PRE-FILED DIRECT TESTIMONY OF MINCHONG MAO

2025 DWELLING INSURANCE RATE FILING
by the
NORTH CAROLINA RATE BUREAU

Q. Please state your full name and business address for the record.

A. My name is Minchong Mao. My business address is Aon, 200 East Randolph Street, 11th Floor, Chicago, Illinois 60601.

Q. What is your involvement in this matter?

A. My employer, Aon, has been retained by the North Carolina Rate Bureau (NCRB) to provide catastrophe modeling and reinsurance analytics with respect to the expected hurricane losses utilized in the NCRB 2025 Dwelling Insurance rate filing. I am part of the catastrophe analytics team at Aon that performed these services.

Q. What is Aon?

A. Aon is a leading global professional services firm that provides advice and solutions to clients focused on risk, retirement, and health. Aon is one of the world's largest reinsurance brokers and has extensive experience in catastrophe modeling.

Q. What are your primary responsibilities for Aon?

A. I am a Senior Managing Director and a Catastrophe Actuary at Aon's Reinsurance Solutions - Catastrophe Risk Analytics group. I manage an analytics group within the Catastrophe Management area that focuses on catastrophe actuarial and predictive analytics as it relates to ratemaking and underwriting. I advise clients on catastrophe actuarial services, such as rate indications, rate filing strategy, underwriting strategy, and use of catastrophe models in risk management. I am responsible for Aon's compliance with ASOP 38 regarding use of catastrophe models. I am a consulting actuary for Aon's in-house model, Impact Forecasting, LLC. I work with a group of catastrophe modelers to provide catastrophe modeling support for reinsurance placements. Our client services include but are not limited to support for multi-model analytics, customized view of risks, catastrophe pricing, catastrophe risk selections, data augmentation, model evaluation, real-time event response, portfolio optimization, actuarial support, reinsurance cost allocations, and rating agency questionnaire support.

Q. Describe your professional and educational background.

A. I have been with Aon since September 2018. Prior to joining Aon, I worked at State Farm Insurance Companies for over 17 years from 2001 to 2018 where I led the catastrophe modeling functions since 2005. During my tenure at State Farm, I was responsible for State Farm's use of catastrophe models in pricing,

underwriting, claims, reinsurance, securitization, enterprise risk management, and rating agency reporting.

I had 2 years of ratemaking experience as a pricing actuary for Homeowner lines at State Farm. I am familiar with the development and implementation of property insurance rates and rules. I understand the challenges for an insurer to balance rate adequacy and competitiveness and to meet financial objectives at the same time.

I have a Bachelor's degree in Biochemical Engineering from Beijing University of Chemical Technology, a Master's degree in Chemistry from Eastern Illinois University, and a Master's degree in Computer Science from the University of Missouri - Columbia.

Q. Are you a member of any professional actuarial organizations?

A. Yes. I am a Fellow of the Casualty Actuarial Society (FCAS) and a Member of the American Academy of Actuaries (MAAA). I am a Certified Catastrophe Risk Management Professional (CCRMP), a new designation created by the CAS Institute (iCAS) and International Society of Catastrophe Managers (ISCM). I am currently serving on the Casualty Actuarial Society's Climate Change Committee, the American Academy of Actuaries' Extreme Event Risk Committee, and on the

advisory board for CCRMP designation. I am in good standing with the requirements of all of these organizations.

I am part of a working group that authored the following monographs for the American Academy of Actuaries:

- The National Flood Insurance Program: Challenges and Solutions (2017)
- Uses of Catastrophe Model Output (2018)
- Wildfire: An Issue Paper - Lessons Learned from the 2017–2018 California Events (2019)

I am one of the recipients of the Casualty Actuarial Society's Above and Beyond Achievement Award in 2019 to recognize my leadership and contributions to establish the CCRMP designation for the insurance industry.

Q. Please describe your relevant experience and qualifications for this proceeding.

A. My CV is included in the filing as Exhibit RB-7. I started practicing in the catastrophe risk management field in 2005. During my tenure at State Farm, I managed State Farm's catastrophe modeling function from 2005 to 2018. I managed vendor relationships with AIR (now Verisk), EQECAT (now Cotality), ARA, and RMS (now Moody's). I provided filing support and helped my employer through many regulatory challenges related to the use of models in insurance operations. I provided actuarial opinions on State Farm's use of catastrophe

models. I established the due diligence and model validation framework to ensure catastrophe modeling practices at State Farm met the actuarial standards and complied with laws and regulatory requirements. My team provided various catastrophe risk measures and analytics for State Farm Fire and affiliates for ratemaking, exposure management, claims, ERM, rating agency reporting, reinsurance, and securitization purposes.

From 2010 to 2013, I was a member of an advisory group to the Insurance Bureau of Canada (IBC) and the Office of the Superintendent of Financial Institutions (OSFI) to provide expert opinions on insurance and the economic impact of major earthquakes in Canada. From 2011 to 2013, I was a member of an advisory group for IBC and OSFI to revise OSFI Guideline B-9 (Earthquake Exposure Management Sound Practice Guideline for insurance companies). I led a State Farm team to establish the compliance framework to meet OSFI B-9 regulation requirements.

In January 2015, I was appointed by Florida CFO Jeff Atwater to serve on the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM) as the industry actuary. From January 2015 to September 2018, I represented the property insurance industry on the FCHLPM to review and accept hurricane models for use in ratemaking in the State of Florida. My term on the FCHLPM ended in September 2018 due to my job change.

The hurricane models used for this rate filing, Verisk (also known as and hereinafter referred to as “AIR”) Touchstone V12 (a.k.a Touchstone 2024) and Moody’s (also known as and hereinafter referred to as “RMS”) RiskLink V23, are both certified by FCHLPM.

Q. What does the FCHLPM do?

A. FCHLPM scrutinizes hurricane models and authorizes their use in Florida rate filings and has done so over many years. FCHLPM retains experts in relevant fields who review the meteorological, wind engineering, damageability, claims, statistical, computer programming, economic and other aspects of modeling in great detail. Over the years, FCHLPM has recognized advancements in various scientific disciplines related to hurricane modeling and has required modelers to incorporate such advancements. FCHLPM approves only those models that meet its rigorous standards.

Q. Please describe how ASOP 38 is applicable in this rate filing?

A. The Actuarial Standard of Practice No. 38 (ASOP 38) has been in effect since December 2000. ASOP 38 was created, to some extent, to address the use of stochastic computer hurricane simulation models in the insurance ratemaking process. ASOP 38 established certain requirements for actuaries who use output from a model that is outside of that actuary’s area of expertise. Hurricane

models are developed by groups of experts including meteorologists, structural engineers, actuaries, statisticians, and computer scientists. Some model components are outside of the area of expertise of actuaries. Due to the models' complexity and reliance on different science disciplines, as well as the relative newness of their use in establishing property insurance rates, many actuaries are not as knowledgeable about these models as they are about the traditional ratemaking methodologies.

Hurricane models are utilized to establish the hurricane loss costs and reinsurance cost allocation for this NCRB filing. Therefore, compliance with ASOP 38 is relevant to the filing.

Q. Is Aon's use of catastrophe models in compliance with ASOP 38?

A. Yes, Aon's catastrophe modeling practice in general and as it relates to this NCRB filing is in compliance with ASOP 38. ASOP 38 provides guidance to the actuary in using models that incorporate specialized knowledge outside the actuary's own area of expertise when developing an actuarial work product and has been included as Exhibit RB-9. When using such a model, the standard requires that the actuary perform five specific tasks:

a. Determine the appropriate level of reliance on experts;
b. Have a basic understanding of the catastrophe model;

c. Evaluate whether the catastrophe model is appropriate for the intended purpose;

d. Determine that appropriate validation of the catastrophe model and output has occurred; and

e. Determine the appropriate use of the catastrophe model and output.

In addition to relying on vendors' experts, Aon has an in-house model evaluation team. This team consists of members with advanced degrees in meteorology, structural engineering, and statistics. Soon after models are released, the model evaluation team performs sensitivity testing to identify key drivers of model changes and potential anomalies. I work closely with the model evaluation team at Aon to ensure the sensitivity testing covers all aspects of ASOP 38 requirements. I review the testing results through an analytics dashboard. I document my reviews for each peril model. Upon completion of the review, I sign an ASOP 38 attestation. Copies of the current ASOP 38 attestations for the AIR and RMS models are included in the filing as Exhibits RB-10 and RB-11, respectively.

Q. Describe the role of Aon Reinsurance Solutions Analytics and Catastrophe Risk Analytics.

A. Aon Reinsurance Solutions Analytics (a.k.a Reinsurance Analytics) provides consultative services to Aon's clients who place catastrophe reinsurance through

Aon. These clients are primary insurers selling property insurance products in catastrophe prone areas. Aon Reinsurance Analytics provides value added service that is above and beyond reinsurance brokering transactions. Our client services include but are not limited to support for multi-model analytics, customized view of risks, catastrophe pricing, catastrophe risk selections, data augmentation, model evaluation, real-time event response, portfolio optimization, reinsurance cost allocations, actuarial support, and rating agency questionnaire support.

Within the Reinsurance Analytics division, there is a team specialized in catastrophe risk analytics. I am part of the catastrophe risk analytics team that provides clients with catastrophe risk management information and assists clients with their reinsurance purchasing decisions.

Q. Describe your experience with catastrophe models.

A. From 2005 to 2006, I performed the catastrophe modeling analyst's role at State Farm, which includes hands-on experience with multiple models - from data preparation to running the models to post-model aggregation. My daily work involved data preparation and converting exposure data into model input files. I gained knowledge about how different models handle building characteristics and insurance terms. I used RMS RiskLink, AIR, and EQECAT models on a daily basis. I developed an understanding of the models' back end database and output. I performed post-model analysis and wrote computer programs to

develop risk metrics such as probable maximum loss (PMLs), average annual losses (AALs), and total value at risk (TVaR) to help State Farm assess and manage catastrophe risks. Later in my career, I assembled a team and supervised many modeling tasks delegated to my colleagues. I continued to provide guidance and managed the day-to-day work of the catastrophe modeling unit.

Q. Describe your experience with catastrophe reinsurance.

A. My experience with reinsurance started in 2005 at State Farm. State Farm is a reinsurance buyer, and I was a part of the company's reinsurance buying team. I supported the reinsurance function at multiple levels. My work included using catastrophe model output and financial information to help my employer in structuring reinsurance, conducting technical pricing, drafting and reviewing reinsurance contracts, and participating in reinsurance buying trips. I evaluated catastrophe risks and cost of capital from both ceding and assuming parties. I worked closely with our reinsurance broker to validate our view of risks using external benchmarks. At Aon, I work directly with our clients who are seeking to purchase catastrophe reinsurance. Output from models is used by our brokers, clients, and capital markets to determine the reinsurance structure and pricing. We customize reinsurance solutions based on clients' risk appetite and risk profile.

Q. Do you speak on topics pertaining to catastrophe modeling?

A. Yes. I have presented at CAS Ratemaking, Product, and Modeling Conferences. I am a frequent speaker at Reinsurance Association of America's annual catastrophe modeling conference. My topics have included model blending, model regulation, and wildfire modeling, among others. From 2012 to present, I am a visiting instructor for the Illinois State University Math Department Actuarial Science program. I presented catastrophe modeling and regulatory topics to actuarial students. From 2016 to 2018, I was a member of the planning committee for the Reinsurance Association of America's annual catastrophe modeling conference. I organized and moderated panels and engaged speakers to cover a variety of catastrophe topics.

Q. Would you please explain why you are providing this testimony?

A. I manage Aon's Catastrophe Actuarial and Predictive Analytics team that developed the provisions for the modeled hurricane losses, the net cost of reinsurance, and the compensation for assessment risk used in this filing. I am responsible for the work product provided to NCRB on those items for this filing.

Q. What was Aon's role in this filing with respect to expected hurricane losses?

A. Aon performed data validation and shared control totals with NCRB; Aon's catastrophe modelers ran AIR Touchstone V12 (a.k.a Touchstone V2024) and RMS RiskLink V23 models based on exposure data provided by NCRB; Aon blended the model results for NCRB based on well-established methodology and provided the modeled average annual loss to NCRB; Aon conducted industry research, recommended, and applied catastrophe loss adjustment factors for NCRB.

Q. Are catastrophe simulation models commonly used by insurers for ratemaking in catastrophe-exposed lines and jurisdictions?

A. Yes, catastrophe models have become the standard method of estimating catastrophe risk in rate filings and reinsurance. Hurricane losses are so extreme and volatile that, for many years now, the accepted actuarial procedure for estimating catastrophe risk in rate filings and in the reinsurance market has been through the use of catastrophe models rather than actual hurricane losses. Such volatility is greatly compounded in hurricane prone states such as North Carolina. In North Carolina and other hurricane prone states, a significant percentage of the prospective long-term average annual losses in certain territories of the state are caused by intense hurricanes, which are relatively infrequent but are devastating when they do occur. It would be actuarially unsound to rely on a few years of actual hurricane losses to estimate prospective hurricane losses because of the volatility of these losses driven by low frequency and high

severity. We have provided data and analysis from the use of catastrophe models for Aon clients to use in their rate filings in multiple states.

Q. Did the NCRB ask Aon to run the AIR and RMS models?

A. Yes. Aon ran AIR Touchstone and RMS RiskLink for the NCRB under the NCRB's direction. AIR and RMS are the most commonly used catastrophe models in the insurance and reinsurance industries. Aon runs these two models on all of Aon clients' exposure data pertinent to reinsurance transactions. The majority of Aon's clients use either one or both models when evaluating their catastrophe risk.

Q. Why did the NCRB ask Aon to run two models?

A. My understanding is that the NCRB has been using two models since 2016 and also that running two models complies with N.C.G.S. 58-36-10(3), which became effective in 2017 and requires the NCRB to present data from more than one model if modeled hurricane losses are based upon a commercial hurricane simulation model.

