and Severities

Standard

Professional Team: **Technical**

Amendatory Language:

MHF-5 Flood Probabilities and Severities Distributions

~~A. Modeled probability distributions of flood parameters and characteristics shall be consistent with historical floods for Florida resulting from coastal and inland flooding.~~

~~B.A. Modeled flood frequency distributions and the associated flood extent and depth shall be scientifically defensible and shall be consistent with flooding observed for Florida and neighboring states impacting over the time frames relevant to each data source and shall be consistent with those observed for each coastal and inland segment (or partition) of Florida and in which the flood event could occur in other parts of the United States where flooding damage impacts Florida.~~

B. Flood frequency distributions for storm surge affected areas shall include both tropical and extra-tropical events.

C. Any additional probability distributions of flood parameters and modeled characteristics shall be consistent with historical floods for Florida resulting from coastal and inland flooding.

Purpose

Professional Team: **Technical**

Amendatory Language:

This standard requires that the probability of occurrence of floods and flood extent and depth reasonably reflect the historical record with respect to geographical locations. This standard addresses consideration of flooding events in neighboring states (e.g., Georgia) which could impact Florida (e.g., Apalachicola River flooding in the panhandle~~Chattahoochee River floods~~ from rainfall in the Chattahoochee River watershed in North Georgia).

This standard requires that the probability of occurrence of flood extent and depth be determined by combining storm surge from tropical and extra-tropical events. Such combination can be through explicit modeling of both types of events, or by statistically combining extra-tropical flood frequency information with explicitly modeled tropical event flood frequency.

This standard requires that the ~~modeled~~ probability distributions of flood parameters not treated as constants and modeled characteristics be consistent with those documented in official meteorological and hydrological databases. Consistent means that spatial distributions of modeled flood probabilities accurately depict coastal and inland flooding in Florida.

~~The probability of occurrence of floods and flood extent and depth shall reasonably reflect the historical record with respect to severity and geographical locations.~~

Relevant Forms: GF-2A, Meteorological/Hydrological Flood Standards
Meteorologist Expert Certification
GF-2B, Meteorological/Hydrological Flood Standards
Hydrologist Expert Certification
MHF-~~12~~, Annual Coastal Flood Occurrence RatesReturn Periods
MHF-3, Inland Flood Return Periods
AF-2, Flood Event Data Sources Statewide Losses
SF-1, Probability and Frequency of Florida Flood Events per Year
SF-3, Distributions of Stochastic Flood Parameters
(Coastal and Inland)

AIR: **Editorial**

Amendatory Language:

Relevant Forms: GF-2A, Meteorological/Hydrological Flood Standards
Meteorologist Expert Certification
GF-2B, Meteorological/Hydrological Flood Standards
Hydrologist Expert Certification
MHF-1, Flood Severity Quantile Estimates~~Annual Flood Occurrence Rates~~
AF-2, Flood Event Data Sources Statewide Losses
SF-1, ~~Probability and Frequency~~Severity of Florida Flood Events ~~per~~
Year for Specified Probabilities and Frequencies
SF-3, Distributions of Stochastic Flood Parameters
(Coastal and Inland)

Disclosures

Professional Team: **Technical**

Amendatory Language:

2. Describe how extra-tropical and tropical event coastal storm surge flood frequencies are combined. Provide one example demonstrating the process.

~~2.3.~~ Provide ~~a brief~~ the rationale for each of the probability distributions used for relevant flood parameters and characteristics.

Audit

Professional Team: **Editorial**

Explanation: Revised for consistency with usual audit wording.

Amendatory Language:

2. ~~Describe and support t~~The method ~~of~~and supporting material for generating stochastic coastal and inland flood events will be reviewed.
3. ~~Describe and support t~~The method ~~of~~and supporting material for determining flood extent and depth for coastal and inland flooding will be reviewed.
4. ~~Provide a~~Any modeling organization specific research performed to develop the functions used for simulating flood model variables ~~or~~and to develop flood databases will be reviewed.

MHF-6, Modeling of Flood Mitigation and Prevention Measures and Their Failures

Standard

Professional Team: **Editorial**

Amendatory Language:

MHF-6 Modeling of Regional Flood Mitigation and Prevention Measures ~~and Their Failures~~

- B. The modeling organization shall have a documented procedure for reviewing available flood mitigation and prevention data ~~sets~~ and shall update the flood model mitigation and prevention databases as necessary.

