CATASTROPHE RATEMAKING

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A STUDY NOTE FOR THE CASUALTY ACTUARIAL SOCIETY EXAMINATIONS
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This material has been prepared at the request of the CAS Syllabus Committee as a basis for study for one or more CAS examinations dealing with the subject of catastrophe ratemaking.

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CHAPTER 1 – NATURE OF CATASTROPHE PERIL

For ratemaking purposes, a *catastrophe* is defined as an event whose losses are very large and very infrequent such that their inclusion in a normal rate level review exercise would severely distort the estimation of future expected losses. Hence some special measures must be taken to exclude that data from the regular rate review.

For liability coverage, an example would be a very large total limits loss. The remedy is usually to exclude the high severity amount, and only retain the basic limits portion of the loss in the regular ratemaking exercise.

For an extraordinary type of liability loss, such as environmental or asbestos, the method would be to eliminate all such losses, and separately measure the total expected loss from that cause of loss in the future.

For unusual property perils within a broad property line of business, such as hurricane, tornado, winter freeze, or sinkhole, the actual losses need to be removed from the relatively short experience review period, so as to estimate the future expected losses without the short-term bias of the recent past. The key is to consider the likely return period.

Return Period

The *return period* is the length of time that these types of unusual losses can be expected to start repeating, so that a longer period is not necessary to use in the averaging process.

For tornadoes and hail storms in the U.S., tradition has been to treat them as having a 20 or 30 year return period by state. But this is clearly not enough on a territory basis, so some other method than actual loss experience may be warranted.

Similarly for winter freeze events, there may not be enough data from the last 40 years to assume that represents a sufficient period for actual losses to be averaged.

For sinkholes, a relatively new phenomenon, clearly not enough is known about the underlying cause to make a judgment whether actual losses are a reasonable estimate of future expected losses, especially over a short period of 10 or 20 years. There may be changing conditions or coverage terms that render older years not typical.

For earthquake, actual losses have never been used in ratemaking, so a return period estimate is not relevant. For flood cover, traditionally considered uninsurable in the private insurance market, 100 years has been considered the minimum return period necessary to quantify the expected loss levels based on actual losses.

For hurricanes, an inspection of the record of landfalling hurricanes from the mid-1800s makes it clear that even 150 years is not an adequate return period to use actual hurricane loss experience in ratemaking.

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CHAPTER 2 – CATASTROPHE METHODS USING ACTUAL LOSS EXPERIENCE

Considerations

Since ratemaking needs to be prospective by nature, and not a recoupment exercise, it is crucial to ask whether the past experience is a good surrogate for what might happen in the future. Have conditions changed since the last occurrence? Has the coverage changed so that the same event would produce different losses? Have the exposures changed as well?

Is the frequency of the event more credible, so that a separate estimate can be made of the future severity, while using the past purely as a basis to derive a frequency estimate? Or vice versa?

Are there simple adjustments that can be made to past experience data?
Or is the peril so volatile that a more fundamental method of loss estimation would be superior to simply assuming that the loss experience of the past 30 years or so would repeat itself?

Is there a base coverage that can be used so that catastrophe losses can be estimated as a percentage of that base – e.g., excess wind versus regular wind, similar to excess liability relative to basic limits?

Or is the peril so unusual that it is better to treat it totally separately, and add a measure of that peril's expected losses to the regularly measured expected losses?

Credibility

If actual experience is used in calculating expected catastrophe losses, a credibility factor is needed for the data used in the current rate review. For catastrophe perils with a very long return period, it is likely that current catastrophe rates based on the insurer's own much shorter term loss experience may have a large element of instability. Including later actual catastrophe claim experience for that insurer may add very little to the reliability of the rate review.

On the other hand, catastrophe estimates based on much broader data outside the individual insurer and using a much longer period of time have inherent advantages and may be assigned a much higher credibility weight than relying solely on the insurer's own actual loss experience.

Composite Rate or Separate Rate?

Whatever the method to estimate catastrophe expected losses in the future, some key questions need to be asked regarding the appropriateness of a separate rate for this peril:

- Does the catastrophe peril have the same risk variation elements as the regular perils, so that the same class plan should apply?

- If so, did the class plan relativities get reasonably measured using catastrophe loss experience? This is not likely if the return periods used in the ratemaking process are very long.

- If the cat peril likely needs its own class plan rather than the one applying to the regular perils, is there a way to measure those risk variations? If not, is it better to have no class plan than the wrong one?

For earthquake ratemaking, it is easy to deduce that a separate class plan is needed, as the entire peril is rated separately. For a package policy such as homeowners, these are relevant questions because this coverage has generally been rated on an indivisible premium basis in the past. However, the hurricane peril as part of total wind may be such that it needs its own class plan, as it obviously does not vary by fire protection class, or even policy form (as the wind cover is the same in a named perils policy as in a broad form; only the non-wind perils vary).

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CHAPTER 3 – OVERVIEW OF MODELING METHODS

Sometimes actual experience for a catastrophe peril is simply not relevant enough. The data may be too old to be reliable, or the exposures may have changed so much, or the coverages may now be very different. This renders the past measure of loss an imperfect surrogate for what might occur in the future.

If actual loss experience is not really usable for the catastrophe peril, then the use of models comes into play. Models are really a broad class of methods of analyzing risk using the fundamentals of frequency and severity to estimate expected values.

Simple Models

A model can be as simple as using external data to estimate expected frequency, plus judgment on an average size of loss, and a combination of internal and external data. Early methods of rating no-fault auto insurance used a variation of this method. Some estimate of single car claim frequency had to be made, and surveys of accident statistics were used to gain this relative frequency. Because more coverage on a first party basis was involved, some use of severe injury cases was made to estimate the severity.

Computer Simulation Models

More recently, personal computers have become so powerful that simulations of past and future events – or modeling – are much more feasible as a way of ratemaking for catastrophe perils.

For example, the physics of hurricane wind have been well known since the 1980s such that a few parameters can actually specify the wind field for a typical tropical cyclone. It may take a series of differential equations, but scientists have successfully simulated the key elements of a hurricane by using its central pressure, radius of maximum winds (size of the eye), forward speed, pressure differential from the ambient pressure, direction and landfall location. These simulated storms give reasonably close approximations of the wind speeds at various distances from the center and over the life of the storm as it progresses over land.

So the wind fields of actual past storms – even those more than 50 years ago – can be somewhat replicated in the computer. All that is needed are those key inputs for which public records exist.

The next development was to measure the damage done by a 100 mph sustained wind, for example, on a typical structure in its path. Structural engineers have estimated these damage curves based on the theory of wind load pressures and the resistance of typical house constructions. The damage curves would escalate by rising wind speed, and vary by type of exposure (house versus contents versus additional living expense), and by type of construction feature.

To validate these curves, it took a series of actual hurricanes and a set of exposures and known losses from insurance companies to calibrate the damage factors. The result is a set of damage curves that conform to the average over a series of hurricanes. The assumption is that future hurricane will have similar damage at a given wind speed at ground level, for comparable coverages.

The early use of these models as described above was to get an estimate of the probable maximum loss for an insurer from the peril of hurricane using that insurer's current exposure base concentrations.

When these models first came on the scene in the late 1980s and early 1990s, one could run a past storm of a given magnitude (say Hurricane Hugo from 1989), but place it on any configuration of exposures for that company in any state. The basic assumption was that a Hugo-type storm was a sort of a one-in-a-hundred-year event. Hence, one should look at what another storm of that magnitude could do to an insurer's current exposure concentrations. If another Hugo hit, but in Florida or Louisiana, and it could cost the insurer half of its surplus, then more reinsurance was needed to protect its policyholders.

Hurricane Frequency

The next phase of hurricane modeling was to estimate the relative frequency of different sizes of storms. The National Weather Service (NWS), National Hurricane Center (NHC) and National Oceanographic and Atmospheric Administration (NOAA) have researched the history of hurricanes and published the records of these events in the Atlantic and Gulf Coast Basins since about 1850.

The earliest storms have only approximations of wind speeds and central pressures, while the later ones are documented more thoroughly. (There have been some 270 landfalling hurricanes in the U.S. from 1850 to 2000.)