Q. How are losses from the two models blended?

A. We run the individual models independently and determine the appropriate loss costs and reinsurance cost allocation for each model. The blended results

from the two models are derived by taking the straight average, thus weighting the models equally.

Q. Is it common that modeled losses will differ between the various model vendors?

A. Yes. Catastrophe models are complex. When modeling vendors develop a hurricane model, they start with similar underlying information, such as the National Hurricane Center's historical hurricane dataset, land use/land cover database, similar wind engineering principles, and statistical theories. However, there are differences between modeling vendors in their approaches to interpreting and supplementing the data to build a robust model. Different assumptions and judgments are made by model developers. Vendors may also use claims data from different data sources to calibrate their model. These varying assumptions, judgments, and methodologies will result in different model results. Model results deviate more at location level than at the state level. When models generate different results, it does not necessarily mean any model is wrong. The spread among different views of the same risk reflects the inherent uncertainties of catastrophe modeling.

Given the number of variables involved in the development of a catastrophe model and the degree of uncertainty associated with each variable, we would not expect that two independently developed models would result in the same output or conclusions on a given set of data.

Q. Does the use of catastrophe models produce artificially high rate levels?

A. No. Models help stabilize rate levels. Without modeling, rate levels would fluctuate wildly following the occurrence or non-occurrence of significant hurricanes. Modeling is relied upon by all stakeholders in insurance, reinsurance, catastrophe bond, and other financial transactions to give the best and most unbiased projection of future hurricane losses. Different parties to those transactions often have opposing economic interests, but they all rely on models in their negotiations with each other.

Q. How do the models change over time?

A. Catastrophe models are built based on state of the art science and technology. As science continues to evolve and computing powers continue to advance, modeling technology is updated and improved. In addition, research into historical and recent events, updates to building practices and building codes, and data from engineering experiments also provide insights to enable model developers to enhance their models. Each modeling vendor takes a different approach on how frequently it updates its models and which perils and regions will be updated. As noted above, because different assumptions and judgements are made when information is applied, the impact of an update could vary greatly between models. Changes due to model updates are to be expected.

Q. Is using multiple models to determine catastrophe risk actuarially sound?

A. Yes. Using multiple models allows users to incorporate different views of risk into their exposure management. Using multiple models can effectively mitigate modeling volatility and smooth out significant model changes. Using multiple models is a practice endorsed by major rating agencies such as AM Best and S&P.

Q. How does the NCRB exposure data impact model output?

A. The following data factors would impact model output:

- Changes in coverage and/or policy conditions such as deductible and limits, and the underlying policies-in-force
- Changes in an insurer's portfolio composition, such as geographic concentration
- Changes in building characteristics, such as loss mitigation features and age of roof
- Changes in data quality, such as replacing unknown building characteristics with known building characteristics

Q. Please describe the client data that was employed as input for the model runs?

A. The underlying exposure data was provided to Aon by the NCRB. The NCRB advised me that the data was compiled on behalf of the NCRB by Insurance Services Office (ISO). NCRB's exposure data sent to Aon consisted of the trended aggregate exposure information for all residential Dwelling risks in North Carolina, including those written voluntarily by insurance companies and those written by the residual market (NCIUA and NCJUA). NCRB instructed Aon to run the models using the aggregate data at zip code and territory level for the entire North Carolina portfolio in a single model run. Model results were aggregated by territory, policy form, and coverage.

Q. Please describe what Aon Reinsurance Solutions then did with the data provided by the NCRB.

A. We reviewed the data received from the NCRB for completeness and reasonableness before we input it into the AIR and RMS models. Since the two models have different formats for inputting data, we worked with the NCRB to assure that the exposure data was properly and consistently mapped in the required format for each model. NCRB provided earned insurance years (EIY), which is the sum of primary coverage amount expressed in thousands, and earned house years (EHY), which is the number of risks. Limit by coverage is calculated from EIY and EHY as instructed by the NCRB. A comparison of this year's data with last year's data was conducted. Any anomalies were investigated.

The next step was to input the data and run the models. We ran the AIR Standard model using the 100K event catalogue and the RMS Historical model (both are long term views of the hurricane risk) to determine the modeled hurricane loss cost. We also ran the AIR Warm Sea Surface Temperature (WSST) model using the 10K event catalogue and the RMS Medium Term Rate model (both are near term views of hurricane risk) to analyze the cost of reinsurance. It is a standard practice throughout the reinsurance industry to rely upon the models we used to determine modeled hurricane loss cost and reinsurance placements, and this has been true since the 1990s.

After the models were run, we reviewed each model's output separately to ensure data integrity. We then blended the results of the two models by taking a straight average of the results. Additional reviews were conducted of the blended results to ensure that the blending procedures were correctly performed and that the blended results were reasonable. The blended modeled hurricane loss results were provided to the NCRB for use in its Dwelling rate review. Exhibits RB-8A and RB-8B set forth the blended modeled hurricane losses resulting from the work I have described. Based on my knowledge and experience, and the input data provided by the NCRB, these modeled hurricane losses are reasonable and appropriate projections of expected hurricane losses for use by the NCRB in its Dwelling rate review and rate filing.

Also, we employed the modeled hurricane losses as part of our work in determining and allocating the cost of reinsurance.

Q. What are the differences and similarities between using the AIR Touchstone's 10K event set and the 100K event set?

AIR Touchstone's 10K hurricane event set is a subset of the 100K event set. These two event sets are designed to have the same theoretical frequency and intensity distributions in coastal segments, and to produce similar results with minimal variabilities. Using the 10K event set provides benefits in performance and storage. AIR Touchstone's 10K event set is standard for use in a majority of catastrophe modeling exercises – including reinsurance renewal data distribution for quoting and placement purposes. The 100K event set is used to determine hurricane loss costs for ratemaking purposes.

Q. Did Aon make adjustments to the modeled results?

Yes. A 6% loss adjustment expense (LAE) factor was applied to modeled losses. This factor was recommended by Aon based on a broad industry study at the state level. The results of that study are shown in Exhibit RB-14. The application of the LAE factor was reviewed and approved by the NCRB, and the 6% catastrophe LAE factor was selected by the NCRB.

Q. What is demand surge?

A. Demand surge is a social economic phenomenon defined by the Actuarial Standards Board as 'a sudden and usually temporary increase in the cost of materials, services, and labor due to the increased demand for them following a catastrophe.' Demand surge usually occurs after large-scale disasters such as earthquakes, tsunamis, cyclones, or flooding. The models incorporate demand surge into their loss estimates.

Q. Should model output include demand surge?

A. All applications of catastrophe model output should reflect demand surge. Demand surge is a real social economic phenomenon. Insurance companies' claims experience includes the effect of demand surge. Excluding demand surge would underestimate catastrophe losses.

Q. Does the model output used in this filing include demand surge?

A. Yes. As is the customary and accepted practice in the insurance, reinsurance, and catastrophe bond industries, the models were run with aggregate demand surge (AIR) and loss amplification (RMS) included. The FCHLPM has approved the use of aggregate demand surge and loss amplification for the AIR and RMS models, respectively. These aspects of the models account for the expected additional cost for supplies and labor if a very large hurricane event or series of

events occurs. Experience demonstrates that when such catastrophic events have occurred, there is significant increase in demand for the limited supply of plywood, shingles, labor, hotel rooms and other necessities. The high demand for specialized labor often requires contractors to come in from out of state. Fundamental economic principles dictate that such a spike in demand increases prices and consequently results in larger than normal claims payments in the aggregate. Additionally, there are delays in repairing properties, which can directly lead to longer stays in hotels, and there are other increased costs beyond those that occur after smaller hurricanes. Loss amplification also factors in claims inflation. Claims adjusters may not investigate every claim individually if it is under a certain threshold, given the volume of claims they have to settle post-event in a limited amount of time.

Q. Does any state prohibit the inclusion of demand surge in modeled losses for rate filings?

A. I am not aware of any prohibitions against the use of demand surge in rate filings in any jurisdiction. The South Carolina Department of Insurance Bulletin 2014-03 states “Demand surge may be included in the modeled results as long as the company provides the impact it has on the modeled losses.” The Florida Commission on Hurricane Loss Projection Methodologies’ actuarial standards require hurricane models to incorporate demand surge based on relevant data and actuarially sound methods and assumptions.

Q. North Carolina has laws prohibiting "price gouging" following a hurricane. Does that eliminate demand surge?

A. No. Florida has a similar law (Title XXXIII 501.160). Demand surge can and does occur due to supply and demand economics in situations that would not be considered price gouging and/or that would not be prevented by statutes prohibiting price gouging.

Q. Does it make sense for North Carolina hurricane losses to include demand surge for very large events impacting other states even if those events were less significant in North Carolina?

A. Yes, the intent of the model is to reflect economic conditions that will influence construction prices and other aspects of insured loss (such as, for example, the increased period of time a carrier has to pay for hotel rooms for insureds while their damaged homes are repaired) in the time period shortly after a catastrophe event occurs. Since labor and materials resources are exchanged by people across state lines, we believe the demand surge effect on prices in other states will have an effect in North Carolina.

Q. You noted earlier that you and your team developed the provision in the filing for the net cost of reinsurance. First, what is reinsurance?

A. Put simply, reinsurance is insurance for insurers. When insurers are aware of scenarios in which the potential losses are greater than the company is willing or able to tolerate, they will frequently purchase reinsurance to mitigate the risk in those situations. For similar reasons, insurers may issue catastrophe bonds to protect themselves in those situations. Essentially the insurers will use a portion of the premium to purchase reinsurance. This is common across the industry.

Q. What is catastrophe reinsurance, who buys it, and why do they buy it?

A. Catastrophe reinsurance is a contract purchased by a primary insurance company and sold by a reinsurer, or a group of reinsurers, to transfer risk from loss due to large catastrophic events. Large catastrophe losses present a very real risk to the long-term viability of Dwelling insurers and their ability to follow through on their promise to policyholders to pay losses when they occur. There are numerous scenarios where the potential losses due to a single hurricane are far greater than the entire premium collected by all the companies for the entire state of North Carolina. To remain viable long-term and protect against insolvency, the industry must purchase reinsurance to help cover this risk.

The most common type of contract used for catastrophe risk is called “Portfolio Excess of Loss”, a.k.a. “Portfolio XOL”, or just “XOL”. A single XOL contract has an “attachment” and a “limit”. An XOL covers the amount of portfolio loss caused by a single event in the amount that exceeds the XOL attachment with a

maximum equal to the XOL limit. In some instances, there is co-participation, which means that only a percentage of the amount of loss in the XOL layer is covered. Portfolio XOL contracts (a.k.a. “treaties” since there are typically multiple reinsurers involved) cover the first event within a year of coverage. It is standard practice to write into the treaty a provision for the primary carrier to automatically purchase a “reinstatement” if they have a loss that triggers a reinsurance payment. The reinstatement premium allows for the full limit to be reinstated after the first event uses up the limit provided. There are cases where a limit is provided and if an event exhausts that limit, then there is no coverage available for the remainder of the contract period. It is typical of primary carriers to buy multiple treaties that stack on top of each other. In other words, a treaty will have an attachment equal to the attachment plus limit of another treaty. Primary carriers buy reinsurance to ensure the company is financially viable after very large and uncommon to rare events.

The costs associated with this catastrophe reinsurance are costs of doing business in the state. To reflect the portion of those costs that is not already covered in the filing, a provision for the net cost of reinsurance is included in the filing.

Q. What was your role in this filing with respect to net cost of reinsurance?

A. I worked with my colleagues within the Aon Catastrophe Actuarial team to determine a suitable provision for the net cost of reinsurance for the state overall and an allocation of that cost by territory and policy form. The provision used

exposure data from all the Dwelling risks in the state so that a cost provision would be appropriate to use in a uniform rate schedule applicable to all insurers in the state.

Q. Please describe how the reinsurance program was designed and priced for purposes of NCRB's Dwelling rate filing? Do you think it is reasonable?

A. Yes, I think the reinsurance program is reasonable. The Aon Catastrophe Actuarial team designed the reinsurance program for this rate filing. I manage this team and I am responsible for its work product. The basis of the reinsurance program structure and pricing is determined by an analysis of reinsurance programs placed by Aon for its reinsurance clients. Three components of the analysis are described here.

Program attachment and total limit describes the total amount of reinsurance coverage. Since companies vary substantially in size, so does their limit purchase and attachment for their bottom layers. To normalize for company size, we looked at the frequency with which a single event would trigger a recovery and the frequency with which a single event would exhaust the limit of the entire program for each company. This was calculated separately for the AIR and the RMS models. We then calculated the median attachment and exhaustion (exhaustion = bottom layer attachment + total program limit) frequencies by model and by region (Southeast and Nationwide). The frequencies for attachment and exhaustion were averaged across the regions, which resulted in

attachment and exhaustion frequency by model. Using portfolio loss distributions by model for the portfolio in the filing, we calculated the dollar amount of attachment and exhaustion (and therefore limit) by model. The attachment of the reinsurance program in the filing is the average of the AIR indicated attachment and RMS indicated attachment. The exhaustion of the reinsurance program in the filing is the average of the AIR indicated exhaustion and the RMS indicated exhaustion.

Reinsurance Market Pricing Model For AIR and RMS, a log-linear regression model was built to calculate fitted reinsurance price based on modeled expected ceded loss. Using these regression models, an indicated price for any layer can be calculated based on each catastrophe model (AIR and RMS). The selected prices by layer used in this rate filing are the averages of the AIR indicated prices and the RMS indicated prices.

Note: Because insight into reinsurance market pricing is an important proprietary asset for Aon, the log-linear models are considered a trade secret and therefore not disclosed in this public filing.

Program Structure. After the market pricing model is determined along with the program's attachment and limit, the program is then broken into layers. We run an optimization analysis to find the five-layer catastrophe program that has the lowest deposit premium. The method is designed to calculate an indicated

reinsurance premium that is as low as possible, subject to the market pricing model and program attachment and limit specifications.

