# 4. Review of EQECAT Model

### 4.1 General

In its initial draft report, the panel of experts indicated that

"In its responses to the initial and follow-up questions, EQECAT states that WORLDCATenterprise Versions 3.16 and 3.13 include Florida Hurricane Model 2011a and Florida Hurricane Model 2009, respectively. It should be noted that FCHLPM has reviewed and accepted the latter two Florida-specific models, not WORLDCATenterprise which includes other hazards and regions including hurricane hazards in South Carolina."

Notwithstanding the above, per the panel of experts' review of the responses from EQECAT it is recommended that EQECAT WORLDCATenterprise Version 3.16 which includes Florida Hurricane Model 2011a (accepted by FCHLPM with expiration date of September 2013) may be used for rate filings in South Carolina. It should always be determined that the version of the model used for rate filings in South Carolina should include only a long-term prediction of hurricane risk. All of the models currently accepted by the FCHLPM use only a long-term view of hurricane risk. Thus, the FCHLPM has not accepted any implementation of the WORLDCATenterprise Version 3.16 model that specifies warm water, warm phase, medium-term, short-term, or any other variations of historical hurricane risk and so these are not recommended for use in rate filings in South Carolina. As such, if these "larger" EQECAT models (WORLDCATenterprise Versions 3.16 and 3.13) are used for rate filing in South Carolina, we recommend that documentation be required in the rate filing to specify the view of risk (with adequate detail to ensure there is no variation from the long-term historical view of hurricane risk) and to document and justify the differences in hurricane risk models between the Florida specific models and the South Carolina models.

In response to the initial draft report, EQECAT has introduced the new version of their model. Specifically EQECAT states that:

"In addition, EQECAT will release a new model version entitled Risk Quantification and Engineering (RQE) v14 on August 9. The Florida Commission on Hurricane Loss Projection Methodology has certified the Florida portion of RQE v14 in June 2013. EQECAT is providing results in Forms SC2 and SC3 that are from RQE v14."

EQECAT continues to summarize the differences between the new RQE v14 and WCe v3.16. Upon review and comparison of Forms SC-2 and SC-3 completed



using these two versions of the model, the panel of experts encountered some inconsistent results. For example, where WCe 3.16 produced non-zero loss cost for ZIP Code 29390 for various construction types, RQE v14 produces zero loss costs. Similarly, where WCe 3.16 produced zero loss costs for ZIP Code 29503 for various construction types, RQE v14 produces non-zero loss costs. These discrepancies cannot be easily explained by the summary of differences between the two models provided by EQECAT. It is recommended that if and when RQE v14 is used for rate filing in South Carolina, these differences be satisfactorily detailed and explained.

In its initial draft report the panel of experts indicated that

"The variations of loss costs for the same ZIP Codes for various EQECAT model versions are relatively large. For example for ZIP Code 29458 the ratio of Version 3.13 loss cost to Version 3.16 loss cost is in the range of 2.5 to 3.0, whereas for ZIP Code 29810 the same ratio is in the range of 0.7 to 0.75. In other words, from version to version, loss costs have decreased and decreased substantially from ZIP Code to ZIP code. The regulator should require justification by the modeler for future changes as suggested in the Findings and Recommendations section of this report."

In its response, EQECAT explained the differences are due to changes in updated roughness lengths in the model. Panel of experts believe that this explanation and the roughness lengths provided for the ZIP Codes in the two models are satisfactory.

# 4.2 Meteorology Module

The Meteorology module of the model develops a geographically varying picture of hurricane-related risk based upon the historical hurricane records for the region (not only for South Carolina).

## Use of historical storms

The data sources utilized by EQECAT for developing the stochastic storm set produced by the model are all from NOAA documents and historical databases issued by the National Hurricane Center. The modeler states that the model versions submitted for review are based on the complete historical hurricane database for 1900-2009, without modification or frequency adjustment (pages 6 and 7 of their follow-up response).

In their August 2013 responses, EQECAT note that they have updated the historical hurricane database to include the 1900-2011 hurricane seasons and the coincident NHC reanalyses of earlier hurricanes in their new model (RQE v14). EQECAT state that this updated hurricane database results in an increase in South Carolina statewide loss costs.



This increase in loss costs due to updates in the long-term historical hurricane database demonstrates why it is important that the long-term view of risk be used for rate filings: if shorter segments (or other subsets) of the historical record are used, the loss costs will be even more sensitive to changes in an individual event.

While the entire hurricane database has been used in developing the model, the landfall frequencies for the stochastic hurricane set are lower for weaker storms and more frequent for more intense hurricanes, including Cat 5 systems (page 11, follow-up responses). These frequency variations are acceptable, but should be examined with each new model submitted to the Department of Insurance.

## Landfalling hurricanes

The definition of a hurricane used in the EQECAT model for compiling the stochastic storm set is the same as the definition used by the Florida Commission: the storm must be a hurricane when it is near or over the US mainland and must cause damaging winds in the state (but need not have hurricane winds in the state).