All of these storms have been categorized by size and speed and other metrics, and form the basis for estimating a robust set of possible storms in the future. Thus the next phase in hurricane modeling was the formation of storm databases to create simulation modeling of all likely future storms. By including landfalling probabilities for 50 nautical mile segments of coast line, and variations in direction and curving, quite a plausible database can be set up by storm intensity to approximate a reasonable representation of possible future reality.

Risk Studies

The first such use of these new model capabilities was in Probable Maximum Loss (PML) studies for insurers and reinsurers. Now a modeler could take an insurer's current exposure database, run a large number of simulations over the exposure set, and accumulate the results into various categories. By rank ordering the results, one could now calculate the insured loss for a company, with particular focus on the 1-in-100 year risk, or 1-in-500 year risk. This refined definition of PML could be measured with a reasonable degree of accuracy, if one accepted the basic premises. Namely, a hundred or more year history of storm specifications coupled with recent validation of storm damage could reasonably represent the likely future risk for a current profile of exposures.

Parameter Risk

There is also the *parameter* risk that not all of the hurricane variability can be accurately captured by a hundred years of past experience (maybe the next hundred years will be worse or better). In addition, the different commercial modelers do not all produce the same model results using a similar set of exposures. That is why rating agencies, regulators and reinsurers all require periodic use of multiple models. But when compared to the alternative – using actual experience from the past 30 or 50 years, the models represent a vast improvement. In addition, when considering refined results, such as by state or by territory, actual past history is a poor second choice to using simulated results which take the process risk out of the picture.

Need for Detailed Insurer Exposures for Risk Analysis

The essence of these risk analyses for insurers requires a detailed database of the exact location and characteristics of the insureds being measured for concentration risk. This usually means amount of insurance by coverage, deductible amount and policy form at the zip code level. If available, latitude and longitude coding for each individual risk is preferred, as the models can generally produce wind fields with that level of precision**.** When using data by zip code, the models assume each risk is located at the centroid of that zip code.

When running the model on the entire database of the insurer, simulation results are obtained representing the insurer's loss potential under the library of scenarios. For example, what would be the losses over the next 10,000 years of simulated possible hurricanes given the insurer's current exposure database?

Use of Models for Ratemaking

Since the models were expanded to try to measure all possible storms of varying sizes, with probabilities, in order to quantify the results in the extreme, it was a natural extension to use them to quantify the expected value results – a key component for ratemaking. The main problem with using actual loss experience for hurricanes is the process variance observed from only a few actual occurrences in the past several decades. Also the coverages may have changed from 40 or 50 years ago. By using the power of computer simulation, that process variance is eliminated by using the expected value calculations of thousands of years. It also solves the even greater problem of territory risk measurement, because the models have been calibrated to replicate the relative risk by area as well.

The other salutary benefit of using a computer simulation model is that you don't even need to run it over a particular company's database to get values useful for ratemaking. If the desired result is an expected loss cost for a base class house in a territory, one can run the model for a sample base class house at the centroid of the territory, or at the zip code centroids to derive a new territory definition using a combination of zip codes.

The second advantage of using the model directly on a base class house is that it eliminates the need to factor out the average class plan differences when running it over a company's database with different classes of risk in each territory. This assumes one is trying to get a pure premium for a territory to which an expense ratio is applied.

If one only wants a statewide rate level change calculated, then running the model over the company database may be a simple calculation. Yet given the robust nature of these models by territory, and the likelihood that current hurricane rates may be substantially mispriced, it is usually wise to measure the indicated rates by territory to compare them to current base rates to see how much relative need exists by territory. This is a classic illustration of how a pure premium method of ratemaking is superior to a loss ratio method when these conditions are present.

Use of Multiple Models

Given the existence of parameter risk, it is often wise to use several models for ratemaking, just as it is for risk analysis and PML studies. That is yet another reason to look at the models run on a base class risk, instead of over an insurer's database. One could ask the modeler to produce loss costs per $1000 of exposure by zip code, as these are independent of insurer input. Once produced, the same values are used by all insurers as the starting point to price total expected costs. Of course, each insurer will have different expense loads and even different risk loads as its reinsurance costs vary as well.

If three models are available, the median value by zipcode is a reasonable starting point, or some other averaging process. One should recognize that there is much more variation by zip code among modelers than in a statewide average. Variations of 50% or more are common, as differing assumptions are made on storm dissipation over land or storm frequency by 50 mile segment of coastline. It is easy to understand that for a 50 mile geographic segment, actual landfall results have varied greatly even in a 100 or 150 year time period.

Using Models to Measure Risk Margin

The Appendix illustrates methods to quantify risk margin using models. In summary, using implied risk margins in the insurer's reinsurance premiums by layer is a convenient way to approximate indicated risk margins. This involves calculating the expected losses underlying the cat reinsurance premiums and reflecting the differential between the expected ceded losses and the actual reinsurance premium (the net cost of reinsurance) as a pass-through to the underlying insureds.

Some measure of the implied risk margin for the unreinsured layers is also needed, and this can be deduced by doing the above analysis by layer and making some key assumptions on the nature of increasing risk margins as the layers increase and become more volatile.

Models for Class Plan Analysis

Some models may have modules that are sophisticated by class and may be used to develop rates for risk differences. Others are based on broad averages, especially those validated with industry experience from past storms. When those storms occurred, no separate coding existed by hurricane class, as those had not been designed at the time. Hence the development of a hurricane class plan is a separate skill which will be covered in another chapter.

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CHAPTER 4 – RATE LEVEL INDICATION METHODS USING MODELS

Composite Rate Indications

Since homeowners insurance has been rated on an indivisible premium basis for over 50 years, there is a temptation to continue to produce a rate level indication on a composite basis. Perhaps the only advantage of this is that the earned premium does not have to be split into components.

However, there are a number of disadvantages, including complexity in handling credibility and risk margins, as well as issues in how to distribute the overall rate changes by territory. This is especially a problem dealing with credibilities by territory, where the hurricane model results are virtually 100% credible in the classic sense, but the individual insurer non-wind results fluctuate much by territory, and territory credibility of new experience is usually low.

Furthermore, because of these complications, there is less precision in the overall statewide indicated rate level change, such that a review on a component basis is usually warranted anyway, to gain more insight on where the rate level need is.

Split Rate Indications

Exhibits 4.1 to 4.3 show how to produce a traditional *loss ratio* method of statewide ratemaking for the non-wind component of homeowners coverage, if the earned premiums are not yet kept separately for that coverage in the insurer's data base

Non-Wind Indications

Exhibit 4.1 illustrates how to split composite earned premium into components.
Exhibit 4.2 compares expense and risk margin loadings for non-wind and hurricane.
Exhibit 4.3 derives an indicated statewide rate level change for non-wind.

The reason for splitting the rates is to estimate the non-wind portion of the premium that is actually reviewed using the carrier's own loss experience. The non-wind portion of the business (and the non-hurricane wind) can then be periodically updated using the insurer's actual loss experience. In that sense, the precision in deducing the current implicit component premiums by coverage is not all that critical, because the fully credible hurricane model results will fix the hurricane component quickly. Furthermore, the experience reviews of non-wind coverage will be self correcting depending on the volume of business. For a large insurer, this will happen very quickly; however, it will take some time if the insurer's data base is very small.

Exhibit 4.1 is a method for splitting the composite premium into non-wind, hurricane and other wind components. There may also be policies written without wind coverage, if operating in a state that has a wind pool (a residual market for the wind portion of the homeowners coverage), with rates and coverage determined by a state-created mechanism. This would allow private carriers to sell multiperil policies without wind coverage. Initially, carriers may have had to file factors to exclude wind from the composite premium. These wind exclusion credits can be applied to the composite base premium to get an estimate of the base rate excluding wind.

If there is no filed wind exclusion credit, an estimate is needed of that quantity. One can start with a long term average of the carrier's own distribution of losses by cause, and use the average of wind losses to total for that period. By territory estimations may be reasonable only for the very large insurers. Smaller insurers would need an alternative estimate by territory, such as using a statistical agent's summary of wind to total losses for that state over a long period. If there has been a recent large hurricane in that state, care should be taken to adjust the average to an expected loss level. Another method for smaller insurers is to analyze large insurers' filed component differences by territory if available.