The reinsurance structure determined by the method described above is shown in Exhibit RB-12. The pricing with loss analysis is shown in Exhibit RB-13.

Q. Have you seen reinsurance costs going up in recent years?

A. The global reinsurance market has experienced some extraordinary volatilities since 2019. Reinsurance prices have increased significantly in the U.S. during 2019 to 2024. This increase was initially driven by Florida in the Southeast region, but the significant increase has been seen countrywide since 2021. Reinsurance prices peaked in early 2024 and have started to stabilize since then.

Q. How was the net cost of reinsurance calculated?

Net cost of reinsurance is Deposit Premium + Expected Reinstatement Premium - Expected Ceded Loss & LAE. The reinsurance program, the loss distribution from the portfolio as determined by event loss tables (ELTs) from catastrophe models, and the LAE assumptions are input into a DFA (Dynamic Financial Analysis) program to calculate the average ceded loss and LAE and average reinstatement premium over a specified number of simulated years. The loss distribution that is produced by the AIR model is already in the form of simulated loss experience for 100,000 years. The DFA program calculates for each year

the total reinsurance recoveries and reinstatement premium paid. The program then calculates the average annual ceded loss & LAE and the average reinstatement premium. The loss distribution from RMS models is a list of possible catastrophic events. Instead of providing specific year and amount of loss from each event, each event has a parametric distribution for frequency and severity. The DFA program creates a simulation of 1,000,000 years of loss experience to make a table containing year, event id, and specific amount of loss. From that point, the calculation works the same as for the AIR model.

For the NCRB filing, our analysis shows that expected reinsurance premium is $391,144,273, expected ceded loss & LAE is $77,294,432, and the net cost of reinsurance is $313,849,841, as shown on Exhibit RB-16 and the summary on Exhibit RB-13. Allocation by territory is done using the method described above.

Q. How was the reinsurance premium allocated?

A. Reinsurance premium by layer is allocated to a territory based on that territory's share of expected ceded loss and loss adjustment expense (LAE) by layer. Exhibit RB-13 shows the total expected ceded loss and LAE by layer and Exhibit RB-15 shows the proportion of hurricane peril reinsurance premium, ceded average annual loss, and reinsurance margin (a.k.a. "net cost of reinsurance") allocated to each territory segment for each layer. Other perils were used in the calculation, but because they contributed such a small amount of expected ceded loss they were not shown on the exhibits. Exhibit RB-16

shows the dollar amount of reinsurance margin allocated by territory and policy form.

Q. Given your experience in catastrophe reinsurance, do you find this approach to be reasonable?

A. Yes. Aon's approach is based on detailed information on current reinsurance market rates and underlying model output.

Q. Do you know whether the Rate Bureau has used in its 2025 Dwelling filing the Aon net cost of reinsurance results you provided?

A. Yes, I am advised that the Rate Bureau has used in the filing both our statewide net cost of reinsurance results and those results allocated to the territory level.

Q. Are you aware of the following provisions in the North Carolina statutes, in N.C.G.S. 58-36-10(7):

Property insurance rates established under this Article may include a provision to reflect the cost of reinsurance to protect against catastrophic exposure within this State. Amounts to be paid to reinsurers, ceding commissions paid or to be paid to insurers by reinsurers, expected reinsurance recoveries, North Carolina exposure to catastrophic events relative to other states' exposure, and any other relevant information may be considered when determining the provision to reflect the cost of reinsurance.

A. Yes, I am. This NC statute provision is consistent with ASOP 53, Estimating Future Costs of Prospective Property/Casualty Risk Transfer and Risk Retention,

which “applies to actuaries when performing actuarial services with respect to developing or reviewing future cost estimates (commonly known as actuarial indications) for prospective property/casualty risk transfer and risk retention. For example, this standard applies when actuaries are developing future cost estimates underlying product prices, estimating funding requirements for self-insured programs and captives, and developing reinsurance prices.”

Q. Do you have an opinion whether the analysis you and Aon have performed on behalf of the Rate Bureau on the net cost of reinsurance for this filing has taken into consideration the provisions of that statute?

A. Based on my experience with hurricane models and using modeled hurricane losses along with my experience with catastrophe reinsurance and determining catastrophe reinsurance costs for rate filings, it is my opinion that the net cost of reinsurance analysis for this filing properly considers all of the items set forth by the statute. Further, based on my experience in the actual marketplace, it is my opinion that a reasonable and appropriate provision for the net cost of reinsurance must be incorporated into Dwelling insurance rates in North Carolina for those rates to properly reflect and protect against the catastrophe exposure in this state.

Q. Do you have an opinion regarding the appropriateness of the net cost of reinsurance provision incorporated into this Dwelling filing?

A. Yes. Based on my experience with hurricane models and using modeled hurricane losses along with my experience with catastrophe reinsurance and determining catastrophe reinsurance costs for rate filings, it is my opinion that the provision for the net cost of reinsurance in the filing, at the statewide and territory levels, is reasonable and appropriate.

Q. Can you please describe the issues related to the compensation for assessment risk?

A. Property insurance written in the residual market in North Carolina presents considerable risk for primary insurers that write property insurance. The North Carolina Insurance Underwriting Association (i.e., the Coastal Property Insurance Pool, or “Beach Plan”) and the North Carolina Joint Underwriting Association (i.e., the FAIR Plan) together serve as that residual market. The Beach Plan and FAIR Plan provide property insurance when policyholders are unable to purchase insurance coverage from companies in the voluntary market. In states like North Carolina with significant exposure to catastrophic events and/or where the availability of insurance is limited in the voluntary market, property insurance residual markets may grow to represent a sizable portion of the total insured risk. In North Carolina, the Beach Plan and FAIR Plan have become the predominant writers of dwelling insurance in both the 18 coastal counties and the rest of the state.

Similar to insurance companies writing voluntary business, the Beach and FAIR Plans use the premiums collected from policies they issue to fund the losses and expenses attributable to the coverages they insure. When premiums are greater than losses and expenses during a given year, the Beach Plan and the FAIR Plan accumulate surplus. That surplus is available to pay losses in the event that future losses and expenses exceed collected premiums plus investment income. However, if the surplus of either the Beach Plan or FAIR Plan is exhausted, then additional losses of that entity are passed through to property insurers in North Carolina in the form of an assessment. The potential overall industry assessment from the Beach Plan for any single year is capped at $1 billion, but the potential assessment from the FAIR Plan is unlimited. If losses in the Beach Plan exceed the retained surplus, the $1 billion industry assessment, and any other resources of the Beach Plan (such as reinsurance), any additional losses are passed through directly to residential property insurance policyholders in North Carolina.

This risk of potential assessment by the Beach Plan and/or FAIR Plan on property insurers in North Carolina requires that those companies be compensated for the additional risk to their capital. To quantify this risk, Aon has applied a procedure previously developed by Milliman and adopted by NCRB to incorporate a provision in property insurance rates (homeowners insurance, dwelling insurance, and mobile home insurance) that compensates insurers for that risk.

Q. Can you please explain the procedure you used to determine the needed compensation for assessment risk?

A. Yes. There are two steps in the methodology to quantify the compensation for assessment risk (sometimes “CAR”). The first step is to calculate the magnitude of the exposure itself, and the second step is to determine the fair compensation to be paid to insurers for being required to bear that risk.

To quantify the magnitude of the exposure, it is necessary to estimate the expected value of the assessments on insurers arising from catastrophic losses incurred by the Beach Plan and/or FAIR Plan. Because an assessment on insurers results only after either the Beach Plan or FAIR Plan has exhausted other resources available to pay losses, we needed to determine the likelihood of that occurring as well as the amount by which the losses exceed those other resources.

Aon quantified the risk of assessment by the Beach Plan and FAIR Plan using a methodology similar to that developed by Milliman and presented in previous filings. First, Aon collected the Beach Plan’s and FAIR Plan’s exposure at county level from the Beach Plan’s and FAIR Plan’s websites for the 2025-2026 storm season. Then we reviewed the Beach Plan’s and FAIR Plan’s reinsurance programs in place for the 2025-2026 storm season, along with assumptions of

the Beach Plan's and FAIR Plan's accumulated surplus available for the season. The accumulated surplus and available reinsurance are the "other resources" that are available to pay for hurricane losses during the 2025-2026 storm season. Aon then ran the AIR and RMS hurricane models on the Beach Plan's and FAIR Plan's exposures for the 2025-2026 storm season, calibrated modeled event losses based on the published PML information available on the Beach Plan's and FAIR Plan's websites, and evaluated the impact of reinsurance on each modeled event. Aon utilized its in-house dynamic simulation model ReMetrica to calculate the Beach Plan and FAIR Plan deficits after applying their reinsurance and surplus. For each adjusted modeled loss, ReMetrica determined the amount of loss that would be covered by reinsurance and the remaining losses that would be funded either from the Beach Plan's or FAIR Plan's accumulated surplus, through assessments on property insurers in the state, or ultimately through assessments on North Carolina property insurance policyholders. We subtracted the accumulated surplus of the Beach Plan and FAIR Plan from the losses remaining after reinsurance, limited the assessable losses due to the Beach Plan exposures to $1 billion, and calculated the average assessment on property insurers across all events simulated by the models. This average assessment on property insurers is equal to the expected value of the losses that would be funded through assessments on North Carolina property insurers.

As I mentioned earlier, this calculation produces a measure of the magnitude of the assessment exposure. That is, it represents the risk to insurers' capital that

is associated with the exposure to Beach Plan or FAIR Plan assessments. The next step is to use the method previously developed by Milliman to measure the fair compensation to insurers for bearing this risk.

Q. Can you please explain how you measured the compensation needed for bearing this risk?

A. Yes. To measure the fair compensation for bearing this risk, we relied on publicly available data that quantifies the market price of catastrophe risk, taken from recently-issued insurance linked securities. Insurance linked securities (ILS) are securities, such as catastrophe bonds, that have conditional payoffs that are very similar to reinsurance. Investors purchase these securities at significant yield premiums compared to risk-free bonds because the investors are exposed to loss of principal and interest if certain “insured events” occur.

Q. What kind of ILS data are available and how is this information used to determine the compensation for assessment risk?

A. We relied on insurance linked security yield information to price the compensation for assessment risk. Lane Financial, LLC is a firm that has specialized in the analysis of insurance linked securities. In the past, Lane published a table of data each year that summarized a variety of information that can be used to evaluate the fair compensation for bearing catastrophe risk. For

each ILS in the table, Lane published the following data: the yield on the security; the excess return over the risk-free rate; the probability that the security will suffer a loss; and the expected value of loss anticipated on the security. These data elements provide the foundation for the analysis of the proper compensation for bearing the risk of Beach Plan or FAIR Plan assessments. However, Lane has not published the insurance linked securities table since March 2022.

Aon also collects and aggregates insurance linked securities information similar to the information published by Lane. For each insurance linked security in Aon's table, the following data are available: the peril and region the insurance linked security covers; the yield on the security; the excess return over the risk-free rate; the probability that the security will be attaching; and the expected value of loss anticipated on the security. For the 2025 CAR study, the 2016 – 2021 information utilized was from Lane Financial and the 2022 and later data utilized was from Aon.

There are a number of defined terms that are useful in describing the mechanics of the compensation for assessment risk analysis.

- The "*yield spread*" is the difference between the yield on a particular ILS and the risk-free rate. If a $100 million bond is issued with a yield spread of 10%, this implies that the insurer issuing the bond would pay $10 million in interest

in excess of the interest at the risk-free rate to encourage investors to purchase such a security.

- Continuing with the example of the $100 million bond above, now assume that the distribution of hurricane losses is such that, based on the probability and amount of potential hurricane losses, an investor would anticipate having an average loss of $2 million per year. This amount is identified as the "expected loss."
- Since the investor in this example receives compensation of $10 million in excess of the risk-free rate for bearing the risk of loss, the "expected profit" to the investor is $8 million (i.e., $10 million in interest in excess of the interest at the risk-free rate minus $2 million of expected losses).
- Finally, the "profit multiple" is the ratio of expected profit to expected loss. In the above example, the profit multiple would be $8 million of expected profit divided by $2 million of expected loss, or a profit multiple of 4.0.

The profit multiples derived from insurance linked securities provide an estimate of the compensation that investors require to bear catastrophe risk. This information tells us what investment returns are required by capital providers in order to take on the risk of loss from a catastrophic event. One particularly important feature of this metric is that it is a measure of compensation per dollar of expected loss. As a result, because the first step of our analysis determines the expected value of losses that would be funded through assessments, the profit multiple can be applied to those expected values to develop an estimate of the fair compensation for bearing such risk. This is the measure of risk we relied

upon in evaluating the fair compensation for property insurers whose capital is exposed to Beach Plan and/or FAIR Plan assessments.

Q. Generally speaking, which insurance linked securities have larger risk premiums and higher profit multiples?

A. For exposures such as catastrophic events, securities that have a lower probability of incurring a loss have greater volatility and, as a result, have larger risk premiums. Securities with larger risk premiums have a larger ratio of expected profit to expected loss and, as such, have higher profit multiples.

Q. Have you developed any exhibits that summarize the calculations used to develop the fair compensation to insurers for bearing the risk of Beach Plan and/or FAIR Plan assessments?

A. Yes. Exhibit RB-17 contains ten pages of information required to develop the fair compensation for bearing Beach Plan and FAIR Plan assessment risk.

- Page 1 of Exhibit RB-17 shows the curve fit to the ILS profit multiples based on all catastrophe-related securities issued in the last ten years. As I explained earlier, some of the ILS data came from Lane and some came from Aon. This exhibit also includes the equation of the fitted curve, which can be used to determine the profit multiple for any layer to which insurer capital is exposed.