The EQECAT model has a tendency to produce a higher fraction of intense hurricanes (Category 3 and 4) at landfall and fewer weaker storms (table on page 10 and histogram on page 11 in the pdf of the EQECAT initial responses – the pages are not numbered).

The most intense modeled hurricane that makes landfall in South Carolina (page 16) is 20% more intense than Hurricane Andrew (1992) (30% stronger than the 140 mph of Hurricane Hugo). Its radius of maximum winds (*Rmax*) is less than 5 miles; Hurricane Charley (2004) is the only historical landfalling hurricane with its strongest winds this close to the center at landfall. The forward speed of the model storm is similar to that of Hurricane Hugo (1989) at landfall. This model storm is very much an outlier compared to historical U.S. landfalling hurricanes, but the combination of a small maximum wind radius and unusually strong maximum winds is possible based on the physics governing these storms.

Simulation of damaging winds associated with a modeled hurricane

The description of the modeled storm characteristics and how they are used to develop a spatial distribution of hurricane winds is consistent with the EQECAT model approved by the Florida Commission, however, it differs in the treatment of hurricane weakening over land; since many hurricanes affecting South Carolina will make landfall in other states this component of the model is important. The method used in the EQECAT model has been shown by them to reproduce storm intensity over land to within  $\pm 20\%$  of another inland wind decay model (page 14 in the original responses and page 4 in the revised responses); statistics on direct comparisons between observed storm weakening and inland decay produced by the model are not given.



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In their August 2013 response (page 1), EQECAT note that the timestep used for inland decay has changed from 15 minutes to 5 minutes in their new model (RQE v14). The decrease in timestep (to 5 minutes) means that the model calculates the damaging winds three times more often, and so will sample the stronger winds near landfall more often. EQECAT state that this will result in a minor increase in loss costs in South Carolina. This timestep change has been reviewed and found acceptable for use in Florida by the FCHLPM. However, EQECAT do not provide any discussion on how the change affects windspeeds over land for South Carolina compared to historical storms.

While only applying to a single very intense storm, Form SC-1 gives some information on over-land weakening. The storm characteristics input to the EQECAT model to simulate Hurricane Hugo are reasonable and modeled winds simulated using these characteristics compare reasonably well with observed winds (comparing the top map on page 43 with the map on page 44 of their initial response).

EQECAT accounts for the effects of terrain by using a variation to the roughness factor (page 15, follow-up responses; "secondary friction factor"). Recall that the roughness factor is used to modify the winds based on the land use characteristics (lake, forest, field, town, etc.). This EQECAT variation to the roughness appears to be an effective approach for accounting for the topography in the west of the state, but has not been evaluated by the FCHLPM or the panel of experts. It is — understandably — not used in the model accepted by the Florida Commission and so has not been reviewed in the FCHLPM process. Comparison between the two maps on page 43 (original submission) is helpful in understanding the effects of this secondary friction factor. The factor should only be included in winds plotted in the top map (actual terrain), but not the other map (open terrain): comparison of these maps shows that the effect of the secondary roughness factor for topography is small in the case of Hurricane Hugo.

# Summary of Meteorology Module

The stochastic storm tracks produced by the EQECAT model are reasonable; the intensities of the stochastic storms affecting South Carolina have a tendency to be higher than the past 110 years, but are within reasonable bounds. The strongest stochastic storm is 20–30 % more intense than historical landfalls, but the very small maximum wind radius means that the central pressure (876 mb) could be within the bounds of historical storms even though the winds are so intense. The modeler should be readily able to supply this central pressure information.

The spatial distribution of winds over South Carolina for Hurricane Hugo is in reasonable agreement with observations and shows only a small possible effect of the treatment of topography.



Uneven information has been provided in later communications from EQECAT. For example, EQECAT state that (1) the updated historical hurricane set used for development of the stochastic hurricanes and (2) the reduction in the timestep used for damaging wind reduction over land (August response) will both contribute to increases in the loss costs over South Carolina, yet we do not have the corresponding exhibits for this version of the model. Assuming no other changes in the treatment of hurricanes between RQE v14 and the earlier model for which detailed exhibits were provided, the meteorology underlying RQE v14 should be deemed acceptable for use in South Carolina. The panel of experts recommends that the Department of Insurance request a complete set of exhibits for any new versions of models submitted.

## 4.3 Vulnerability Module

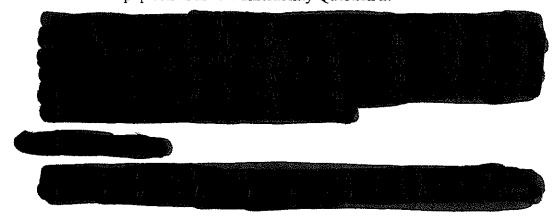
In its initial draft report the panel of experts indicated that "In general the building classifications for personal residential occupancy and primary characteristics used to model properties located in South Carolina are reasonable, however, EQECAT does not differentiate vulnerability functions among 1-, 2-, and 3-story building for South Carolina construction types. In their initial response, EQECAT notes that "A breakdown by number of stories will be implemented in future releases" (page 19 in the pdf) but gives no timeline for this update."