Also, if using loss distributions to split composite rates by component, strong recognition is needed of the much higher risk margin on the hurricane peril. A simple adjustment on the loss distributions would be to double the wind loss fraction to account for the effect on premium of risk margin and cost of reinsurance. (See Appendix Exhibits A-1 and A- 2 for ways of quantifying the indicated risk margins, and for the order of magnitude of a hurricane risk margin being over 100% of expected losses.)

This original split of the composite premium into components doesn't need perfect precision in the initial analysis, because the first split of the composite rate will ultimately be self correcting, as each piece will be separately evaluated over time.

The *hurricane component* earned premiums are then not really used for deducing the indicated hurricane rates, since a pure premium method is used for the latter. The current hurricane base rates are only needed to estimate the relative rate level change on that component, and on the total combined rate level change calculation.

Exhibit 4.2 shows expense ratios, risk margins and credibility for statewide ratemaking purposes for non-wind versus hurricane.

Note that *loss adjustment expense* loadings as a function of loss for hurricane are likely to be different from non-wind, as the severity level of claim costs are usually quite different.

The *risk margins* for hurricane are much different from traditional experience-rated coverages. The reason the hurricane risk is separately estimated is due to its very low frequency and very high severity – a clue that the needed reward for risking capital to cover it is much larger than normal.

In this example, a hurricane risk margin is set a 110% of the expected hurricane loss costs. This is in contrast to a non-hurricane risk margin of 6% of expected losses (or roughly equivalent to about 3.7% of premium). A derivation of needed risk margin for hurricane is contained in the Appendix to this Study Note.

Similarly the *credibility* of hurricane indications is quite different from non-wind.
If the hurricane component is derived from catastrophe modeling output, the results can be fully credible in the classic sense. The reason is the models use virtually all the data available to arrive at their conclusions – over a hundred years of frequency

data, and large portions of industry data to calibrate the severity component. Hence, there is no company data set to which one would apply the complement of credibility - certainly not the existing hurricane rates, if they have been derived without using models.

Exhibit 4.3 is the traditional loss ratio method of deriving an indicated rate level change for the non-wind component. This rate level change on a state wide basis then needs to be distributed to territory using traditional methods, recalling that the territory credibilities are much less than statewide. The calculations of territory indications are not shown in this paper, but the results are shown in Exhibit 4.6, Column (10).

Non-Hurricane Wind Indications

The *non-hurricane wind* coverage may be a partially catastrophic coverage, if the element of tornado is present. (It is probably better to estimate tropical storm expected losses as part of the overall hurricane risk analysis.) Other Wind can therefore be analyzed from a variety of sources other than an insurer's own data, e.g., other carriers, an advisory organization, or even from other non-hurricane states' ratio of wind to non-wind losses (where it might be 5% to 10% of those losses).

In hurricane-prone states, this component is generally a small quantity compared to the hurricane peril. Nevertheless to do a rate level review on it may require a much longer experience period than other non-wind homeowners perils, and require supplements from broader industry data.

For the first time around, it may be sufficient just to assume the current deduced non-hurricane wind rates are close to adequate, and use them as a balancing item. Hence this illustration of split rates (component) ratemaking, for simplicity purposes, will assume that the small Other Wind component of homeowners coverage in this sample state has adequate rates at the current time. So the overall statewide (and territory) assumed indicated rate level changes are 0.0% for Other Wind.

Hurricane Indications and Overall Indications

Exhibits 4.4– 4.6 illustrate a *pure premium* method of ratemaking using hurricane model results. They also show how to combine the pure premium method results for hurricane with a separate *loss ratio* analysis for non-modeled losses to produce an overall statewide rate level indication. The combination is done by comparing indicated base rates to current base rates and aggregating territory changes to a statewide average using territory exposure distributions. The same exhibit can then be used to tally the statewide filed rate level change.

Exhibit 4.4 shows how to produce indicated base rates by territory for hurricane.
Exhibit 4.5 uses a multiplier to convert hurricane pure premiums to base rates.
Exhibit 4.6 shows current and indicated rates by component, by territory, and derives the statewide indicated overall rate level change.

Exhibit 4.4 starts with hurricane expected loss costs for a base class in column (2). These can be obtained directly from the modeling process by running the model storm sets over a base class house in each zip code, and averaging the results over the insurer's exposures by zip code in each territory.

If the modelers have already published their results as an average loss cost by zip code, then it would be necessary to adjust the results to the insurer's base class. For example, if the only hurricane class distinction were gable roof versus hip roof and a hip roof deserved a 10% discount, the average loss cost would represent the average of gable and hip roofs. If the two roof types were evenly distributed, then the adjustment factor to a base class of gable roof would be an increase of 5% to represent the loss cost of gable roofs. There may be other differences as well (e.g., different amount of insurance for the base and different deductible, or other base coverage). These can be adjusted for in the next exhibit (4.5) via a coverage adjustment factor.

Alternatively, hurricane loss costs by base class may be obtained from advisory organizations or deduced from other carriers' published and approved rate filings. Similar adjustments may be necessary if there are differences in base class or base coverage.

The final indicated base rate uses a loss cost multiplier (Column (3), obtained from Exhibit 4.5) on the base loss costs to reflect expenses and risk margin. The risk margin for hurricane is easier to derive as a function of loss costs, using information from reinsurance placements (example provided in the Appendix to this Study Note), so it does not have to be converted to a percentage of premiums. The equivalent number as a percent of premium can be algebraically calculated if required.

The resulting indicated base rate can then be juxtaposed with the current actual (or deduced) hurricane base rate to see what the indicated rate level change is by territory. Notice how different this is from the usual ratemaking exercise, whereby the indicated *rates* are not determined until first getting the indicated *rate level change* from the loss ratio analysis.

Exhibit 4.5 calculates the total loss cost multiplier to convert the model-based hurricane pure premium by territory into indicated base rates by using expense loads and a hurricane risk margin. This exhibit also allows for any coverage adjustments to make the base rates comparable. The Coverage Adjustment Factor, for example, could take a 1% deductible to a 2% level, and adjust the base coverage to $100,000 Coverage A from $75,000, but using the insurer's estimates of those factors.

Exhibit 4.6 shows a summary of the current base rates and indicated base rates. This same format can be used to list the filed base rates, and calculate the filed rate changes, using exposure distributions by territory.

This exhibit also illustrates a major difference in hurricane ratemaking, where the *territory* indications are *first* determined, and then aggregated to deduce the statewide indication. In other lines of business, first the statewide indicated change is determined, and then distributed to territory, using separate credibility criteria by territory.

Columns (2) through (5) show the current deduced base rates (if not already split in the manual) by component from Exhibit 4.1. After the component rates are filed and implemented, actual current base rates will be used in future years' analyses.

The hurricane indicated base rates in column (8) are from Exhibit 4.4. The indicated non-wind rates in column (6) are from the carrier's experience rate review. The first time this is done, as illustrated in Exhibit 4.3, the carrier can use factors derived from Exhibit 4.1 to deduce the earned premiums for non-wind coverage. Then a standard loss ratio analysis is done using the non-wind loss experience by state.

A territory analysis is then done to distribute the statewide indicated change to territory (not shown here but typical of personal lines territory rate reviews). Column (10) shows how indicated statewide rate level change has been distributed by territory. Those territory rate level changes then determine the indicated base rates in Column (6).

A carrier would also do well to begin splitting the incoming written premium by peril to create a data base of non-hurricane earned premiums to do future rate level reviews. These earned premiums can also be used in performance reviews where actual results are compared to expected. Hurricane actual loss ratios are virtually useless for performance evaluation, because the return period could be 100 to 200 years or more (and even more by territory).

In Exhibit 4.6 the indicated statewide hurricane rate changes are deduced from the indicated territory hurricane rates by comparing indicated rate to current rate. These changes are then averaged to get a statewide indicated change. This is exactly the opposite of how a loss ratio analysis is done, where first the statewide change is produced, and then distributed to territory, as is done for the non-wind coverage.

An exhibit similar to this would be used for presentation of filed rates and filed rate level changes by substituting filed rates in columns (6) through (13).

CATASTROPHE RATEMAKING
CHAPTER 5 – TERRITORY REVIEWS USING MODELS

Considerations

Traditional rate level reviews by territory are heavily dependent on the credibility of the new experience data versus the implied relativities from the existing rates. Often one additional year of actual territory experience may reveal very little new information.