Purpose

Professional Team: **Editorial**

Amendatory Language:

This standard ~~ensures~~requires that regional/local flood mitigation and prevention measures are accounted for and updated ~~on a periodic basis~~as necessary. It also ~~ensures~~requires that any treatment of the potential failure of flood mitigation or prevention measures properly reflects the scientific and engineering basis.

Disclosures

Professional Team: **Technical/Editorial**

Amendatory Language:

2. ~~If applicable, d~~Describe the methodology to account for flood mitigation and prevention measures in the flood model and indicate if these measures can be set (either to on or off) in the flood model.
3. Describe if ~~temporary/ongoing~~ flood mitigation and prevention measures, ~~and measures requiring which require~~ human intervention or ongoing maintenance, are incorporated into the flood model. Disclose ~~if the~~ consideration ~~is given, if any,~~ on ~~how much the~~ time ~~is~~ required to construct, install or activate such measures, as compared with warning time that may be available before a flood event. Disclose ~~if the~~ consideration ~~is given, if any,~~ for the likelihood of construction/installation/activation based on reports ~~in the literature~~ for past storm events.
4. ~~If applicable, illustrate~~Provide the probability distributions of flood extent, depth, and other characteristics showing the impact of flood mitigation and prevention measures versus no flood mitigation and prevention measures.

6. ~~If applicable, d~~Describe and justify the methodology used to account for the potential failure or alteration of flood mitigation and prevention measures in the flood model and if the level of failure can be adjusted in the flood model.

~~7. If applicable, provide the probability distribution for flooding scenarios incorporating the failure of flood mitigation and prevention measures.~~

~~8.7.~~State whether the flood model incorporates ~~natural or~~ intentional discharge of flood waters by governmental or other human actions for flood mitigation purposes. If so, describe how this is handled in the flood model.

~~9. If applicable, describe the flood loss distributions assuming no failure of flood mitigation and prevention measures compared to the flood loss distribution accounting for failure.~~

Audit

Professional Team: **Technical/Editorial**

Amendatory Language:

2. The documented procedure addressing the ~~periodic~~ updating of ~~current~~ flood mitigation and prevention measures as necessary will be reviewed.

3. ~~As applicable, t~~The methodology and justification used to account for the potential failure or alteration of flood mitigation and prevention measures in the flood model will be reviewed.

4. ~~As applicable, t~~The probability distribution for flooding scenarios incorporating the failure of flood mitigation and prevention measures will be reviewed.

~~6. As applicable, the flood loss distributions assuming no failure of flood mitigation and prevention measures compared to the flood loss distribution accounting for failure will be reviewed.~~

MHF-7, Logical Relationships of Flood Characteristics

Standard

Professional Team: **Technical/Editorial**

Amendatory Language:

- A. The water ~~level~~ surface elevation shall increase with increasing ~~surface~~ terrain roughness, all other factors held constant.
- B. The rate of water flow shall increase with increase in steepness in the topography ~~and increase in surface slope~~, all other factors held constant.
- C. The inland flood extent and depth associated with riverine and lacustrine flooding shall increase with increasing discharge in the river, all other factors held constant.
- D. The coincidence of storm surge and inland flooding shall increase the flood extent and depth, all other factors held constant.
- E. ~~The larger the over-water storm, as measured by the area enclosed by windspeed or pressure contours, the greater the storm surge extent and depth area, all other factors held constant.~~ Storm surge shall increase with greater over-water storm size, as measured by the area enclosed by windspeed or pressure contours, all other factors held constant.
- F. Storm surge shall increase with ~~increasingly~~ shallower bathymetry, all other factors held constant.
- G. ~~The height of s~~Storm surge shall increase with increasing windspeeds, all other factors held constant.
- H. If locally generated coastal waves are represented, ~~wave (sea as distinct from swell)~~ the heights and periods shall increase with increasing windspeed, subject to depth, fetch and duration limits, all other factors held constant.

Purpose

Professional Team: **Technical/Editorial**

Amendatory Language:

This standard requires that the relationships ~~The flood model shall produce logical consistencies associated~~ among the ~~flood~~ parameters and ~~the flood~~ characteristics ~~used in of~~ the flood model are logically consistent.