- Page 2 of Exhibit RB-17 shows a summary of the Beach Plan's reinsurance program, and Page 6 shows a similar summary of the FAIR Plan's reinsurance program, both for 2025. These summaries include the various layers of reinsurance purchased and the coverage levels within those layers.
- Pages 3 and 7 display the profit multiples calculated for each layer of the Beach Plan's and FAIR Plan's loss distributions, based on the equation shown on Page 1. In order to determine the fair compensation to voluntary insurers for bearing the risk of assessments, we need to determine which layers contain losses that will be funded by assessments, as well as the corresponding expected losses within those layers. The profit multiples can then be applied to the expected losses to determine the appropriate compensation per dollar of expected loss in each layer.
- Pages 4 and 8 illustrate how potential losses for the Beach Plan Residential Account and FAIR Plan are funded. (The Beach Plan determines losses and assesses voluntary insurers separately for each account, while the FAIR Plan has only one account.) Because of the $1 billion annual cap on Beach Plan assessments, any amounts needed to pay claims in excess of the assessable amounts are to be collected through surcharges on property insurance policyholders statewide. For each event simulated by the hurricane models, losses are separated by account (Beach Plan Residential, Beach Plan Commercial, FAIR Plan Residential, and FAIR Plan Commercial). The losses for each account

are then divided into layers based on the source of funding for those losses – Beach Plan or FAIR Plan surplus, assessments on voluntary insurers, private reinsurance, and ultimately any additional amounts in the Beach Plan to be covered by policyholder surcharges. Finally, the losses associated with each event are accumulated in each of the loss layers to determine expected values.

- Pages 4 and 8 illustrate the funding of potential losses within each layer. Since the purpose of this analysis is to determine the fair compensation for the risk of assessments on private insurers, the analysis must take into account the probability of losses occurring within each layer and the expected value of the losses that will be borne by private insurers. Pages 5 and 9 of Exhibit RB-17 provide that analysis. Those pages show the expected value of the losses that would be covered by the Beach Plan Residential and FAIR Plan accounts, and the average annual amount of those losses that would be assessed to private insurers. Pages 5 and 9 also display the average profit multiples associated with each layer of the loss distribution, and the product of the indicated profit multiples times the expected losses within each layer. The sum of those values is the indicated compensation for assessment risk for each account.
- The final step in the calculation is to determine the appropriate provision to be included in the dwelling insurance rates to compensate insurers for the risk of Beach Plan and/or FAIR Plan assessments. This provision is expressed as a percent of premium and is developed on Page 10 of

Exhibit RB-17. Since assessments for Beach Plan and/or FAIR Plan losses are applied to all property insurance lines in the state, the table on Exhibit RB-17, Page 10 shows the development of a provision that will produce an amount of revenue equal to the total required compensation of $233.83 million when incorporated into the rates for homeowners, dwelling and mobile home insurance in North Carolina. As shown on this exhibit, that provision is 4.2% of total property insurance premium in the state.

Q. Did you make any adjustments to the 4.2% compensation for assessment risk provision for North Carolina property insurance?

A. Yes. The Rate Bureau has become aware that some reinsurance contracts provide coverage for residual market assessments, including the potential non-recoupable assessments from the Beach Plan and FAIR Plan. As a result, it is possible that the reinsurance contracts purchased by North Carolina property insurance companies may include some coverage for assessments such that the exposure to Beach Plan and/or FAIR Plan assessments is no longer fully retained by the primary carrier. Given this information and the information that not all companies buy reinsurance that includes coverage for residual market assessments, the Rate Bureau made the assumption that 50% of the North Carolina property insurance companies' exposure to assessments from the Beach Plan and/or FAIR Plan is retained by the companies.

As a result, we multiplied this expected 50% market share by the 4.2% full compensation for assessment risk provision to determine an overall compensation for assessment risk provision of 2.1%.

Q. In your opinion, is it appropriate to include a 2.1% provision for the compensation for assessment risk in dwelling insurance rates in North Carolina?

A. Yes. Insurance companies writing dwelling policies in North Carolina are exposed to the risk of Beach Plan and FAIR Plan assessments as a result of writing voluntary market property insurance in the state. Those insurance companies are entitled to receive fair compensation for bearing that risk, and it is appropriate to include that compensation in the dwelling rates. The compensation for assessment risk methodology we used here relies on a widely accepted measure of compensation to determine a provision that will fairly compensate insurers for bearing this additional risk to their capital. Moreover, the North Carolina statutes provide that prospective exposure to non-recoupable assessments shall be considered as an appropriate factor in the making of rates by the Rate Bureau.

Q. Are you aware that the North Carolina statutes increased the Beach Plan's coverage limits in late 2023?

A. Yes, I am aware that the Beach Plan's coverage limits were increased then from $750,000 to $1 million on habitational property, from $3 million to $4 million on commercial property, and from $6 million to $10 million on structures with multiple firewall divisions.

Q. Do you have an opinion on how these new coverage limits on Beach Plan policies would impact the hurricane, net cost of reinsurance, and compensation for assessment risk provisions in this Dwelling filing?

A. The new coverage limits on Beach Plan policies could potentially increase the exposure in the Beach Plan and increase the compensation for assessment risk provision. This stems from two potential exposure changes: 1) more policies will be eligible for coverage in the Beach Plan and these policies may move from the voluntary market to the Beach Plan; and 2) some Beach Plan existing policies that were capped at the previous limits are now eligible for a higher coverage limit. The magnitude of the potential increases of the filing's hurricane loss provision and net cost of reinsurance provision depends on how policies shift from the voluntary market to the Beach Plan and the number of limit policies in the Beach Plan.

Q. Do you have an opinion on whether NCRB should make any adjustments to this filing to account for the increase in the Beach Plan coverage limits?

A. It is unclear how many policies in the Beach Plan will be subject to the new limits, and it is likewise unclear whether and how many additional policies would be written by the Beach Plan due to the higher coverage limits. It is also unclear how the Beach Plan's PML and reinsurance program will be impacted by the higher coverage limits. Therefore, the impact of the higher coverage limits is not quantifiable at this time. Currently, I don't recommend any adjustments to this filing to account for the higher coverage limits in the Beach Plan.

Q. Does that conclude your testimony?

A. Yes.

Minchong Mao, FCAS, CCRMP, MAAA, Actuary

Reinsurance Solutions, Aon plc
200 E Randolph Street
Chicago, IL 60601
Phone: 312-381-2009(O) 312-581-7425 (C)
Email: minchong.mao@aon.com

Summary

- Over twenty years of experience with insurance, reinsurance, catastrophe risk management , actuarial pricing and management at State Farm Insurance Companies and Aon plc
- Commission Member, actuary representing the property insurance industry on the Florida Commission on Hurricane Loss Projection Methodology (FCHLPM) 2015-2018
- Strong leadership, work ethic, communication and teamwork skills
- Deep knowledge and experience in Insurance operations, including Actuary, Underwriting, and Claims.
- Extensive experience and understanding with catastrophe models, underlying science and methodologies

Experience

Senior Managing Director, Actuary
Aon Reinsurance Solutions
April 2021– Present

Managing Director, Actuary
Aon Reinsurance Solutions
September 2018– April 2021

Major Responsibilities include:

- Manage the catastrophe actuarial and predictive analytics group within Aon Reinsurance Solutions which focuses on supporting Aon clients' ratemaking and underwriting needs.
- Implement and sign off Aon's ASOP 38 compliance framework.
- Provide rate filing support for Aon's clients through regulatory challenges.
- Serve on Impact Forecasting leadership steering committee to oversee Impact Forecasting's product strategies and priorities.
- Serve as Aon Impact Forecasting's signatory actuary during Florida Commission on Hurricane Loss Projection Methodology submissions.
- Manage Homeowner Return on Equity (ROE) Outlook study. Aon's Homeowners ROE Outlook calculates risk-adjusted returns for the US homeowners industry, provides the insurance industry with market reality diagnostics and profitability insights.
- Manage Residual Market Industry study. This product provides a holistic view of the residual market's impact on the property insurance industry and the individual company's risk profile.
- Serve as Aon's key corporate contact for China business development and expansion.

Catastrophe Modeling Manager, Actuary
State Farm Insurance Companies
Feb. 2005– Sept. 2018
Major Responsibilities included:

- Manage State Farm's catastrophe modeling unit. State Farm's catastrophe modeling practice grew into the industry's leading practice with high quality and productivity under my leadership.
- Manage vendor relationships with AIR, EQECAT, ARA, and RMS. Negotiate contract terms and conditions, engage vendors' support through regulatory challenges.
- Provide Actuarial opinions on State Farm's use of catastrophe models. Oversee the due diligence and model validation work to ensure catastrophe modeling practices at State Farm meet the Actuarial Standards and comply with laws and regulatory requirements.
- Serve as a resource to the Corporate Law department for litigation and legislative issues.
- Provide various catastrophe risk measures and analytics (PML, TVaR, Standard Deviations, etc.) for State Farm Fire and Affiliates for exposure management and reinsurance purposes.
- Provide catastrophe information to rating agencies such as AM Best, S&P and Moody's.
- Develop and deploy hazard analysis tools across the Enterprise for exposure underwriting and management.
- Utilize catastrophe data in Dynamic Financial Analysis projects to analyze capital adequacy and capital allocation; develop simulation tools to incorporate catastrophe risk into Enterprise Risk Management.
- Provide exposure information, technical support, risk analysis and documentation reviews for all State Farm's issuances of catastrophe bonds.
- Lead State Farm's compliance work to meet Office of the Superintendent of Financial Institutions (OSFI) B-9 - Earthquake Sound Practice requirements.
- Monitor modeling regulations in several jurisdictions (FL, LA, SC, HI, MD, etc.). Work with State Farm counsel to provide revisions to bills related to coastal issues and catastrophe risk management during legislative sessions.
- Represent the Actuarial department on State Farm Enterprise Catastrophe Response Team. Provide real time analysis for actual catastrophe events to assist Catastrophe Claims' resources deployment, Catastrophe Reserving and communicate with Senior Management about the potential impact.
- Serve as a homeowner pricing manager for Mississippi for two years, with major responsibilities including:
    - Manage the development and implementation of rates and rules for several personal lines which satisfy the financial objectives of the enterprise.
    - Coordinate the analyses of actuarial ratemaking process
    - Review rate proposals.
    - Serve as a key Actuarial resource for Market Areas and regulators.

Actuarial/Statistics/Modeling Analyst
Jan 2001– Feb. 2005

- Conducted homeowner rate revisions for Maine, Kansas, and Mississippi.
- Developed and maintained State Farm's rate revision tool for property lines.

Other Professional Activities

- 2015 – 2018, Commission Member, Industry Actuary, Florida Commission on

Hurricane Loss Projection Methodology (FCHLPM). I was appointed by Florida CFO Jeff Atwater to this position in Jan. 2015.

- 2010 – 2013, advisory group member to the Insurance Bureau of Canada (IBC) and Office of the Superintendent of Financial Institutions (OSFI) to provide expert opinions on a study for insurance and economic impact of major earthquakes in Canada.
- 2011- 2013, advisory group member for the Insurance Bureau of Canada (IBC) and Office of the Superintendent of Financial Institutions (OSFI) to revise OSFI Guideline B-9 (Earthquake Exposure Management Sound Practice Guideline for insurance companies).
- 2012-2016, organized nine State Farm senior executives delegation (including State Farm's CEO, COO, CFO, CMO, General Counsel, CTO, CSO) visits to China. Established relationship and set up meetings with Chinese regulators and senior executives of top Chinese insurance companies. Participated in discussions, served as advisor and interpreter for State Farm delegations.
- 2012-2018, visiting instructor for Illinois State University Math Department Actuarial Science program. Present catastrophe modeling and regularity topics to actuarial graduate students.
- 2014- 2018, board member of the International Society of Catastrophe Managers (ISCM). Promote education and career development for Catastrophe Modeling professionals.
- 2016- Present, co-chair of a taskforce to create a credential and certificate program for catastrophe risk management professionals on behalf of Institute of Casualty Actuarial Society (iCAS) and International Society of Catastrophe Managers (ISCM).
- 2016- 2023, Member of Property /Casualty Extreme Events Committee, American Academy of Actuaries. This committee identifies issues relevant to the treatment of extreme catastrophe risks including sizing, insurability, pricing, funding, reserving, capital management, and loss mitigation. The committee also monitors federal and state catastrophe legislation and interacts with NAIC on these issues.
- 2016 – 2018, member of planning committee for the Reinsurance Association of America's annual catastrophe modeling conference.
- 2016 – Present, member of CAS Climate Change Committee. This committee recommends, supports and performs research on climate change and assesses the potential risk management implications for the insurance industry.
- 2023, I was invited to participate in the Insurance, Climate and AI forum at the Kennedy School of Government, Harvard University. The forum was initiated by President Obama's advisor on Science and Technology, Dr. Daniel Schrag. I provided key insights from insurance perspectives during the forum.

Designations

- Fellow of Casualty Actuarial Society (FCAS, 2007)
- Certified Catastrophe Risk Management Professional (CCRMP, 2019)
- Associate of Society of Actuaries (ASA, 2010) Currently, I am not an active member at SOA.
- Member of American Academy of Actuaries (MAAA,2005)
- Microsoft Certified Solution Developer (MCSD)
- Microsoft Certified Professional (MCP)

Education

- Master's degree in Computer Science, University of Missouri-Columbia, 2000
- Master's degree in Chemistry, Eastern Illinois University, 1997

- Bachelor's degree in Chemical Engineering, Beijing University of Chemical Technology, 1993

Award

- Special Achievement awards for excellent performance and exceptional business achievements, Property and Casualty Actuarial Department, State Farm Insurance in 2002, 2009, 2011, 2012, 2014, 2015, and 2016.
- Casualty Actuarial Society (CAS) Above and Beyond Achievement Award in 2019 to recognize my leadership role to establish Certified Catastrophe Risk Management Professional (CCRMP) designation for CAS Institute. The "Above & Beyond Achievement Award" is made annually, to one or more members of the CAS, who have made extraordinary contributions to the society.