This is in contrast with doing a territory review using a hurricane model. If this is the first year that a model is being used, then the old territory rates for the hurricane peril likely do not have much credibility at all. If based on only a few decades of actual hurricane experience for the carrier or even a broader experience base, it is now evident that more than 100 years of hurricane data is needed, certainly for the frequency estimate – especially for refined geographic areas, where there may not even have been a single landfalling hurricane in recorded history, much less for the insurer individually.

Hence the modeled loss costs by zip code making up a territory could well deserve 100% credibility, since the existing rates, if based on the insurer's own data, have virtually no credibility by territory.

To buttress the credibility of the model based results, one can access several models to assign initial estimates by zip code. Furthermore, individual zip codes can be combined into individual territories. Using these model estimates, the indicated rates are then established by territory and compared to existing rates by territory. Then the statewide indication is generated using the insurer's distribution of exposures by territory (see Exhibit 4.6).

Adjustments for Class Plan Differences

If the territory loss costs for hurricane are developed by running a model over the insurer's exposure data base, then other steps are needed in the process – namely an average class plan differential needs to be calculated and offset from the average loss cost.

Running a model over an actual exposure base produces total loss costs by territory. Applying an expense ratio and risk margin will produce indicated *average* rates. Yet the base rate is for a fixed base class – for example, a frame, gable roof house with no mitigation. Those average loss costs are for a mixture of gable and hip roof houses. Some estimate is needed to account for the difference between an average house and a base class house. Therefore some understanding is needed on what the base class is for the modeled loss costs.

Can Territory Rate Reviews Be Done on a Composite Basis?

If the hurricane component is left in the composite rate, territory rate reviews become much more difficult on composite loss ratio basis. This is because of the credibility issue. It is a complex task to calculate the implied credibility when mixing the perils of hurricane and non-hurricane. The hurricane indications are essentially 100% credible by territory, and the credibility of the non-hurricane data varies by territory depending on the volume of claim experience.

The reason the hurricane credibilities are essentially 100% by territory, if done by modeling, is that the models include virtually all the relevant information by locale going back more than 100 years for frequency. If the current deduced hurricane rates by territory were based on a carrier's own hurricane loss experience or even industry data for only 30 years, those estimates of territory expected loss costs have very little credibility. Hence, the new estimates are much more reliable.

Should Hurricane Be Separately Rated in the Manual?

Ultimately ratemaking becomes a much easier process if the premiums are split between hurricane and non-hurricane and accumulated separately. This allows traditional methods to use earned premiums on level in the loss ratio analysis without having to deduce the non-hurricane portion each time.

Separate premiums also allow better performance measurement by only using loss ratios for perils that lend themselves to it - namely non-catastrophe ones. If hurricane is included in the premium, then the concept of an expected loss ratio as a standard loses meaning, One could go for a dozen years without a hurricane in a state, and the actual composite loss ratio would be distorted (biased low), just as an actual hurricane in a given year would distort the performance of the other peril rates that year.

Another reason for separate rating is to apply the appropriate class plan. For non-hurricane homeowners perils, the principal one being fire, it is relevant to reflect fire protection differences in the overall rating. But in a territory where 80% of the combined loss cost is hurricane, it makes little sense to give 25% discounts for excellent fire protection.

Similarly, policy form relativities are often applied statewide, yet the wind coverage is virtually the same for named perils coverage versus broad form (all perils). To surcharge 30% for all-perils in a territory with 80% wind risk is inequitable.

It is arguably better to apply no class plan to the hurricane peril than to apply the wrong class plan. But some work has been done on hurricane class plans, so an insurer need not use the wrong plan or have no plan (see Chapter 6).

CHAPTER 6 – HURRICANE CLASSIFICATION PLANS

In the usual evolution of classification plans, first the class definitions are established and then the class relativities quantified for initial use. These relativities are then revised over time with periodic experience reviews. More modern approaches use inference modeling to deduce more complex schemes, but the process is similar – identify the characteristics which could potentially differentiate and then measure with actual data.

For hurricane class plans, that process is much more difficult, because of the absence of historical data by potential class over a long enough period of time to calibrate. Hence other ways are necessary to create a classification plan.

Rating Variables

In designing a class plan from scratch (since hurricane was never rated by itself before or the magnitude of its loss costs was not fully appreciated in the past), one should start with the fundamentals of class plan design, as described in the CAS textbook chapter on Risk Classification (in *Foundations of Casualty Actuarial Science*).

Operationally, hurricane classification variables should be objective, verifiable, cost-effective to administer and intuitively related to the risk of loss, among the considerations. Actuarially, they should be accurate, homogeneous, credible and reliable. Degrees of constraint on variables include social acceptability and legality.

These considerations were essentially used in the 1999 class plan design for the residual market wind insurer in the state of Florida. First, input was obtained from wind engineers and hurricane specialists on what features contributed materially to differentiating hurricane loss costs on residential structures.

Those relevant factors can be illustrated by the tables in Exhibit 6.1, in a practical format that would be understandable to the raters and to the public. The next challenge was estimating the rating differentials that would apply to this combination of rating variables since no historical data had been collected or even existed on most of these new potential rating variables for the hurricane peril.

Initial Selection of Rating Differentials

To quantify the differentials, a group of experts (mainly engineers from modeling firms) was queried on the estimated percentage effects of each device *individually*. The factor estimation technique then quantified the averages, listing the outliers. The outlier estimators were asked for the reasons for their numbers, and all were given the chance to stay with or change their estimates. The next round produced an initial set of discount factors (plus some surcharges, as a base class had to be picked - usually a large single class; e.g., gable roof, no mitigation devices, one story house.

Next, some effects of *interaction* were investigated by one of the firms that had built a “load and resistance” model using engineering principles. By looking at the pressure loads on certain structures at varying wind speeds, and comparing with the force resistance of that combination, one could measure whether two or three features in combination had extra synergy. For example, would a hip roof with shutters and better sheathing attachments have more effect in combination than the additive or multiplicative factor combinations would predict?

Next, a practical array of factors was designed (as shown in Exhibit 6.1) to make it easy for the agents to find the appropriate class factor, after reviewing each well-defined feature in the manual.

Implementing with an Off-Balance Factor

Once the rating differentials are established, one needs to estimate whether there is any rate level effect by introducing the new differentials versus the old class plan. To do this, one needs to use published data as well as some surveys from individual insurers to create an expected distribution of exposures by the new class variables. If the new base class is different from the old, and the differentials are quite different, the net result could be a loss (or gain) in overall rate level merely due to the introduction of the new class plan.

Thus a measurement is made of the average rate effect of the class plan, and the resulting off-balance factor used to make the plan revenue neutral. If the new differentials are expressed mostly as discounts (as was in this case in Florida), then obviously the base class rate needs to be adjusted upwards to provide a zero rate level effect overall.

Revising the Differentials

The next step major step in calibrating hurricane class plans is to use actual hurricane experience. This at first sounds ironic, since hurricane modeling evolved because actual loss experience from even 40 or 50 years was not considered sufficient to generate reasonable expected losses in total.

The class plan relativities are really independent of frequency. Based mostly on mitigation devices and features that are resistant to wind, they essentially measure the difference in claim severity only. Hence, one can expect to calibrate the factors by looking at the actual results of the next five or six hurricanes, assuming there was a sampling of very high winds in a number of zip codes (at least Category 4 winds – 131 to 155 mph).

By looking at the losses produced on different featured houses in that same zipcode with comparable winds, the calculation of pure premiums by property would be meaningful. One must also include exposures with no losses, as some houses may have escaped losses by the combination of mitigation devices.

Some adjustment for mix of wind speeds should be made, but this would be a good start to refining the initial class plan relativities set by informed judgment. It should be recalled that relativities set only by judgment is not really classification rating but essentially a form of schedule rating. There is nothing wrong with schedule rating by experts, but if one can verify by actual data, that is a better method of quantifying risk variation.

CHAPTER 7 – OTHER ISSUES

Concentration Risk

As described in Chapter 3, the original use of hurricane models was for risk analysis. What would be the effect of a large storm on an insurer's current book of business? Was there too much concentration in some areas that surplus would be severely affected? And therefore how much reinsurance should be bought at what price that made sense to arrange the risk transfer?