Disclosures

Professional Team: **Technical/Editorial**

Amendatory Language:

1. Provide a sample graph of water surface elevation and discharge versus time associated with inland flooding for each region in Florida: Panhandle, Gulf Coast, North Florida, Central Florida, and South Florida. Discuss how the flood characteristics ~~result in~~exhibit logical relationships.
2. Provide sample plots and tabulations of storm surge elevations and associated wave conditions at open coast and bay/estuarine locations around the Florida coastline. The number of examples shall be sufficient to demonstrate logical relationships with ~~model applicability to a variety of~~ geographic, oceanographic, hydraulic, and meteorological conditions.
3. Provide any sensitivity analyses performed in response to this standard.

Audit

Professional Team: **Technical/Editorial**

Amendatory Language:

- ~~1. The modeling organization's sensitivity analyses will provide the information used in auditing this standard.~~
- ~~2.1. Verify that t~~he flood model's ability to produces logical relationships ~~among flood characteristics, as listed in this standard~~will be reviewed.
2. The modeling organization's sensitivity analyses will be reviewed.

Form MHF-1: Annual Flood Occurrence Rates

Professional Team: **Technical**

Amendatory Language:

Form MHF-~~1~~²: Annual Coastal Flood Occurrence RatesReturn Periods

For areas subject only to coastal flooding,

- A. Provide ~~annual flood occurrence rates for coastal and inland flooding which includes data for various flood extent and depth~~ erosion depth grids (original grade elevation minus eroded grade elevation) corresponding to modeled ~~5~~10, 25, 50, 100, 200, 500, and 1,000 year return period flood events if erosion is incorporated in the flood model. ~~Provide a separate form for coastal and inland flooding subdivided for each specific location chosen. Annual flood occurrence rates shall be rounded to four decimal places.~~
 - B. ~~Compare the flood model frequencies with the historical flood frequencies to the extent of available data.~~ Provide stillwater flood extent and depth grids corresponding to modeled 10, 25, 50, 100, 200, 500, and 1,000 year return period flood events. If the flood model incorporates erosion, include erosion effects in the flood depth grids.
 - C. ~~Provide vertical bar graphs depicting distributions of flood frequencies.~~ Provide flood extent and depth grids, including overland waves and wave run-up as appropriate, corresponding to modeled 10, 25, 50, 100, 200, 500, and 1,000 year return period flood events. If the flood model incorporates erosion, include erosion effects in the flood depth grids.
 - D. Provide wave height grids corresponding to modeled 10, 25, 50, 100, 200, 500, and 1,000 year return period flood events.
 - E. Provide flow velocity grids corresponding to modeled 10, 25, 50, 100, 200, 500, and 1,000 year return period flood events.
 - F. For selected locations and flood events, compare the flood model elevation frequencies (including wave effects, if present) with historical floods as available data allow.
 - G. Provide graphs and underlying data in Excel format depicting flood elevation frequencies (include wave effects, if present) for selected locations.
 - H. Provide ~~a~~ color coded maps ~~with a legend displaying the flood frequency ranges~~ depicting grids at selected locations. Increasing flood ~~frequency~~ depths, flood velocities, and erosion depths shall ~~correspond to~~ be indicated by greater color intensity.
 - I. Plot the areas where the erosion depth, flood depth, or flood velocity grids area affected by flood protection system failure.
- ~~— If the data are partitioned or modified, provide the annual flood occurrence rates for the applicable partition (and its complement) or modification in additional copies of Form MHF-1 (Annual Flood Occurrence Rates).~~

J. Provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the standards year, and the form name. Form MHF-~~1-2~~ (~~Annual-Coastal Flood Occurrence Rates~~Return Periods) shall also be included in a submission appendix.

Form MHF-3: Inland Flood Return Periods

For areas subject only to inland flooding,

A. Provide erosion depth grids (original grade elevation minus eroded grade elevation) corresponding to modeled 10, 25, 50, 100, 200, 500, and 1,000 year return period flood events if erosion is incorporated in the flood model.

B. Provide stillwater flood extent and depth grids corresponding to modeled 10, 25, 50, 100, 200, 500, and 1,000 year return period flood events. If the flood model incorporates erosion, include erosion effects in the flood depth grids.

C. Provide flow velocity grids corresponding to modeled 10, 25, 50, 100, 200, 500, and 1,000 year return period flood events.

D. For selected locations and flood events, compare the flood model elevation frequencies with historical floods as available data allow.

E. Provide graphs and underlying data in Excel format depicting stillwater flood elevation frequencies for selected locations.

F. Provide color coded maps depicting grids at selected locations. Increasing flood depths, flood velocities, and erosion depths shall be indicated by greater color intensity.

G. Plot the areas where the erosion depth, flood depth, or flood velocity grids area affected by levee or other flood protection system failure.