Publications

- As a member of the American Academy of Actuaries Flood Working Group, I am one of the authors for the Monograph on Issues Surrounding National Flood Insurance Program - The National Flood Insurance Program: Challenges and Solutions. *American Academy of Actuaries*, April, 2017
- Akram Hazeen, Yan Zhang, **Minchong Mao**, Kraig A. Wheeler,a and Mark E. McGuire, 6-[(4-Hy-droxy-phen-yl)diazenyl]-1,10-phenanthrolin-1-ium chloride monohydrate, *US National Library of Medicine, National Institutes of Health (NIH)*, Dec. 1, 2011.
- As a member of the American Academy of Actuaries Flood Working Group, I am one of the authors of the following Monographs:

The National Flood Insurance Program: Challenges and Solutions (2017) American Academy of Actuaries, April, 2017

Uses of Catastrophe Model Output (2018). American Academy of Actuaries, July, 2018

Wildfire: An Issue Paper - Lessons Learned from the 2017–2018 California Events (2019), American Academy of Actuaries, June, 2019

Reference

- Available upon request.

North Carolina Rate Bureau
Gross Modeled Hurricane Expected Losses including Cat LAE

Territory	Total Hurricane Loss
110	24,529,593
120	28,217,582
130	3,204,732
140	28,736,436
150	6,136,751
160	7,346,539
170	372,545
180	4,225,301
190	2,315,771
200	1,324,532
210	1,088,493
220	3,532,634
230	2,328,010
240	2,565,721
250	1,507,051
260	642,399
270	2,892,720
280	439,838
290	623,093
300	469,576
310	1,606,904
320	956,974
330	49,121
340	1,813,712
350	575,274
360	767,420
370	32,279
380	82,971
390	67,684
Total	128,451,657

Modeled hurricane expected losses for North Carolina Rate Bureau, net of limits and deductibles. Results include demand surge and exclude storm surge. Losses represent 50/50 blend of AIRv12 100k Standard event set and RMSv23 Historical event set. Results also include provisions for LAE.

North Carolina Rate Bureau
Gross Modeled Hurricane Expected Losses including Cat LAE

Territory	Policy Form 1	Policy Form 2	Total Hurricane Losses
110	1,516,972	23,012,621	24,529,593
120	4,807,913	23,409,669	28,217,582
130	1,094,205	2,110,527	3,204,732
140	9,100,733	19,635,703	28,736,436
150	2,344,145	3,792,606	6,136,751
160	2,154,691	5,191,848	7,346,539
170	180,654	191,891	372,545
180	1,851,652	2,373,649	4,225,301
190	1,197,341	1,118,430	2,315,771
200	848,445	476,088	1,324,532
210	481,290	607,204	1,088,493
220	1,123,974	2,408,660	3,532,634
230	1,708,893	619,117	2,328,010
240	1,173,382	1,392,338	2,565,721
250	636,799	870,252	1,507,051
260	324,986	317,413	642,399
270	304,762	2,587,958	2,892,720
280	131,643	308,195	439,838
290	208,153	414,940	623,093
300	301,358	168,218	469,576
310	468,342	1,138,563	1,606,904
320	343,994	612,980	956,974
330	28,214	20,907	49,121
340	383,418	1,430,294	1,813,712
350	203,437	371,837	575,274
360	304,831	462,589	767,420
370	16,352	15,927	32,279
380	33,666	49,305	82,971
390	28,614	39,070	67,684
Total	33,302,858	95,148,799	128,451,657

Modeled hurricane expected losses for North Carolina Rate Bureau, net of limits and deductibles. Results include demand surge and exclude storm surge. Losses represent 50/50 blend of AIRv12 100k Standard event set and RMSv23 Historical event set. Results also include provisions for LAE.

ACTUARIAL STANDARDS BOARD

Actuarial Standard
of Practice
No. 38

Revised Edition

Catastrophe Modeling
(for All Practice Areas)

Developed by the
Catastrophe Modeling Task Force of the
General Committee of the
Actuarial Standards Board

Adopted by the
Actuarial Standards Board
July 2021

Doc. No. 201

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APPENDIXES

July 2021

TO: Members of Actuarial Organizations Governed by the Standards of Practice of the Actuarial Standards Board and Other Persons Interested in Catastrophe Modeling (for All Practice Areas)

FROM: Actuarial Standards Board (ASB)

SUBJ: Actuarial Standard of Practice (ASOP) No. 38

This document contains the revision of ASOP No. 38, *Catastrophe Modeling (for All Practice Areas)*.

History of the Standard

The ASB first began work on a standard for modeling in the late 1990s. Motivated primarily to address the role catastrophe modeling of earthquakes and hurricanes played in casualty ratemaking, this work was focused on the use of specialized models where the actuary would have to rely on a model that was developed by professionals other than actuaries. As a result of this work, the ASB approved ASOP No. 38, *Using Models Outside the Actuary's Area of Expertise*, in June 2000 with the scope of the standard limited to the Property/Casualty area of practice. At the time, this was the only ASOP that specifically addresses modeling.

Over the ensuing years, the number and importance of modeling applications in actuarial science has increased, with the results of actuarial models often entering financial statements directly. Recognizing this trend, the ASB asked the Life Committee in 2010 to begin work on an ASOP focused on modeling. The Life Committee formed a task force to address this issue and, in February 2012, a discussion draft titled *Modeling in Life Insurance and Annuities* was released. Nineteen comment letters were received.

Based upon this feedback and numerous other discussions on the topic of modeling, in December 2012 the ASB created two multidisciplinary task forces under the direction of the General Committee: i) a general Modeling Task Force, charged with developing an ASOP to address modeling applications in all practice areas, and ii) a Task Force to consider expanding ASOP No. 38 to all practice areas while focusing exclusively on using catastrophe models.

An exposure draft titled *Modeling* was released in June 2013 with a scope that provides guidance to actuaries when selecting, designing, building, modifying, developing, or using models when performing actuarial services. ASOP No. 56, *Modeling*, was adopted by the ASB in December 2019. Changes have been made to this exposure draft of ASOP No. 38 to be consistent with ASOP No. 56 and other recent ASOPs.

The exposure draft of this revision of ASOP No. 38 was the work of the Catastrophe Modeling Task Force, whose membership has experience in life insurance, health insurance, property/casualty insurance, and enterprise risk management.

At the direction of the ASB, this standard was developed to apply to all practice areas and all forms of catastrophe models, including natural catastrophes such as hurricanes, earthquakes, and severe convective storms, and other catastrophes such as terrorist acts and pandemics.

Exposure Draft

The exposure draft was approved in September 2020 with a comment deadline of January 15, 2021. Four comment letters were received and considered in making changes that were reflected in the final ASOP.

Notable Changes from the Exposure Draft

Notable changes made to the exposure draft are summarized below. Additional changes were made to improve readability, clarity, or consistency.

1. Section 1.2, Scope, was revised to provide additional guidance to actuaries whose actuarial services involve reviewing or evaluating models.

2. In section 2, Definitions, the definition of "catastrophe model" was expanded to include a definition of model.

3. Section 3.2, Appropriate Reliance on Experts (now titled Catastrophe Models Developed by Experts), was revised to adopt language from ASOP No. 56, section 3.5(b).

4. An existing ASOP No. 38 example regarding validation to evaluate results derived from other models was reinserted into section 3.5.

5. A disclosure requirement for the extent of reliance on experts was added to section 4.1(b) and (c).

Notable Changes from the Existing ASOP

A cumulative summary of the notable changes from the existing ASOP are summarized below. Notable changes do not include additional changes made to improve readability, clarity, or consistency.

1. The ASOP was revised to apply to catastrophe models only and to all practice areas.

2. The scope was expanded to include the activities "selecting, reviewing, and evaluating" models in addition to the existing activity of "using" a model when performing actuarial services.

3. The scope was expanded to clarify that if the actuary determines that the guidance in the ASOP conflicts with the guidance in ASOP No. 56, the guidance of this ASOP will govern.

4. A new section specifically addressing reliance on data or other information supplied by others (section 3.8) was added.

5. The guidance on documentation (section 3.9) was updated and expanded to be consistent with current ASOPs.

The ASB thanks everyone who took the time to contribute comments and suggestions on the exposure draft.

The ASB would like to posthumously thank Martin M. Simons for his contribution to the ASOP No. 38 task force.

The ASB voted in July 2021 to adopt this standard.

Catastrophe Modeling Task Force

Shawna S. Ackerman, Chairperson
David A. Brentlinger
Bradley J. Davis

General Committee of the ASB

Susan E. Pantely, Chairperson
Geoff Bridges
Andrew M. Erman
Julianne H. Fried
Robert S. Miccolis
Brian J. Mullen
Keith A. Passwater
Hal Tepfer
Christian J. Wolfe

Actuarial Standards Board

Darrell D. Knapp, Chairperson
Elizabeth K. Brill
Robert M. Damler
Kevin M. Dyke
David E. Neve
Cande J. Olsen
Kathleen A. Riley
Judy K. Stromback
Patrick B. Woods

The Actuarial Standards Board (ASB) sets standards for appropriate actuarial practice in the United States through the development and promulgation of Actuarial Standards of Practice (ASOPs). These ASOPs describe the procedures an actuary should follow when performing actuarial services and identify what the actuary should disclose when communicating the results of those services.

ACTUARIAL STANDARD OF PRACTICE NO. 38

CATASTROPHE MODELING (FOR ALL PRACTICE AREAS)

STANDARD OF PRACTICE

Section 1. Purpose, Scope, Cross References, and Effective Date

1.1 Purpose—This actuarial standard of practice (ASOP or standard) provides guidance to actuaries when performing actuarial services with respect to selecting, using, reviewing, or evaluating **catastrophe models**.

1.2 Scope—This ASOP applies to actuaries in any practice area when performing actuarial services with respect to selecting, using, reviewing, or evaluating **catastrophe models** to assess risk, including but not limited to **models** of hurricanes, earthquakes, severe convective storms, terrorist acts, and pandemics. This standard applies to the selection, use, review, or evaluation of **catastrophe models**, whether or not they are proprietary in nature.

If the actuary's actuarial services involve reviewing or evaluating **catastrophe models**, the reviewing or evaluating actuary should apply the guidance in this standard to the extent practicable within the scope of the actuary's assignment.

In addition to this standard, the actuary should follow the guidance in ASOP No. 56, *Modeling*, when selecting, using, reviewing, or evaluating **catastrophe models**. If the actuary determines that the guidance in this ASOP conflicts with the guidance in ASOP No. 56, the guidance of this ASOP will govern.

This standard does not apply to **models** of operational risks. This standard also does not apply to **models** of economic risks that deal with instances of extreme events such as hyper-inflation or a stock market collapse.

This standard also does not apply when the actuary is only designing, developing, or modifying a **catastrophe model** (or a portion of a **catastrophe model**).

If the actuary departs from the guidance set forth in this ASOP in order to comply with applicable law (statutes, regulations, and other legally binding authority), or for any other reason, the actuary should refer to section 4. If a conflict exists between this standard and applicable law, the actuary should comply with applicable law.

1.3 Cross References—When this ASOP refers to the provisions of other documents, the reference includes the referenced documents as they may be amended or restated in the future, and any successor to them, by whatever name called. If any amended or restated document differs materially from the originally referenced document, the actuary should consider the guidance in this ASOP to the extent it is applicable and appropriate.

1.4 Effective Date—This standard is effective for work performed on or after December 1, 2021.

Section 2. Definitions

The terms below are defined for use in this actuarial standard of practice and appear in bold throughout the ASOP.

2.1 Assumption—A type of explicit **input** to a **catastrophe model** that is derived from **data**, represents possibilities based on professional judgment, or may be prescribed by law or others. When derived from **data**, an **assumption** may be statistical, financial, economic, mathematical, or scientific in nature, and may be described as a **parameter**.

2.2 Catastrophe Model—A **model** of low-frequency events with high-severity or widespread potential effects. **Catastrophe models** may be used to explain a system, to study effects of different components, or to derive estimates.

2.3 Data—Facts or information that are either direct **input** to a **catastrophe model** or inform the selection of **input. Data** may be collected from sources such as records, experience, experiments, surveys, observations, benefit plan or policy provisions, or **output** from other **models**.

2.4 Expert—One who is qualified by knowledge, skill, experience, training, or education to render an opinion concerning the matter at hand.

2.5 Input—**Data** or **assumptions** used in a **catastrophe model** to produce **output**.

2.6 Intended Purpose—The goal or question, whether generalized or specific, addressed by the **catastrophe model** within the context of the assignment.

2.7 Model—A simplified representation of relationships among real world variables, entities, or events using statistical, financial, economic, mathematical, non-quantitative, or scientific concepts and equations. A **model** consists of three components: an information **input** component, which delivers **data** and **assumptions** to the **model**; a processing

component, which transforms **input** into **output**; and a results component, which translates the **output** into useful business information.

2.8 Output—The results of the **catastrophe model** including, but not limited to, point estimates, likely or possible ranges, and **data** or **assumptions** (as **input** for other **models**), behavioral expectations, or qualitative criteria on which decisions could be based.

2.9 Parameter—A type of statistical, financial, economic, mathematical, or scientific value that is used as **input** to **catastrophe models**. Examples of **parameters** include expected values in probability distributions and coefficients of formula variables.

Section 3. Analysis of Issues and Recommended Practices

3.1 Introduction—In performing actuarial services, the actuary may find it appropriate to select, use, review, or evaluate **catastrophe models**. When selecting, using, reviewing or evaluating a **catastrophe model**, the actuary should do the following:

a. determine the appropriate level of reliance on **experts**;

b. have a basic understanding of the **catastrophe model**;

c. evaluate whether the **catastrophe model** is appropriate for the **intended purpose**;

d. determine that appropriate validation of the **catastrophe model** and **output** has occurred; and

e. determine the appropriate use of the **catastrophe model** and **output**.