A number of modelers made versions of their models available to clients to run their own studies in-house, especially for those who wanted the information more frequently than annually. Hence individual books of business could even be evaluated, and other "what if" analyses made.

The crucial *input* element needed to run the models for risk analysis is a *detailed edited data base*. It must be available in sufficient detail to measure the variations in wind speed in refined fashion – zip code, or even latitude/longitude coordinates. Also needed is coverage and classification information is sufficient detail to match what the modeler has developed as separate damage factor curves.

The *output* is a very robust listing of the damage from each storm in the modeler's storm set, plus a rank ordering of the total damage of those storms to draw probability estimates of exceeding certain loss levels.

Outside organizations such as rating agencies and regulators also periodically request results from several models, recognizing that there is parameter risk. If there is too much variability between the two estimates, even a third model might be utilized. There is still a lot of uncertainty in modeling, even though the modelers essentially started with the same basic information, namely the history of storms by size and locale and the damage from these storms as measured by actual insurance data at the time of landfall.

It is also useful to try to reconcile any initial differences in assumptions made on the insurer data base. For example, some homeowners insurers have offered much more coverage on contents as a marketing device, say 100% of the building amount for contents. This departure from the traditional 50% may be coded on the data base the same as the coverage A amount. Yet when the models were calibrated using storms in the 1980s, for example, the traditional coverage amount was 50%. Increasing the nominal amount of coverage C (contents) to 100% of Coverage A is not a real doubling in coverage since very few homes actually have that much in contents. It may in fact be only a small real increase in potential loss. Yet applying the modeler's damage factors for contents to a doubled exposure base would double the deduced losses from the model. These and other differences need to be better understood in how the models treat varying coverages and classifications. (See Appendix B for using models outside the actuary's area of expertise.)

PML

The concept of probable maximum loss (PML) has been around for a long time. It wasn't until the modelers introduced probabilities via distributions of storm variations over future time periods that specificity could be introduced into the definition and measurement.

A PML of x dollars does not have much meaning unless you can specify the return period (which means the probability). Historically the PML meant what a reasonably foreseeable and plausible very large loss could be to the insurer from a named peril. Often judgment was the main ingredient in estimating this loss level.

Now, via running a model, the question can be phrased more precisely: What is the 100-year PML from hurricane on your current countrywide exposures? What is the same PML in the northeast or the southeast? What is the 250-year PML?

The answer for an insurer might be $200 million for the 100-year PML and $500 million for the 250-year PML for hurricane. The answers actually come from the model results arrayed as above. Sometimes judgment needs to be applied on top of the pure model results, as some questions are not yet answerable directly from the models, such as the effect of *demand surge*. Demand surge is the added cost of some very large storms that create huge supply shortages in an area, such that repairs and replacement cost are much higher than in the modeler's storm history validation data base.

There has been only one landfalling Category 5 storm in over 30 years (Hurricane Andrew originally classified as a very strong Category 4, but now in retrospect reclassified as a weak Category 5). The prior Category 5 storm to make U.S. landfall was in 1969 (Hurricane Camille on the Mississippi coast), but no information was available in sufficient detail in 1969 to calibrate the models for storm surge. The only other Cat 5 storm was in 1935, hitting the Florida Keys. Hence the likely effect of the next big Category 5 storm on the phenomenon of demand surge requires a lot of judgment.

Impact on Pricing

The immediate impact of PML studies on pricing is the effect on cost of reinsurance. Obviously an insurer with heavy concentrations in exposed areas presents an added risk to the reinsurer who must either absorb that extra risk or itself retrocede in the worldwide markets. Passing along the reinsurance costs is part of the primary insurer's decision process if it affects the overall cost of risk.

As shown in Appendix A, the likelihood is that a heavy concentration will also show up in the indicated margins above and below the layers of reinsurance. The data to calculate those margins is the same as used for the PML analysis. In fact, it is useful to quantify the expected losses in the layers at the same time as the PML runs are made from the models to save time and costs when ratemaking analyses are done.

Reinsurance
The expected losses by layer in the analysis above are useful in evaluating reinsurance quotes. Making simple assumptions on the reinsurer expense ratios allows the deducing of the reinsurer's assumed risk margin. One can then track this over time, as well as from different reinsurance quotes. Of course, the reinsurers may not be using the same model or two models the primary insurer has used, and also may be factoring in parameter risk over and above the models.

Loss Adjustment Expense
For the same reason models are superior to actual experience reviews for catastrophe, the traditional use of the Insurance Expense Exhibit as the main source of expense ratio analysis is outmoded for catastrophe coverage. The absence or presence of large catastrophes in the past few years needs to be evaluated before applying loss adjustment expense ratios for example. Given the large size of individual claims from major hurricanes, the countrywide ratios from non-hurricane years simply do not apply to the hurricane peril. These ratios applied to the non-hurricane peril also need to be reviewed if large hurricanes are in the expense data base.

Claims
A big issue is how to pay claims when there is storm surge contributing to the loss given that flood is a standard exclusion in a homeowners policy (while covered on some commercial policies). It is possible that some surge claims have been paid as part of historical loss evaluations going into the validation of damage factors for the models – especially if some ambiguity has been resolved in favor of the insured. Adjusters on site have the ability to discern the pattern of damage on a house still standing to gauge the portion done by wave action (lower portions) and the amount done by wind (upper damage including roof). If there is a Federal flood policy in effect, some cooperation among adjusters usually happens on sharing the loss payment.

Underwriting
For the hurricane peril, underwriting questions are relatively simple, as the location is usually the overbearing question, along with existence or absence of mitigation devices. If a rating plan does not include mitigation discounts, then there would be major differences in underwriting acceptability among risks depending on what mitigation devices were in place on the house versus what was reflected in the official premium.

Final Perspective
Hurricane and other large catastrophes present special problems for the rate maker. The traditional actuarial tools of evaluating recent past loss experience and using credibility factors simply do not apply. Fortunately computer capabilities and other sciences now allow quantifications that were not even dreamed of a few decades ago.

These advancements mean extra responsibility for the actuary to make sure those added capabilities are being applied appropriately (See Appendix C), but now quantification of these heretofore abstruse risks is now possible.

CATASTROPHE RATEMAKING
Appendix A – RISK MARGINS USING MODELS

Practical Considerations

A risk margin in ratemaking is the element of cost that makes a private insurer willing to offer the risk transfer over and above the other expected costs. For many coverages, the amount of the risk margin can usually be expressed as a single digit number as a percentage of the final premium. It is usually calculated from an overall target rate of return on surplus that the insurer needs to be competitive with other sources of investment with comparable risk.

For catastrophe coverages that risk large portions of an insurer's surplus, the determination of an appropriate risk margin to write these coverages is much more complicated, as there are not usually comparable risk measures to set as a target.

The first issue to resolve is whether to get a combined risk margin or separate margins for the key components of a package rate such as homeowners insurance. As will be evident from the methods illustrated here, it is much easier to use separate margins.

For one thing, a state regulator may have published target margins (or ranges) for the standard coverages, using industry obtainable interest rates, and making basic assumptions on leverage ratios (premium to surplus) for standard lines and overall target after-tax returns on equity. However, it unlikely that regulators have yet published those same ranges for catastrophe coverages, as that is a relatively new topic with little published material.

Even in a separate context of what is reasonable for an individual insurer to target, it is much cleaner to divide the coverages into the easy-to-price non-catastrophe components and difficult-to-price catastrophe covers. This division requires a separate ratemaking exercise for the two type components. The actuary can combine them in an overall statewide rate level analysis, but the key is knowing what to do separately for each component.

Theoretical Considerations

Once the non-catastrophe component has been analyzed, and a target risk margin selected, some basic assumptions can be made about the catastrophe component. The first is that profit should be proportional to the standard deviation of losses. Some theorists argue that risk load should be proportional to variance, but these arguments apply to individual risks, not to whole portfolios. Using standard deviation on portfolios is not inconsistent with variance on individual risks. Furthermore, the high correlation of individual losses exposed to catastrophe risk, plus the existence of parameter risk in the overall scheme of things, leads toward the use of standard deviation for portfolio ratemaking risk margin calculation.

And there is the issue of risk margin net of reinsurance, since the tail of the distribution is favorably affected by catastrophe reinsurance.