For areas subject to both inland and coastal flooding,

H. Provide separate flood depth and flood velocity and erosion grids with combined coastal and inland stillwater flooding, including erosion effects if the flood model incorporates erosion.

~~A.~~I. Provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the standards year, and the form name. Form MHF-3 (Inland Flood Return Periods) shall also be included in a submission appendix.

AIR: Technical

Problem Statement: On the wind hazard side, the concept of an occurrence rate is directly tied to the five Saffir-Simpson categories. In other words, if you talk about the hurricane occurrence rate, it is the rate *with respect to a particular SS-category*. The issue we have been struggling with on the flood side is defining what the occurrence rates are *with respect to* because floods do not have a handy “category” like winds do. AIR suggests that the concept of flood severity quantiles corresponding to specific return periods is an appropriate “*with respect to*” for the flood peril. The word “Quantile” typically is used for referring to the magnitude of any variable that corresponds to certain probability of exceedance (or return period). In this case, it is basically to say Flood (magnitude) Quantile estimate corresponding to 2, 5, 10, ... return periods.

Explanation: This is an edit to the nature of the data requested in the form in order and to make things clearer.

Amendatory Language:

Form MHF-1: ~~Annual Flood Occurrence Rates~~ Flood Severity Quantile Estimates

- A. Provide ~~annual flood occurrence rates~~ flood severity quantile estimates for coastal and inland flooding, which includes data for ~~various~~ flood extents and depths corresponding to 5, ~~25~~20, 50, 100, 200, 500, and 1,000 year return periods. Provide a separate form for coastal and inland flooding subdivided for each specific location chosen. ~~Annual flood occurrence rates shall be rounded to four decimal places.~~
- ~~A.~~ B. Compare the flood model frequencies with the historical flood frequencies to the extent of available data.
- ~~B.~~ C. Provide vertical bar graphs depicting distributions of flood frequencies.
- ~~C.~~ D. Provide a color coded map with a legend displaying the flood frequency ranges. Increasing flood frequency shall correspond to greater color intensity.
- ~~D.~~ E. If the data are partitioned or modified, provide the annual flood occurrence rates for the applicable partition (and its complement) or modification in additional copies of Form MHF-1 (Flood Severity Quantile Estimates ~~Annual Flood Occurrence Rates~~).
- ~~E.~~ F. Provide this form in Excel format. The file name shall include the abbreviated name of the modeling organization, the standards year, and the form name. Form MHF-1 (Flood Severity Quantile Estimates ~~Annual Flood Occurrence Rates~~) shall also be included in a submission appendix.

Form MHF-2: Maps of Flood Extent and Depth by Return Period

Professional Team: **Technical**

Amendatory Language:

Form MHF-21: ~~Maps of~~Historical Event Flood Extent and Depth ~~by Return Period~~Validation Maps

Historical Florida Floods

~~A. Identify six recent historical Florida floods that illustrate coastal and inland flooding.~~

~~BA.~~ Provide ~~exhibits~~color-coded contour maps with appropriate base map data illustrating modeled flood extents and peak stillwater elevations for the ~~selected~~following six historical Florida flood events: ~~illustrating modeled return periods for different river or coastal segments.~~

Hurricane Ivan (2004)

Hurricane Jeanne (2004)

Hurricane Wilma (2005)

Tropical Storm Fay (2008)

Unnamed Storm East Central Florida (2009)

Unnamed Storm Florida Panhandle (2013)

B. Provide corresponding color-coded contour maps with modeled flood depths for each of the six historical events, contoured at no more than one foot intervals.

Elevation datum shall be North American Vertical Datum 1988 (NAVD88).

Plot the locations and ~~numerical measures of the maximum flood level relative to the local datum for coastal and inland areas~~values associated with validation points (maximum flood elevations or depths from observations such as gage data, water marks, etc.) on each contour map for the six historical events.

Provide the resolution of the model depth grid used on each contour map.

Modeled Florida Floods

~~C. Demonstrate the consistency of the spatial distribution of model-generated flood extent and depth with observed flood extent and depth for coastal and inland floods affecting Florida. Contour colors will be the same as those used for the maps provided in response to B above.~~each historical event.

~~DC.~~ Explain any differences between the modeled flood extent and depth and the historical flood observations ~~identified in item A. above.~~ Include an explanation if the differences are impacted by flood mitigation and prevention measures.

~~All maps shall be color-coded or shaded at elevation contours to describe the topography associated with the flood extent and depth.~~