The actuary's level of effort in understanding and evaluating a **catastrophe model** should be consistent with the **intended purpose** and the **catastrophe model output's** materiality to the results of the actuarial analysis.

3.2 Catastrophe Models Developed by Experts—When selecting, using, reviewing, or evaluating a **catastrophe model** developed by **experts**, the actuary should take into account the following:

a. whether the individual or individuals who developed the **catastrophe model** are **experts** in the applicable field;

b. the extent to which the **catastrophe model** has been reviewed or validated by **experts** in the applicable field, including known differences of opinion among

experts concerning aspects of the **catastrophe model** that could be material to the actuary's use of the **catastrophe model**; and

c. whether there are industry or regulatory standards that apply to the **catastrophe model** or to the testing or validation of the **catastrophe model**, and whether the **catastrophe model** has been certified as having met such standards.

The actuary may rely on **experts** in the applicable field in the evaluation of items in section 3.2(a)-(c) and should disclose the extent of such reliance.

3.3 Understanding of the Catastrophe Model—The actuary should be familiar with the basic components of the **catastrophe model** and understand both the user **input** and the **catastrophe model output**, as discussed below.

3.3.1 Catastrophe Model Components—The actuary should be familiar with the basic components of the **catastrophe model** and have an understanding of how such components interrelate within the **catastrophe model**. In addition, the actuary should identify which fields of expertise were used in developing or updating the **catastrophe model** and should make a reasonable effort to determine if the **catastrophe model** is based on generally accepted practices within the applicable fields of expertise. The actuary should also be familiar with how the **catastrophe model** was tested or validated and the level of independent **expert** review and testing.

3.3.2 User Input—The actuary should take reasonable steps to confirm that the precision and accuracy of the user **input** are consistent with the **intended purpose** and should refer, as applicable, to ASOP No. 23, *Data Quality*, when selecting, using, or evaluating **data** used in the **catastrophe model**. Certain user **input** may be required to produce **catastrophe model output** for the specific application. User **input** can include **assumptions** or **data**. If the **catastrophe model** requires user **input**, the actuary should evaluate the reasonableness of the user **input** and should have an understanding of the relationship between the user **input** and **catastrophe model output**.

3.3.3 Catastrophe Model Output—The actuary should determine that the **catastrophe model output** is consistent with the **intended purpose**.

3.4 Appropriateness of the Catastrophe Model for the Intended Purpose—The actuary should evaluate whether the **catastrophe model** is appropriate for the **intended purpose** and take into account the following:

3.4.1. Applicability of Historical Data—To the extent historical **data** are used in the development of the **catastrophe model** or the establishment of **catastrophe model parameters**, the actuary should take into account the adequacy of the historical **data** in representing the range of reasonably expected outcomes consistent with current knowledge about the phenomena being analyzed.

3.4.2. Developments in Relevant Fields—The actuary should make a reasonable effort to be aware of significant developments in relevant fields of expertise that are likely to materially affect the **catastrophe model**.

3.5 Output Validation— The actuary should validate that the **output** reasonably represents that which is being modeled. Depending on the **intended purpose**, **output** validation may include the following:

a. comparing **output** to those of an alternative **model(s)**, where appropriate;

b. comparing the **output** produced by the **catastrophe model** with historical observations, if applicable;

c. comparing the consistency and reasonableness of relationships within the **output**; and

d. evaluating the reasonableness of changes in the **output** due to variations in the user **input**.

3.6 Appropriate Use of the Catastrophe Model and Output—The actuary should evaluate the reasonableness of the **catastrophe model output**, considering the **input** and the **intended purpose**. The actuary should take into account the limitations of the **catastrophe model** and use professional judgment to determine whether it is appropriate to use the **catastrophe model output**. The actuary should also use professional judgment to determine whether any adjustments to the **catastrophe model output** are needed to meet the **intended purpose**. The actuary should disclose any such adjustments in accordance with section 4.1.

3.7 Reliance on Another Actuary—The actuary may rely on another actuary who has selected, used, reviewed, or evaluated the **catastrophe model**. However, the relying actuary should be reasonably satisfied that the other actuary is qualified to select, use, review, or evaluate the **catastrophe model** in accordance with applicable ASOPs, and the **catastrophe model** is appropriate for the **intended purpose**. The actuary should disclose the extent of any such reliance.

3.8 Reliance on Data or Other Information Supplied by Others—When relying on **data** or other information supplied by others, the actuary should refer to ASOP No. 23 and ASOP No. 41, *Actuarial Communications*, for guidance.

3.9 Documentation—The actuary should consider preparing and retaining documentation to support compliance with the requirements of section 3 and the disclosure requirements of section 4. If preparing documentation, the actuary should prepare such documentation in a form such that another actuary qualified in the same practice area could assess the reasonableness of the actuary's work and should document the steps taken to comply with this standard in light of proprietary aspects of the **catastrophe model**, if any. The degree of such documentation should be based on the professional judgment of the actuary and may vary with the complexity and purpose of the actuarial services. In addition, the actuary should refer to ASOP No. 41 for guidance related to the retention of file material other than that which is to be disclosed under section 4.

Section 4. Communications and Disclosures

4.1 Required Disclosures in an Actuarial Report—When issuing an actuarial report to which this standard applies, the actuary should refer to ASOP Nos. 23, 41, and 56. In addition, the actuary should disclose the following in such actuarial reports, as appropriate:

a. the **catastrophe model** used and the **intended purpose**;

b. the methodology used to validate the **catastrophe model** developed by **experts** (see section 3.2);

c. the extent of reliance on **experts** (see section 3.2);

d. a description of the user **input** that was incorporated into the **catastrophe model** (see section 3.3.2);

e. a description of adjustments made to the **catastrophe model output** (see section 3.6); and

f. the extent of any reliance placed upon the work of another actuary (see section 3.7).

4.2 Additional Disclosures in an Actuarial Report—The actuary also should include disclosures in accordance with ASOP No. 41 in an actuarial report for the following circumstances:

a. if any material **assumption** or method was prescribed by applicable law;

b. if the actuary states reliance on other sources and thereby disclaims responsibility for any material **assumption** or method selected by a party other than the actuary; and

c. if in the actuary's professional judgment, the actuary has deviated materially from the guidance of this ASOP.

4.3 Confidential Information—Nothing in this ASOP is intended to require the actuary to disclose confidential information.

Appendix 8

Background and Current Practices

Note: This appendix is provided for informational purposes and is not part of the standard of practice.

Background

Hurricane Andrew in 1992 and the Northridge Earthquake in 1994 led actuaries involved in evaluating hurricane and earthquake exposures to recognize the severe inadequacy of the traditional, empirical actuarial methods used for ratemaking for these exposures. Recognizing the need to replace these methods, many actuaries began using stochastic computer simulation models for their actuarial analysis of hurricane and earthquake exposure. Computer simulation models had been commonly used for some time by actuaries and others for the purpose of evaluating probable maximum loss but had not been widely used for ratemaking.

Over time, the output from catastrophe models became commonly used by property/casualty actuaries in developing rates for catastrophic perils as well as many other risk management purposes.

Current Practices

Catastrophe models are now widely used by actuaries in all practice areas for risk management analyses and calculating expected losses due to hurricanes, earthquakes, and terrorist acts. More recently, catastrophe models have also been developed to simulate wildfires, severe convective storms, tsunamis, and pandemics.

In addition, due to changes in regulations and financial reporting requirements, the number and importance of modeling applications in actuarial science has increased, with the results of actuarial models often entering financial statements directly.

Lastly, due to the evolution of enterprise risk management (ERM) practices and regulations, there has been increased use of catastrophe modeling as part of insurer stress testing and risk management across all practice areas. This trend is likely to continue to evolve and heighten in light of the emergence of the novel coronavirus and the COVID-19 pandemic.

Appendix 2

Comments on the Exposure Draft and Responses

The exposure draft of the proposed revision of ASOP No. 38, *Catastrophe Modeling (for All Practice Areas)*, was issued in September 2020 with a comment deadline of January 15, 2021. Four comment letters were received, some of which were submitted on behalf of multiple commentators, such as by firms or committees. For purposes of this appendix, the term "commentator" may refer to more than one person associated with a particular comment letter. The ASOP No. 38 Task Force carefully considered all comments received, and the ASB reviewed (and modified, where appropriate) the changes proposed by the ASOP No. 38 Task Force and the ASB General Committee.

Summarized below are the significant issues and questions contained in the comment letters and the responses. Minor wording or punctuation changes that were suggested but not significant are not reflected in the appendix, although they may have been adopted.

The term "reviewers" in appendix 2 includes the ASOP No. 38 Task Force, the ASB General Committee, and the ASB. Also, the section numbers and titles used in appendix 2 refer to those in the exposure draft, which are then cross referenced with those in the final ASOP.

SECTION 1. PURPOSE, SCOPE, CROSS REFERENCES, AND EFFECTIVE DATE	
Section 1.2, Scope	
Comment	One commentator requested a clearer definition of what is excluded from the scope of ASOP No. 38, noting that catastrophe models can be used to infer economic impacts beyond direct claims and that novel catastrophic perils may fall into a gray area in which ASOP No. 38 may or may not apply.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment. The reviewers note that section 1.2 does not limit the reason why a catastrophe model is used to perform actuarial services or whether the catastrophe model is a mature or novel catastrophe model.
Comment	One commentator suggested that section 1.2 should state that the guidance in the standard applies to the extent practicable within the scope of the actuary's assignment when the actuary is reviewing or evaluating a catastrophe model.
Response	The reviewers agree and made the change.
Comment	One commentator suggested that "review or evaluation" be removed from the scope of the standard or alternatively that the scope be changed to exclude an actuary performing a regulatory review.
Response	The reviewers believe the revised guidance is appropriate and made no change in response to this comment.

Comment	One commentator recommended that section 1.2 should state that the application of the standard be based on the actuary's professional judgement as to the materiality of the model output for the intended user.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment. The reviewers note that section 3.1 addresses materiality.
Comment	One commentator recommended that section 1.2 should state that the guidance in the standard applies only to the extent of the actuary's responsibilities and adopt the language from ASOP No. 56 section 1.2.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment.
Comment	One commentator suggested that the scope of the standard be expanded to include elements similar to ASOP No. 56.
Response	The reviewers believe the revised guidance is appropriate and made no change in response to this comment.
Comment	Several commentators questioned what constituted a conflict between ASOP No. 38 and ASOP No. 56 versus what constituted a difference and asked how potential conflicts are meant to be resolved.
Response	The reviewers believe the revised guidance is appropriate and made no change in response to this comment. The reviewers note that ASOP No. 1, *Introductory Standard of Practice*, section 4.4, states, "When an actuary believes that multiple ASOPs have conflicting provisions when applied to a specific situation and none provide explicit guidance concerning which governs, the actuary should apply professional judgment and may wish to contact the ABCD for confidential guidance on appropriate practice."
SECTION 2. DEFINITIONS	
Section 2.2, Catastrophe Model	
Comment	Two commentators suggested clarifying the definition of catastrophe model.
Response	The reviewers agree and made changes similar to those suggested by the commentators to improve clarity.
Comment	One commentator suggested a definition for "model" be added to ASOP No. 38.
Response	The reviewers agree and made the change.
SECTION 3. ANALYSIS OF ISSUES AND RECOMMENDED PRACTICES	
Section 3.1, Introduction	
Comment	One commentator suggested that the use of the term "validation" used in sections 3.1(d) and 3.5 be clarified to distinguish if the terms are being used differently.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment. The reviewers note section 3.1 introduces validation and section 3.5 provides details on the validation of catastrophe model output.

Section 3.2, Appropriate Reliance on Experts (now titled Catastrophe Models Developed by Experts)	
Comment	One commentator recommended changing "should consider" to "may consider" regarding the appropriate level of reliance on experts to be consistent with the corresponding language in ASOP No. 56, section 3.5.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment.
Comment	One commentator recommended changing the language in section 3.2(b) to mirror ASOP No. 56, section 3.5(b).
Response	The reviewers agree and made the change.
Comment	One commentator noted that this section, does not include the language of ASOP No. 56, section 3.5(d), which considers whether the science underlying the expertise is likely to produce useful models for the intended purpose.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment.
Comment	One commentator recommended that ASOP No. 38 be expanded to require disclosure of reliance on experts.
Response	The reviewers agree and made the change.
Comment	One commentator suggested that the ASOP be expanded to explicitly allow reliance on an expert to select, use, review, or evaluate the catastrophe model.
Response	The reviewers believe the guidance is appropriate and consistent with the suggestion, and made no change in response to this comment.
Section 3.5, Appropriate Validation (now titled Output Validation)	
Comment	One commentator requested that results derived from alternate models or methods, where available and appropriate, which is part of current ASOP No. 38, be added.
Response	The reviewers partially agree and modified the language.
Section 3.7, Reliance on Another Actuary	
Comment	One commentator suggested that ASOP No. 56 be added to the requirements for reliance on another actuary.
Response	The reviewers believe the revised guidance is appropriate and made no change in response to this comment.

Statement of Compliance with Actuarial Standard of Practice 38
Minchong Mao, FCAS, MAAA

Background

Actuarial Standard of Practice 38 provides guidance to the actuary in using models that incorporate specialized knowledge outside the actuary's own area of expertise when developing an actuarial work product. When using such a model, the standard requires that the actuary perform five specific tasks, as described below using the numbering system of the standard. This document certifies that Minchong Mao, FCAS, MAAA, has performed these tasks for the catastrophe loss model(s) relied upon in the actuarial work product to which it is attached. It is intended that actuaries utilizing the actuarial work product in their insurance ratemaking efforts can rely on my model evaluation in accordance with Section 3.7 of the standard of practice. In July 2021, Actuarial Standards Board(ASB) adopted revision of ASOP No. 38. This document reflected the most current requirements in the 2021 revision.