Theoretical Illustration
One can illustrate a possible calculation of relative risk margin using some industry available data on homeowners insurance, via **Appendix Exhibit A-1**.
This exhibit starts with an assumed non-catastrophe risk margin of approximately 3%. Once the catastrophe components of homeowners coverage are removed, it is closer to a property coverage like auto physical damage.

A 3% operating margin pre-tax would translate to an approximate 9% after-tax return on equity with the following assumptions: a 2.5 premium to surplus ratio and a 7% pre-tax earnings on investible funds ((2.5 x .03 + .07) x .65 = 9.4%)

The illustrative exhibit takes that 3% margin for non-catastrophe losses and translates it to 131% margin for hurricane losses, on the basic assumption that the margin should be proportional to the standard deviation of losses. This also presumes one year policy terms. If there were multiple year policies, the different variance of results might change the margin, depending on how it affects the two relative coverages behaved over time.

In the illustration, one assumes that the hurricane component is only 20% of total expected losses. This obviously varies by state.

Next, a long-term data base of industry homeowners losses with and without catastrophe yields an estimate of coefficient of variation of about 8% over roughly 40 years. Based on a computer model validated by the Florida Hurricane Commission (Florida Commission on Hurricane Loss Projection Methodology), a coefficient of variation for hurricane losses is of the order of magnitude of 350%.

Translating these quantities into dollar returns shows a need for hurricane to have a pretax return almost 11 times that of non-catastrophe. Relating that to the relative expected loss size makes for a very large percentage expressed as a function of hurricane expected loss (131%).

As it turns out, one can express the risk margins as a direct function of the ratio of CVs, as the risk margin incorporates the ratio of the dollar profit to the mean:

Risk Margin (hurricane) = Risk margin (non-cat) x CV (hurricane) / CV (non-cat)

These risk margins are expressed as a percent of premium and include investment income on the policyholder supplied funds, so they really are a pre-tax operating margin. To calculate them as a pretax underwriting profit margin, one would factor out those investment earnings.

Calculations Based on Actual Data

The above quantifies a risk margin need based on actuarial theory, yet one can measure a risk margin using actual insured data – specifically from the implied margins imbedded in the catastrophe reinsurance quotes. Reinsurers are pricing their cat treaties with risk margins on top of their expenses, and those risk margins implicitly also include parameter risk.

To derive the implied margins by layer requires lining up the layers along with the underlying expected losses derived from running a cat model over the insurer's data base. **Appendix Exhibit A-2** illustrates a way of showing this array so that the risk margins in the unreinsured layers can be extrapolated from nearby layers. Since one may not be able to get actual quotes for the unreinsured layers, as a way of estimating those premiums, one makes the basic assumption is that the higher the layer the more variability and hence a monotonically higher risk margin. Similarly, the layer below the retention also has a lot of risk. Even though reinsurers don't like to play in that working layer, the implied rates on line and expected loss ratios should be consistent with the nearby placed layers.

Notice that the hurricane risk margins in this exhibit are expressed as a function of the expected loss, not as a percent of final premium as other lines often do. This is to make for easier calculations later in the rate review process, and to make it independent of the other expense loadings. If regulatory rate filing rules require expressing it as a traditional percent of premium, for monitoring purposes, that is an easy calculation.

Also, in a given state, the reinsurance premiums may not be available in that level of detail, so the countrywide ratios are calculated here, with the basic assumption that they carry over on a statewide basis. If a state's actual expected losses are higher, the same risk margin ratios apply to those higher expected losses, and vice versa for states with lower expected losses.

For a state with virtually no chance of penetrating the higher layers, one could run the model on its exposures, using its expected loss distribution by layer to recalculate the overall margin to see if the margin changes significantly. However, there is also correlation risk on a given storm so that no state is totally isolated, except perhaps Hawaii.

Also it is likely that the cat reinsurance covers more than just hurricane. If the reinsurer or intermediary can't readily split the premium quote into hurricane and all other, then some steps are needed to estimate the split. If earthquake is a peril to which the insurer is exposed, then the model can measure those expected losses by layer. If models have been run to measure tornado or winter storm, then expected losses by layer derived from the models should be used as well. If not, then judgment needs to be used to factor out the portion of the premium for those unmodeled perils (tornado, freeze, etc.). For many insurers, the higher layers are really there for hurricane and earthquake, which represent the biggest threats to surplus, so only a nominal amount of premium is really allocated to the "minor" catastrophe perils.

CATASTROPHE RATEMAKING
Appendix B - HOW MODELS ARE VALIDATED

Virtually all of the hurricane modelers used the process described in Chapter 3 to validate their models – with special emphasis on the validation of the damage factors initially created from engineering theory and practice. They used large volumes of actual insurance data by zipcode where known storms had precise measures of wind speeds in those areas.

In addition, they had outside experts review the science assumptions in the proprietary portions of their models. However, given the complexity of the models and the impact of the results likely on the consumer public, for the peril of hurricane in particular, the state of Florida took extraordinary measures in validating the models.

The Florida Commission on Hurricane Loss Projection Methodology was established to provide the public and the regulators (and user insurers) with a way to check on the validity of these models for use in ratemaking.

By having a multipartisan commission of experts in the various sciences used, appointed by the governor, a series of standards were established as well as a method of reviewing proprietary models that would give assurances that appropriate methods and data sources were used.

These extensive standards included the following categories:

1. General
2. Meteorological
3. Vulnerability (Damage Factors)
4. Actuarial
5. Statistical
6. Computer

Furthermore, provision was made for on-site visits and testing of the proprietary elements of the models, by utilizing protections of trade secrets signed by the professional team members designated by the Commission to go on site for that purpose.

Model approval of a particular version is thus given for each year, if it qualifies. Standards are updated as the sciences evolve to make sure the latest and best information is being used in each model.

This validation is performed for ratemaking purposes, so the use of that model for PML studies is not being reviewed, although many of the criteria would be the same. Demand surge is currently not part of the review process, yet that would come into play for the very largest storms and have the biggest effects on the tail of the storm distributions for PML purposes, but much less of an effect on the expected value of all storms.

CATASTROPHE RATEMAKING
Appendix C – USING MODELS OUTSIDE ACTUARY'S AREA OF EXPERTISE

The Actuarial Standards Board (created by the American Academy of Actuaries in the U.S.) has issued Actuarial Standard of Practice No. 38 – "Using Models Outside the Actuary's Area of Expertise (Property and Casualty)" to deal with the use of complex models, such as those for catastrophe measurement where scientists and engineers contributed vast amounts to the ultimate development of these models, and where actuaries are not experts in the underpinnings of these models.

Hence, recommended standards of practice now exist involving the following topics relevant to these complex models:

a. Appropriate Reliance on Experts
b. Understanding of the model
c. Appropriateness of Model for Intended Application
d. Appropriate Validation
e. User Input
f. Model Input
g. Appropriate Use of the Model
h. Reliance on Model Evaluation by Another Actuary
i. Documentation
j. Proprietary Information
k. Prescribed Statement of Actuarial Opinion
l. Deviation from Standard

Practitioners in this area need to be familiar with the document (plus introduction) communicating this Standard of Practice and follow it appropriately.