In its response to the above, EQECAT indicated:

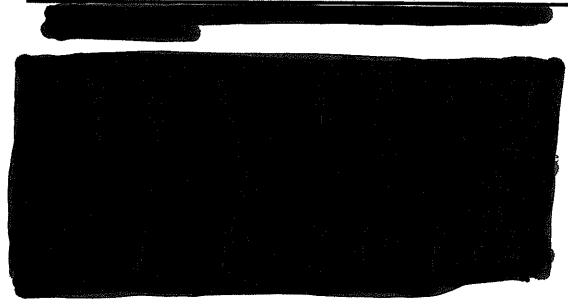
"EQECAT is considering the development of vulnerability functions for each of the low-rise building height in the Florida Commission on Hurricane Loss Projection Methodology 2014 review. This future model update is planned for the 2015 release.

The panel of experts believes this is a satisfactory timeline for improving the model to address the story height for low-rise buildings.

In the follow-up question after Vulnerability Question 2:

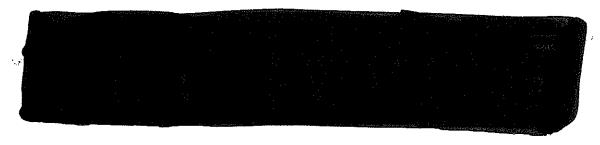




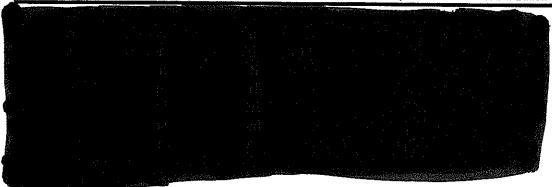


In its response to the above comment, EQECAT responded:

"Before the implementation of the modified Internal Building Code (IBC) and International Residential Code (IRC) in South Carolina in 2002, there was no organized regional variation in building construction practices as there was no mandatory statewide building code. During this period, South Carolina was practicing the Standard Building Code (SBC) with local jurisdictions having the power to opt out of the mandatory building code. Cities and counties had the option of adopting the SBC code if they choose to exercise their option. According to Lindbergh (1989), by the middle of 1989 only half the cities and towns and 17 of the 46 counties had adopted the mandatory code. Where SBC was applied, there was no regional differentiation of building code implementation. Within the SBC, the major factors for regional variations such as hurricane resistant construction and debris impact protection systems were absent prior to the late 1990s. From 1997 through 2006, some regional distinctions began to take effect, but these only became widespread and significant with the adoption of the 2006 South Carolina Building Code. For post 2006 construction, our model (ROE v14) incorporates the regional variation by the use of the Secondary Structural Modifier (SSM) Module."







The panel of experts in its draft report states that "The EQECAT model does account for variations in building codes based on year of construction and adoption of building codes. EQECAT model, however, does not address the current 2006 South Carolina Building Code. It is recommended that rate filings for post 2006 constructions based on EQECAT model not be used. If used, however, appropriate adjustments with justification need to be provided by the modeler or the filing insurer."

In response to Vulnerability Question 8, EQECAT states that:

"The model has no regional variations in the building characteristics in South Carolina due to the size of the state and the limited number of recent events with substantial claims data impacting the state. One may model known regional variations by use of the secondary modifiers discussed earlier."

The panel of experts in its draft report, states that "There are variations in design wind speeds within South Carolina, especially with regards to recent building codes and engineered buildings, but these variations are not accounted for in the EQECAT model. Hurricane models should address such variations. It is recommended that rate filings based on the EQECAT model provide justification for the lack of regional variability in vulnerability functions, especially with regards to engineered structures."

In its response to the above comments in the draft report, EQECAT has responded by:

"South Carolina used the 2006 modified International Residential Code up to June 30th, 2013. The 2012 IRC (with modification) became effective on July 1st, 2013. One of the major differences between the two codes is that the latter code requires wind rated exterior wall coverings and the use of event rated shingles based on ASTM D7158 which were not required in the 2006 building code. These building characteristics and others are handled in RQE using the SSM module both for pre- and post-2006 codes."



For post 2006 building constructions, EQECAT suggests that the new RQE v14 can handle vulnerability differences through the Secondary Structural Modifier. This approach puts the responsibility to recognize the differences in vulnerability of constructions on each user. The panel of experts argues that it is the modeler's responsibility to address regional variations across various wind regions in South Carolina. Similarly, the variation for various construction eras should be addressed by the modelers, for example different vulnerability functions to be used for preand post-2006. It is recommended that the SCDOI require the rate filing companies provide detailed justification for their rates when using an EQECAT model with regard to regional and temporal variations in vulnerability due to variations in building codes and regional wind speed.

### 4.4 Actuarial Module

This model has gone through several revisions in the past few years, most of which resulted in decreases in the loss costs, and each of which have been reviewed by the State of Florida. Nevertheless, the South Carolina Department of Insurance should be notified when changes occur that impact upon South Carolina loss costs along with the estimated effect of such revisions, and whether the revisions have been accepted by the FCHLPM.