Model Versions Covered by this document

- AIR Hurricane model for the United States implemented in Touchstone versions 2023(a.k.a. TS V11.5) and Touchstone Version 2024 (a.k.a. TS V12)
- AIR Severe Thunderstorm Model for the United States implemented in Touchstone version 10, released in 2022, and Touchstone V11, V11.5 and V12
- AIR Winter Storm Model for the United States v1.5 implemented in Touchstone version 5, 6, 7, 8, 9,10, 11,11.5,12 and later
- AIR Wildfire Model for the United States v4 implemented in Touchstone version 12
- AIR Earthquake and Fire Following Model for the United States v10.1 implemented in Touchstone version 6, 7, 8, 9,10,11,11.5, 12 and later and later. This version included Time Dependent Earthquake Hazard Adjustment.

3.2 Appropriate Reliance on Experts

Catastrophe Models Developed by Experts—When selecting, using, reviewing, or evaluating a catastrophe model developed by experts, the actuary should take into account the following:

a. whether the individual or individuals who developed the catastrophe model are experts in the applicable field;

b. the extent to which the catastrophe model has been reviewed or validated by experts concerning aspects of the catastrophe model that could be material to the actuary's use of the catastrophe model; and

c. whether there are industry or regulatory standards that apply to the catastrophe model or to the testing or validation of the catastrophe model, and whether the catastrophe model has been certified as having met such standards.

For those aspects of the model that are outside my area of expertise, I have relied on the list of experts provided by the modeler. Please see the modeler's ASOP 38 document and supporting documentation for additional information.

a. Verisk employs a large, full-time professional staff in actuarial science, computer science, insurance and reinsurance, geology, mathematics, meteorology, hydrology and other physical sciences, software engineering, statistics, and structural engineering, among other disciplines. Most have advanced degrees with approximately 100 holding Ph.Ds. Verisk scientists and researchers apply general accepted practice in their specific discipline in model creation and validation.

b. Verisk uses internal resources to develop models and review models. For particular areas of inquiry or less well-studied regions of the world that lack ample historical data, model development requires the use of expert scientific judgment. In some situations, Verisk supplements in-house knowledge with external expertise using consultants or peer reviewers. For example, Verisk has solicited external expertise on such topics as the impact of climate change on tropical cyclone activity, frequency estimates for assessing terrorism risk, and pandemic flu, among others. For ongoing areas of research where there is no clear scientific consensus, Verisk seeks to provide clients with guidance and modeling best practices in the form of white papers, briefs and, in some cases, alternate credible views of the risk.

Credentials and background of experts who have contributed to the development of Verisk models can be made available upon request to Verisk.

c. Standards for catastrophe loss models have been promulgated by a few states. Most notably, the Florida Commission on Hurricane Loss Projection Methodology was created to review catastrophe loss models. The model(s) used in this work product, or derivatives thereof, have been certified by the Florida Commission on Hurricane Loss Projection Methodology.

3.3 Understanding of the Model

The actuary should be familiar with the basic components of the catastrophe model and understand both the user input and the catastrophe model output, as discussed below.

I have reviewed the modeler's ASOP 38 document and supporting documentation describing the model's components, input, and output, as well as other documentation, to comply with this requirement. In addition, I have specialized in actuarial applications of catastrophe model output since 2005.

3.3.1 Catastrophe Model Components—The actuary should be familiar with the basic components of the catastrophe model and have an understanding of how such components interrelate within the catastrophe model. In addition, the actuary should identify which fields of expertise were used in developing or updating the catastrophe model and should make a reasonable effort to determine if the catastrophe model is based on generally accepted practices within the applicable fields of expertise. The actuary should also be familiar with how the catastrophe model was tested or validated and the level of independent expert review and testing.

I am reasonably familiar with the basic components of the model and have a basic understanding of how such components interrelate with in the model. I have identified the fields of expertise used in developing and updating the model and have determined that the model is based on generally accepted practices within the applicable fields of expertise. I am reasonably familiar with how the model was validated and have reviewed the documentation of reviews by outside experts.

3.3.2 User Input—The actuary should take reasonable steps to confirm that the precision and accuracy of the user input are consistent with the intended purpose and should refer, as applicable, to ASOP No. 23, Data Quality, when selecting, using, or evaluating data used in the catastrophe model. Certain user input may be required to produce catastrophe model output for the specific application. User input can include assumptions or data. If the catastrophe model requires user input, the actuary should evaluate the reasonableness of the user input and should have an understanding of the relationship between the user input and catastrophe model output.

I understand the user input required to produce model output, including the level of detail required to produce results that are consistent with insurance ratemaking and risk management applications.

3.3.3 Catastrophe Model Output—The actuary should determine that the catastrophe model output is consistent with the intended purpose.

I have determined that the model output is consistent with the insurance ratemaking applications for which it was used. We most often use event loss detail in our work, so we are always careful that our results balance to the model's prepared exhibits.

3.4 Appropriateness of the Model for the Intended Application

The actuary should evaluate whether the catastrophe model is appropriate for the intended purpose and take into account the following:

3.4.1. Applicability of Historical Data—To the extent historical data are used in the development of the catastrophe model or the establishment of catastrophe model parameters, the actuary should take into account the adequacy of the historical data in representing the range of reasonably expected outcomes consistent with current knowledge about the phenomena being analyzed.

3.4.2. Developments in Relevant Fields—The actuary should make a reasonable effort to be aware of significant developments in relevant fields of expertise that are likely to materially affect the catastrophe model.

The catastrophe model(s) we have relied upon were developed for purposes related to the management of risk. I have evaluated the model(s) in light of available alternatives and determined that the catastrophe loss model is the most appropriate method of estimating expected catastrophe loss distributions for insurance ratemaking.

Some additional considerations include the following:

3.4.1. Applicability of Historical Data: Historical data is relied upon extensively in the development and validation of catastrophe loss models. Smoothing procedures are applied in cases where reasonably foreseeable events are underrepresented in the historical data.

3.4.2. Developments in Relevant Fields: Catastrophe loss models are typically updated on an annual basis in order to incorporate the most current scientific research and information from recent catastrophe events.

I have made a reasonable effort to be aware of significant developments in the relevant fields of expertise. In particular, meteorological studies related to the current period of elevated hurricane activity are important in determining which of a model's frequency assumptions should be utilized in insurance ratemaking applications involving hurricane-exposed risk portfolios. Aon maintains a documentation library containing current research in the science of catastrophe perils.

3.5 Output Validation

The actuary should validate that the output reasonably represents that which is being modeled. Depending on the intended purpose, output validation may include the following:

a. comparing output to those of an alternative model(s), where appropriate;

b. comparing the output produced by the catastrophe model with historical observations, if applicable;

c. comparing the consistency and reasonableness of relationships within the output; and

d. evaluating the reasonableness of changes in the output due to variations in the user input.

a. Aon conducts extensive testing of each model that we license whenever a new model is released. Output from Model output is checked for reasonability against other models and for consistency with the modeler's representations as to changes incorporated in the current version. I have reviewed the results of these tests and found the model used in this analysis to provide reasonable output.

b. Catastrophes, by their nature, involve significant uncertainty in the amount of insured losses they produce. In light of this uncertainty, the model has been shown to produce reasonable estimates of losses incurred from historical events.

I have reviewed the modeler's ASOP 38 document and supporting documentation describing comparisons of model output to historical observations and found that the model produces reasonable estimates.

c. I have reviewed the relationships among output results and found them to be consistent and reasonable.

d. Aon conducts extensive testing of each model that we license with respect to the sensitivity of model output to variations in the user input and model assumptions. I have reviewed the results of these tests and obtained an understanding of the model's sensitivity.

3.6 Appropriate Use of the Model

The actuary should evaluate the reasonableness of the catastrophe model output, considering the input and the intended purpose. The actuary should take into account the limitations of the catastrophe model and use professional judgment to determine whether it is appropriate to use the catastrophe model output. The actuary should also use professional judgment to determine whether any adjustments to the catastrophe model output are needed to meet the intended purpose. The actuary should disclose any such adjustments in accordance with section 4.1.

In my professional judgment, it is appropriate to use the model results, without adjustment, for the purposes of the actuarial work product to which this document is attached.

3.7 Reliance on Another Actuary

The actuary may rely on another actuary who has selected, used, reviewed, or evaluated the catastrophe model. However, the relying actuary should be reasonably satisfied that the other actuary is qualified to select, use, review, or evaluate the catastrophe model in accordance with applicable ASOPs, and the catastrophe model is appropriate for the intended purpose. The actuary should disclose the extent of any such reliance.

Actuaries utilizing the actuarial work product to which this document is attached can rely on my complete evaluation of the model(s) used as described above. In doing so, they should document the extent of such reliance in their work.

3.8 Reliance on Data or Other Information Supplied by Others

When relying on data or other information supplied by others, the actuary should refer to ASOP No. 23 and ASOP No. 41, Actuarial Communications, for guidance.

We have discussed the treatment of exposure data in 3.3.2, we have reviewed the cat modelers' data quality and investigation procedures and can attest to their procedures being in compliance with ASOP No. 23, Data Quality. We have property communicated ASOP reviews with internal and external stakeholders, we can attest that we are in compliance with ASOP No. 41.

3.9 Documentation

The actuary should consider preparing and retaining documentation to support compliance with the requirements of section 3 and the disclosure requirements of section 4. If preparing documentation, the actuary should prepare such documentation in a form such that another actuary qualified in the same practice area could assess the reasonableness of the actuary's work and should document the steps taken to comply with this standard in light of proprietary aspects of the catastrophe model, if any. The degree of such documentation should be based on the professional judgment of the actuary and may vary with the complexity and purpose of the actuarial services. In addition, the actuary should refer to ASOP No. 41 for guidance related to the retention of file material other than that which is to be disclosed under section 4.

We have retained documentation to support compliance with the requirements of section 3 and the disclosure requirements of section 4 in separate trade secret documents. The sensitivity testing to support section 3 involves detailed model results from several commercial vendors. Aon is required by our license agreements to protect modeling vendors' intellectual properties. The steps of Aon's ASOP 38 compliance work follow the ASOP 38 outline. I can attest that we are in compliance with ASOP No. 41.

Minchong Mao FCAS, MAAA

April 2025

Statement of Compliance with Actuarial Standard of Practice 38
Minchong Mao, FCAS, MAAA

Background

Actuarial Standard of Practice 38 provides guidance to the actuary in using models that incorporate specialized knowledge outside the actuary's own area of expertise when developing an actuarial work product. When using such a model, the standard requires that the actuary perform five specific tasks, as described below using the numbering system of the standard. This document certifies that Minchong Mao, FCAS, MAAA, has performed these tasks for the catastrophe loss model(s) relied upon in the actuarial work product to which it is attached. It is intended that actuaries utilizing the actuarial work product in their insurance ratemaking efforts can rely on my model evaluation in accordance with Section 3.7 of the standard of practice.

Model Versions Covered by this document

- RMS North Atlantic Hurricane Model v23, released in 2023, implemented in RiskLink V23
- RMS North America Earthquake Model v17.0, released in 2017, implemented in RiskLink V17, V18,V18.1, V21, V23
- RMS Sever Convective Strom Model for the United States, released in 2014, implemented in RiskLink V17,V18, V18.1, V21, V23
- RMS Winter Storm Model for the United States, release in 2022, implemented in RiskLink V22,V23

3.2 Appropriate Reliance on Experts

An actuary may rely on experts concerning those aspects of a model that are outside of the actuary's own area of expertise. The experts relied upon may either be the experts who provided the model or other experts.

For those aspects of the model that are outside my area of expertise, I have relied on the list of experts provided by the modeler. Please see the modeler's ASOP 38 document and supporting documentation for additional information.

In determining the appropriate level of reliance, the actuary should consider the following:

a. whether the individual or individuals upon whom the actuary is relying are experts in the applicable field;

The individuals listed as employees of the modeler appear to be experts in their respective fields.

b. the extent to which the model has been reviewed or opined on by experts in the applicable field, including any known significant differences of opinion among experts concerning aspects of the model that could be material to the actuary's use of the model; and

The modeler has provided documentation of reviews by outside experts. Many of these reviewers are well-recognized experts in their fields. I have reviewed the findings of the outside experts and found no significant differences of opinion with respect to the validity of the model.

c. whether there are standards that apply to the model or to the testing or validation of the model, and whether the model has been certified as having met such standards.

Standards for catastrophe loss models have been promulgated by a few states. Most notably, the Florida Commission on Hurricane Loss Projection Methodology was created to review catastrophe loss models. The model(s) used in this work product, or derivatives thereof, have been certified by the Florida Commission on Hurricane Loss Projection Methodology.

3.3 Understanding of the Model

The actuary should be reasonably familiar with the basic components of the model and understand both the user input and the model output, as discussed below.

I have reviewed the modeler's ASOP 38 document and supporting documentation describing the model's components, input, and output, as well as other documentation, to comply with this requirement. In addition, I have specialized in actuarial applications of catastrophe model output since 2005.

3.3.1 Model Components—The actuary should be reasonably familiar with the basic components of the model and have a basic understanding of how such components interrelate within the model. In addition, the actuary should identify which fields of expertise were used in developing or updating the model, and should make a reasonable effort to determine if the model is based on generally accepted practices within the applicable fields of expertise. The actuary should also be reasonably familiar with how the model was tested or validated and the level of independent expert review and testing.

I am reasonably familiar with the basic components of the model and have a basic understanding of how such components interrelate with in the model. I have identified the fields of expertise used in developing and updating the model and have determined that the model is based on generally accepted practices within the applicable fields of expertise. I am reasonably familiar with how the model was validated and have reviewed the documentation of reviews by outside experts.

3.3.2 User Input—Certain user input may be required to produce model output for the specific application. The actuary should understand the user input that is required to produce the model output. This understanding includes the level of detail required in the user input to produce results that are consistent with the intended use of the model.

I understand the user input required to produce model output, including the level of detail required to produce results that are consistent with insurance ratemaking and risk management applications.

3.3.3 Model Output—The actuary should determine that the model output is consistent with the actuary's intended use of the model.