CATASTROPHE RATEMAKING **Exhibit 4.1**
HOMEOWNERS MULTIPERIL
SPLIT OF COMPOSITE RATE INTO COMPONENTS

	Current Base Rates					Earned Premium at Current Rate Level			% of premiums		
Territory	Total Composite Rate	Windstorm Exclusion Base Credit	Total Non-Wind Rate	Other Wind Rate	Hurricane Rate	All Policies	Policies with Wind	Policies Ex. Wind	Non-Wind	Other Wind	Hurricane
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
01	$1,525	$1,025	$500	$25	$1,000	$2,194,000	$2,074,000	$120,000	36.5%	1.5%	62.0%
02	1,575	1,025	550	25	1,000	2,558,250	2,409,750	148,500	38.7%	1.5%	59.8%
03	1,675	1,025	650	25	1,000	3,346,750	3,132,250	214,500	42.7%	1.4%	55.9%
04	1,625	1,025	600	25	1,000	3,654,000	3,510,000	144,000	39.4%	1.5%	59.1%
05	925	525	400	25	500	2,157,000	2,109,000	48,000	44.5%	2.6%	52.9%
06	950	525	425	25	500	1,300,600	1,276,800	23,800	45.7%	2.6%	51.7%
07	925	475	450	25	450	1,951,400	1,872,200	79,200	50.7%	2.6%	46.7%
08	775	175	600	25	150	1,388,700	1,367,100	21,600	77.8%	3.2%	19.1%
09	775	125	650	25	100	1,550,000	1,550,000	0	83.9%	3.2%	12.9%
10	575	175	400	25	150	1,265,000	1,265,000	0	69.6%	4.3%	26.1%
Total						$21,365,700	$20,566,100	$799,600	49.0%	2.2%	48.9%

Notes:
(2),(3) = From prior filing in state
(4) = (2) - (3)
(5) = Estimated by statewide study
(6) = (3) - (5)
(7),(8),(9) From calculation of earned premium at current rate level by territory (calculation not shown)
(10) = [(8) x (4) / (2) + (9)] / (7)
(11) = [(8) x (5) / (2)] / (7)
(12) = [(8) x (6) / (2)] / (7)

CATASTROPHE RATEMAKING
HOMEOWNERS MULTIPERIL
PERMISSIBLE LOSS RATIO AND CREDIBIILTY - COMPOSITE BASIS

Exhibit 4.2

		PERIL	
		Non-Wind	Hurricane
		% of Premium	
(1)	Commission and Brokerage	10.0%	10.0%
(2)	Other Acquisition	8.0%	8.0%
(3)	General Expenses	4.0%	4.0%
(4)	Taxes, Licenses & Fees	3.0%	3.0%
(5)	Variable Expenses	25.0%	25.0%
		% of Loss	
(6)	Risk Margin	6.0%	110%
(7)	Loss Adjustment Expenses	15.0%	10.0%
(8)	Permissible Loss Ratio	62.0%	34.1%
(9)	Credibility	25.8%	100.0%

Notes:
(5) = Sum of (1) to (4).
(8) = [1 - (5)] / [1 + (6) + (7)]

CATASTROPHE RATEMAKING **Exhibit 4.3**
HOMEOWNERS MULTIPERIL
CALCULATION OF STATEWIDE INDICATED RATE LEVEL CHANGE - NON-WIND

Cal./Acc. Year	Earned Premium	Premium Factor to Current Rate Level	Earned Premium at Current Rate Level [(2)x(3)]	Premium Trend	Trended Earned Premium at Current Rate Level [(4)x(5)]	Trended Non-Wind Premium at Current Rate Level [(6)x0.49]
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	3,658,065	1.039	3,800,729	1.177	4,473,458	2,191,994
2	3,903,315	1.027	4,008,705	1.142	4,577,941	2,243,191
3	4,219,532	1.003	4,232,190	1.109	4,693,499	2,299,815
4	4,537,881	1.000	4,537,881	1.077	4,887,298	2,394,776
5	4,786,194	1.000	4,786,194	1.045	5,001,573	2,450,771
Total	21,104,987		21,365,700		23,633,770	11,580,547

Cal./Acc. Year	Non-Wind Incurred Losses	Loss Development Factor	Projected Ultimate Non-Wind Losses [(7)x(8)]	Loss Trend	Trended Ultimate Non-Wind Losses [(9)x(10)]	Rate Level Loss Ratio	Accident Year Weights
(1)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	919,241	1.003	921,999	1.308	1,205,789	55.0%	10%
2	930,722	1.007	937,237	1.246	1,167,351	52.0%	15%
3	1,013,462	1.015	1,028,664	1.186	1,220,214	53.1%	20%
4	1,154,759	1.030	1,189,402	1.130	1,343,698	56.1%	25%
5	1,304,234	1.100	1,434,657	1.076	1,543,591	63.0%	30%
Total	5,322,418		5,511,959		6,480,643	56.0%	100%

Using accident year weights: 56.8% (13a)
Selected loss ratio: 56.8% (13b)

(15) Permissible Loss Ratio 62.0%

(16) Indicated Rate Level Change (Before Credibility) -8.3%

(17) Credibility 25.8%

(18) Complement of Credibility (net trend) 1.9%

(19) Indicated Rate Level Change (After Credibility) -0.7%

Notes:
(5) Annual premium trend is 3%
Trend period for year 5 is 1.5 years.
(7) split of total premium to ex-wind factor of .49 from Exhibit 4.1, Column (10).
(11) Annual loss trend is 5%
Trend period for year 5 is 1.5 years.
(13a) is from accident year weights of 10,15,20,25,30
(13b) is selected from (13a)
(14) is a set of traditional accident year weights
(15) is from Exhibit 4.2, Item (8).
(16) = (13b) / (15) - 1.0
(17) is from Exhibit 4.2, Item (9).
(18) = (1.050 / 1.030) - 1,
loss trend / premium trend - 1
(19) = [(16) x (17)] + (18) x [1.0 - (17)]

CATASTROPHE RATEMAKING **Exhibit 4.4**

HOMEOWNERS MULTIPERIL

INDICATED HURRICANE BASE RATES BY TERRITORY

Territory	Modeled Expected Loss Cost	Loss Cost Multiplier	Indicated Base Rates
(1)	(2)	(3)	(4)
1	$704	2.500	$1,760
2	704	2.500	1,760
3	763	2.500	1,907
4	763	2.500	1,907
5	323	2.500	807
6	323	2.500	807
7	291	2.500	727
8	88	2.500	220
9	59	2.500	147
10	88	2.500	220

Notes:
(2) = for base class (e.g. frame, 1 story, gable roof, no mitigation)
(3) From Exhibit 4.5, Item (9).
(4) = (2) x (3)

Exhibit 4.5

CATASTROPHE RATEMAKING
HOMEOWNERS MULTIPERIL
CALCULATION OF LOSS COST MULTIPLIER FOR
HURRICANE BASE RATES

	% of Premium	
(1)	Commissions	10.0%
(2)	General Expense	4.0%
(3)	Other Acquisition Expense	8.0%
(4)	Taxes, Licenses, and Fees	3.0%
(5)	Variable Expenses	25.0%
(6)	Risk Margin as a Ratio to Loss	1.100
(7)	Loss Adjustment Expense as a % of Loss	10.0%
(8)	Coverage Adjustment Factor	0.852
(9)	Loss Cost Multiplier	2.500

Notes:
(1) to (7) From Exhibit 4.2.
(8) Insurer's base coverage is $75,000 versus $100,000 from the modeled loss costs (.75 factor from amount of insurance curve); insurer's base deductible is 1% vs 2% from the modeled loss costs.
Coverage adjustment is 0.75 x (1 / 0.88) = 0.852
(9) = (8) x [1.0 + (6) + (7)] / (1.0 - (5))

CATASTROPHE RATEMAKING
HOMEOWNERS MULTIPERIL
CALCULATION OF STATEWIDE INDICATED RATE LEVEL CHANGE - COMPONENT BASIS

Exhibit 4.6

	Current Base Rate				Indicated Base Rate				Indicated Base Rate Change				Distribution of Earned Base Class House Years	
Territory	Non-Wind	Other Wind	Hurricane	Composite	Non-Wind	Other Wind	Hurricane	Composite	Non-Wind	Other Wind	Hurricane	Composite	All Policies	Policies with Wind
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
01	$500	$25	$1,000	$1,525	$486	$25	$1,760	$2,271	-2.7%	0.0%	76.0%	48.9%	8.0%	7.3%
02	550	25	1,000	1,575	546	25	1,760	2,331	-0.7%	0.0%	76.0%	48.0%	9.0%	8.3%
03	650	25	1,000	1,675	645	25	1,907	2,577	-0.7%	0.0%	90.7%	53.9%	11.0%	10.1%
04	600	25	1,000	1,625	578	25	1,907	2,510	-3.7%	0.0%	90.7%	54.4%	12.0%	11.7%
05	400	25	500	925	393	25	807	1,225	-1.7%	0.0%	61.4%	32.4%	12.0%	12.3%
06	425	25	500	950	422	25	807	1,254	-0.7%	0.0%	61.4%	32.0%	7.0%	7.3%
07	450	25	450	925	442	25	727	1,194	-1.7%	0.0%	61.6%	29.1%	11.0%	10.9%
08	600	25	150	775	596	25	220	841	-0.7%	0.0%	46.7%	8.5%	9.0%	9.5%
09	650	25	100	775	677	25	147	849	4.2%	0.0%	47.0%	9.6%	10.0%	10.8%
10	400	25	150	575	405	25	220	650	1.2%	0.0%	46.7%	13.0%	11.0%	11.9%
Average	$523	$25	$563	$1,110	$520	$25	$989	$1,533	-0.7%	0.0%	75.7%	38.1%	100.0%	100.0%

By Peril	Premium Distribution	Rate Level Change	
Non-Wind	49.0%	-0.7%	(16)
Other Wind	2.2%	0.0%	
Hurricane	48.9%	75.7%	(17)
Total	100.0%	36.6%	(18)

Notes:
Base class is $75,000 coverage A; frame construction, protection class 5, 1% hurricane deductible, $500 other perils deductible.
(2) Average weighted by (14).
(3),(4) Average weighted by (15).
(5) = (2) + (3) + (4) Avg. weighted by (15)
(6) = (2) + [(2) x (10)] Avg. weighted by (14)
(7) from statewide study (not shown) Avg. weighted by (15)
(8) from Exhibit 4.4, column (4) Avg. weighted by (15)
(9) = (6) + (7) + (8) Avg. weighted by (15)
(10) from territorial relativity study for Non-Wind peril (not shown)
(11),(12),(13) = Indicated / Current - 1.0
(18) Statewide rate change is different from composite rate change Col.(13) average, because (18) includes policies excluding wind at a low rate level change (- 0.7%)

CATASTROPHE RATEMAKING **Exhibit 6.1**
HOMEOWNERS MULTIPERIL
HURRICANE CLASSIFICATION PLAN **FACTORS ONLY ILLUSTRATIVE**

Hurricane Rating Plan Relativities
applied to base class premium - HO - 3, hurricane

A. Loss Mitigation Rating (Hurricane Only)
Primary Rating Factor

				No Roof Straps			With Roof Straps		
	Secondary Water Resistance	**Sheathing Attachment**	**Shuttering**	**Gable Unbraced or Flat Roof**	**Gable Braced Roof**	**Hip Roof**	**Gable Unbraced Roof**	**Gable Braced or Flat Roof**	**Hip Roof**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A	**No**	**Standard**	**None**	1.00	0.95	0.80	0.90	0.85	0.70
B			**Ordinary**	0.90	0.85	0.70	0.80	0.75	0.60
C			**Hurricane**	0.80	0.75	0.60	0.70	0.65	0.50
D		**Superior**	**None**	0.95	0.90	0.75	0.85	0.80	0.65
E			**Ordinary**	0.85	0.80	0.65	0.75	0.70	0.55
F			**Hurricane**	0.75	0.70	0.55	0.65	0.60	0.45
G	**Yes**	**Standard**	**None**	0.95	0.90	0.75	0.85	0.80	0.65
H			**Ordinary**	0.85	0.80	0.65	0.75	0.70	0.55
I			**Hurricane**	0.75	0.70	0.55	0.65	0.60	0.45
J		**Superior**	**None**	0.90	0.85	0.70	0.80	0.75	0.60
K			**Ordinary**	0.80	0.75	0.55	0.70	0.65	0.45
L			**Hurricane**	0.70	0.65	0.50	0.60	0.55	0.40

B. Building Features Table
Secondary Rating Factors

Add for:			
height	**Second story**	0.05	(10)
Subtract for:			
roof	**Tile roof**	0.01	(11)
	Slate roof	0.02	(12)
	Enhanced shingle	0.03	(13)
	Reinforced concrete roof	0.10	(14)
	No skylights (or skylight protection)	0.01	(15)
wall construction	**Unreinforced masonry**	0.03	(16)
	Reinforced masonry	0.05	(17)
doors	**No sliding glass doors**	0.02	(18)
	Single-wide garage doors	0.02	(19)
	Garage door bracing	0.02	(20)
	No garage and no carport	0.03	(21)
porches	**No porches & no carport**	0.03	(22)
attachments	**Enhanced hurricane wrap**	0.02	(23)
	Enhanced deck attachment	0.02	(24)
	Wall to floor clips	0.01	(25)

CATASTROPHE RATEMAKING **Exhibit A - 1**

HURRICANE RISK MARGIN VERSUS NON-CAT MARGIN FOR HOMEOWNERS COVERAGE

AS % OF EXPECTED LOSS

Homeowners Coverage	% of Loss	Coefficient of Variation	Standard Deviation	Relativity	Risk Margin as % of Mean	Dollar Return
(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. Non-Catastrophe	80%	0.08	0.064	1.00	3.0%	0.0240
B. Hurricane	20%	3.50	0.700	10.94	131.3%	0.2625

Notes:

(4) = (2) x (3)

(5B) = (4B) / (4A)

(6A) is assumed reasonable risk margin for non-catastrophe component of homeowners coverage

(7A) =(6A) x (2A)

(7B) = (7A) x (5B)

(6B) = (7B) / (2B)

CATASTROPHE RATEMAKING **Exhibit A - 2**

HURRICANE RISK MARGIN MEASURED BY REINSURANCE PREMIUMS

CALCULATED AS A PERCENT OF EXPECTED HURRICANE LOSS

(Amounts in $000's)

No.	Layer Values			Line of Coverage	% Placed	Premium	Rate on Line	Expected Losses	Cost on Line	Expected Loss Ratio	Net Reinsurance Cost (NRC)	Expense Ratio (Incl.LAE)	Implied Reinsurer Margin (IRM)	Selected Load	Ratio of Selected Load to Expected Loss Ratio
(1)		(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	a		b												
7	100,000	to	500,000	400,000	0%	1,100	0.3%	300	0.1%	27.3%	72.7%	15.0%	57.7%	57.7%	2.12
6	70,000	to	100,000	30,000	95%	700	2.3%	250	0.8%	35.7%	64.3%	15.0%	49.3%	63.5%	1.78
5	40,000	to	70,000	30,000	95%	1,600	5.3%	600	2.0%	37.5%	62.5%	15.0%	47.5%	61.8%	1.65
4	25,000	to	40,000	15,000	95%	1,400	9.3%	550	3.7%	39.3%	60.7%	15.0%	45.7%	60.0%	1.53
3	15,000	to	25,000	10,000	95%	1,100	11.0%	500	5.0%	45.5%	54.5%	15.0%	39.5%	53.8%	1.18
2	7,500	to	15,000	7,500	95%	1,000	13.3%	500	6.7%	50.0%	50.0%	15.0%	35.0%	49.3%	0.99
1	0	to	7,500	7,500	0%	2,500	33.3%	1,500	20.0%	60.0%	40.0%	15.0%	25.0%	25.0%	0.42

		% Placed	Premium	Expected Losses	Expected Loss Ratio	Net Reinsurance Cost (NRC)	Expense Ratio	IRM	Selected Load	Ratio	
A	Reinsured Layer (7,500 to 100,000)	95%	5,800	2,400	41.4%	58.6%	15.0%	43.6%	57.9%	1.40	(14A)
B	Limited Total (layer A + layers 1 & 7); no IRM on 1&7		9,400	4,200	44.7%					0.80	(14B)
C	Total Margin (layer A + layers1&7); Full IRM on 1 & 7		9,400	4,200	44.7%					1.10	(14C)
									Selected	1.10	(14D)

<u>Notes:</u>

(3) =	(2b) - (2a)	(12) =	(10) - (11)
(5) =	Hurricane premium at 100% placement	(13) =	(4) x (10) + (1 - (4)) x (12); charge is risk margin plus reinsurer expense if reinsurance placed
	layers 1 & 7 estimated premium	(14) =	(13) / (9)
(6) =	(5) / (3), estimated for 100% of layer.	(14A) =	average margin in layers where reinsurance actually purchased
(7) =	Modeled hurricane expected losses	(14B) =	lower bound total margin, assuming no margin is included in unreinsured layers; (14A) x (7A)/(7B)
(8) =	(7) / (3)	(14C) =	average total margin including a full risk margin in unreinsured layers
(9) =	(7) / (5)		(14B) + ((14),layer 1 x (7),layer 1 + (14),layer 7 x (7),layer 7)/ (7C)
(10) =	1.0 - (9)	(14D) =	Judgmentally selected considering (14B) and (14C).