I have determined that the model output is consistent with the insurance ratemaking applications for which it was used. We most often use event loss detail in our work, so we are always careful that our results balance to the model's prepared exhibits.

3.4 Appropriateness of the Model for the Intended Application

The actuary should evaluate whether the model is appropriate for the particular actuarial analysis, and consider limitations of the model, modifications to the model, and the assumptions needed in order to apply the model output.

The catastrophe model(s) we have relied upon were developed for purposes related to the management of risk. I have evaluated the model(s) in light of available alternatives and determined that the catastrophe loss model is the most appropriate method of estimating expected catastrophe loss distributions for insurance ratemaking.

Some additional considerations include the following:

a. Applicability of Historical Data—To the extent historical data are used in the development of the model or the establishment of model parameters, the actuary should consider the adequacy of the historical data in representing the range of reasonably expected outcomes consistent with current knowledge about the phenomena being analyzed.

Historical data is relied upon extensively in the development and validation of catastrophe loss models. Smoothing procedures are applied in cases where reasonably foreseeable events are underrepresented in the historical data.

b. Developments in Relevant Fields—The actuary should make a reasonable effort to be aware of significant developments in relevant fields of expertise. The actuary should evaluate whether such developments are likely to materially affect the current actuarial analysis.

Catastrophe loss models are typically updated on an annual basis in order to incorporate the most current scientific research and information from recent catastrophe events.

I have made a reasonable effort to be aware of significant developments in the relevant fields of expertise. In particular, meteorological studies related to the current period of elevated hurricane activity are important in determining which of a model's frequency assumptions should be utilized in insurance ratemaking applications involving hurricane-exposed risk portfolios. Aon maintains a documentation library containing current research in the science of catastrophe perils.

3.5 Appropriate Validation

The actuary should evaluate the user input and the reasonableness of the model output, as discussed below.

3.5.1 User Input—With respect to the quality and availability of the user input data to be used in the model, the actuary should refer to ASOP No. 23, Data Quality.

The model input data for this analysis was supplied by the client. The data was reviewed for reasonableness in accordance with ASOP 23.

3.5.2 Model Output—In view of the intended use of the model, the actuary should examine the model output for reasonableness, considering factors such as the following:

a. the results derived from alternate models or methods, where available and appropriate;

In addition, Aon conducts extensive testing of each model that we license whenever a new model is released. Output from Model output is checked for reasonability against other models and for consistency with the modeler's representations as to changes incorporated in the current version. I have reviewed the results of these tests and found the model used in this analysis to provide reasonable output.

b. how historical observations, if applicable, compare to results produced by the model;

Catastrophes, by their nature, involve significant uncertainty in the amount of insured losses they produce. In light of this uncertainty, the model has been shown to produce reasonable estimates of losses incurred from historical events.

I have reviewed the modeler's ASOP 38 document and supporting documentation describing comparisons of model output to historical observations and found that the model produces reasonable estimates.

c. the consistency and reasonableness of relationships among various output results; and

I have reviewed the relationships among output results and found them to be consistent and reasonable.

d. the sensitivity of the model output to variations in the user input and model assumptions.

Aon conducts extensive testing of each model that we license with respect to the sensitivity of model output to variations in the user input and model assumptions. I have reviewed the results of these tests and obtained an understanding of the model's sensitivity.

3.6 Appropriate Use of the Model

Having completed the analysis described in sections 3.2–3.5 above, the actuary should use his or her professional judgment to determine whether it is appropriate to use the model results, subject to any appropriate adjustments. The actuary should disclose any such adjustments in accordance with section 4.3.

In my professional judgment, it is appropriate to use the model results, without adjustment, for the purposes of the actuarial work product to which this document is attached.

3.7 Reliance on Model Evaluation by Another Actuary

The actuary may rely on another actuary who has, for a particular model, conducted some or all of the evaluations and processes described in this standard. However, the relying actuary should be satisfied that the other actuary's evaluation was performed in accordance with this standard and is appropriate for the intended application. The actuary should document the extent of such reliance in accordance with section 4.1.

Actuaries utilizing the actuarial work product to which this document is attached can rely on my complete evaluation of the model(s) used as described above. In doing so, they should document the extent of such reliance in their work.

Minchong Mao FCAS, MAAA

Dec.1 2023

North Carolina Rate Bureau
Dwelling Insurance Rate Filing
Support for Selected Reinsurance Structure

	Return Periods	
Layer	**Attachment**	**Exhaustion**
1181M XS 2316M	144	323
800M XS 1516M	71	144
600M XS 916M	34	71
400M XS 516M	17	34
300M XS 216M	8	17

The table above shows the All Peril 50/50 RMSv23/TSv12 blend attachment and exhaustion points which combine modeled loss with Catastrophe LAE for the North Carolina Rate Bureau portfolio, along with the selected reinsurance program.

EXHIBIT RB-13

North Carolina Rate Bureau
Dwelling Insurance Rate Filing
Reinsurance Program Summary

Reinsurance Layer	Rate-On-Line	Deposit Premium	Reinstatement Premium	Expected Total Premium	Expected Ceded Loss	Net Cost of Reinsurance
1181M XS 2316M	5.90%	70,033	408	70,441	6,933	63,508
800M XS 1516M	9.10%	72,800	884	73,684	9,837	63,847
600M XS 916M	13.00%	77,760	1,826	79,586	14,409	65,177
400M XS 516M	18.80%	75,080	3,342	78,422	18,477	59,945
300M XS 216M	27.30%	81,930	7,082	89,012	27,639	61,373
Total		**377,603**	**13,542**	**391,145**	**77,295**	**313,850**

Dollar amounts are in thousands

The table above shows indicated rates-on-line for the filing's reinsurance structure along with analysis of modeled catastrophe losses. Rate-on-Line values have been selected using the current Loss-On-Line approach, which is a benchmarking analysis done using reinsurance treaties placed by Aon.

Deposit Premium is Rate-On-Line * Layer Limit

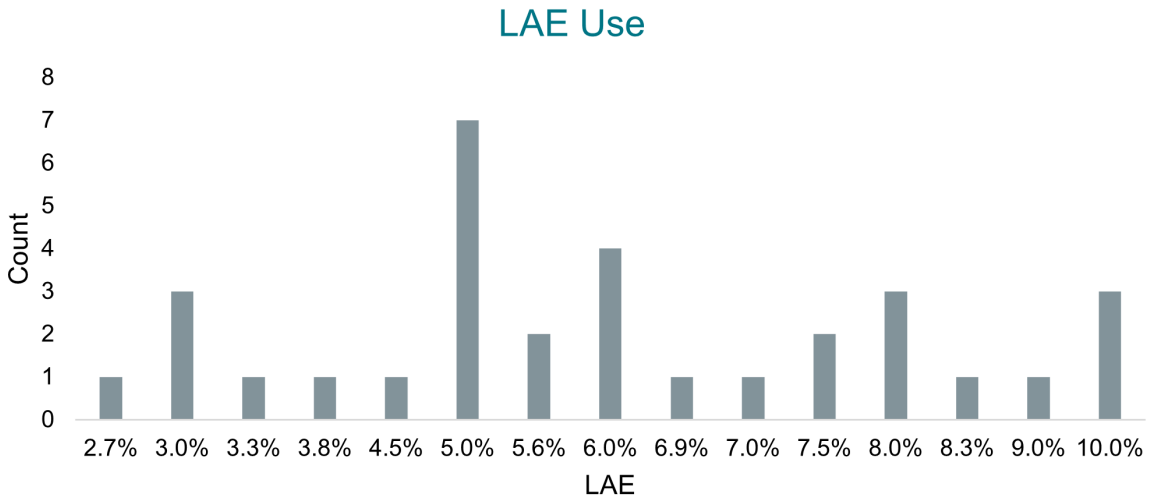
Expected Ceded Loss and Expected Reinstatement premium are the average annual amounts of each based on a simulation of catastrophe losses subject to the reinsurance program.

Expected Total Premium = Deposit Premium + Expected Reinstatement Premium

Net Cost of Reinsurance = Expected Total Premium - Expected Ceded Loss

EXHIBIT RB-14

North Carolina Rate Bureau
Dwelling Insurance Rate Filing
Support for Selected Catastrophe LAE Factor



This chart shows Catastrophe LAE factors applied to modeled catastrophe event losses in AM Best SRQ Submissions by Aon clients in 2025

- Factors were rounded to the nearest 0.1
- A weighted average was used where factors varied by peril
- Multiple factors were counted where factors varied by company within a group
- Reflects all clients that included a provision for LAE

The mean factor is 6.05%, the median is 5.81%, and the mode is 5.00%.

North Carolina Rate Bureau
Reinsurance Cost Allocation
CY 2023
RMSv23/TSv12

Layer 1: 300M XS 216M

Peril/Territory	Premium	Ceded AAL	Reins Margin
HU	**96.83%**	**96.43%**	**97.01%**
110	19.39%	18.94%	19.60%
120	20.67%	20.58%	20.71%
130	2.60%	2.56%	2.61%
140	20.92%	21.24%	20.77%
150	4.96%	4.97%	4.95%
160	5.54%	5.50%	5.57%
170	0.31%	0.31%	0.31%
180	3.38%	3.35%	3.39%
190	1.81%	1.78%	1.82%
200	1.03%	1.00%	1.04%
210	0.86%	0.86%	0.87%
220	2.67%	2.61%	2.69%
230	1.75%	1.73%	1.75%
240	2.00%	2.00%	2.01%
250	1.13%	1.12%	1.13%
260	0.49%	0.50%	0.49%
270	2.15%	2.15%	2.15%
280	0.32%	0.32%	0.32%
290	0.46%	0.46%	0.46%
300	0.35%	0.35%	0.35%
310	1.14%	1.16%	1.13%
320	0.68%	0.69%	0.68%
330	0.03%	0.04%	0.03%
340	1.30%	1.31%	1.30%
350	0.38%	0.39%	0.38%
360	0.45%	0.47%	0.44%
370	0.02%	0.02%	0.02%
380	0.03%	0.04%	0.03%
390	0.02%	0.02%	0.02%
OW	**2.96%**	**3.39%**	**2.78%**
WT	**0.21%**	**0.19%**	**0.22%**
Grand Total	**100.00%**	**100.00%**	**100.00%**

North Carolina Rate Bureau
Reinsurance Cost Allocation
CY 2023
RMSv23/TSv12

Layer 2: 400M XS 516M

Peril/Territory	Premium	Ceded AAL	Reins Margin
HU	**99.28%**	**99.12%**	**99.33%**
110	17.04%	16.34%	17.25%
120	22.13%	22.17%	22.12%
130	2.39%	2.33%	2.41%
140	22.13%	22.80%	21.92%
150	4.93%	4.95%	4.93%
160	6.07%	6.06%	6.07%
170	0.30%	0.30%	0.30%
180	3.60%	3.57%	3.61%
190	1.97%	1.95%	1.97%
200	1.12%	1.08%	1.13%
210	0.93%	0.93%	0.94%
220	3.01%	2.93%	3.03%
230	1.91%	1.90%	1.91%
240	2.19%	2.18%	2.19%
250	1.25%	1.24%	1.26%
260	0.54%	0.55%	0.53%
270	2.47%	2.47%	2.47%
280	0.36%	0.37%	0.36%
290	0.52%	0.51%	0.52%
300	0.36%	0.36%	0.37%
310	1.27%	1.29%	1.27%
320	0.72%	0.73%	0.71%
330	0.04%	0.04%	0.03%
340	1.25%	1.25%	1.25%
350	0.34%	0.34%	0.33%
360	0.39%	0.42%	0.38%
370	0.02%	0.02%	0.02%
380	0.02%	0.03%	0.02%
390	0.01%	0.01%	0.01%
OW	**0.68%**	**0.85%**	**0.63%**
WT	**0.04%**	**0.03%**	**0.05%**
Grand Total	**100.00%**	**100.00%**	**100.00%**

North Carolina Rate Bureau
Reinsurance Cost Allocation
CY 2023
RMSv23/TSv12

Layer 3: 600M XS 916M

Peril/Territory	Premium	Ceded AAL	Reins Margin
HU	**99.92%**	**99.89%**	**99.93%**
110	14.70%	13.68%	14.92%
120	23.57%	23.73%	23.53%
130	2.14%	2.04%	2.16%
140	23.06%	24.07%	22.84%
150	4.67%	4.65%	4.68%
160	6.44%	6.47%	6.43%
170	0.28%	0.28%	0.28%
180	3.62%	3.59%	3.63%
190	2.04%	2.04%	2.04%
200	1.18%	1.14%	1.19%
210	0.96%	0.95%	0.96%
220	3.21%	3.14%	3.23%
230	2.00%	2.00%	2.00%
240	2.25%	2.25%	2.25%
250	1.32%	1.31%	1.32%
260	0.55%	0.57%	0.55%
270	2.64%	2.66%	2.64%
280	0.39%	0.40%	0.39%
290	0.55%	0.54%	0.55%
300	0.37%	0.36%	0.37%
310	1.35%	1.36%	1.34%
320	0.73%	0.73%	0.72%
330	0.03%	0.04%	0.03%
340	1.18%	1.17%	1.18%
350	0.29%	0.31%	0.29%
360	0.35%	0.38%	0.34%
370	0.01%	0.02%	0.01%
380	0.02%	0.02%	0.02%
390	0.01%	0.01%	0.01%
OW	**0.08%**	**0.11%**	**0.07%**
WT	**0.00%**	**0.00%**	**0.00%**
Grand Total	**100.00%**	**100.00%**	**100.00%**

North Carolina Rate Bureau
Reinsurance Cost Allocation
CY 2023
RMSv23/TSv12

Layer 4: 800M XS 1516M

Peril/Territory	Premium	Ceded AAL	Reins Margin
HU	**100.00%**	**99.99%**	**100.00%**
110	12.66%	11.26%	12.88%
120	24.92%	25.10%	24.89%
130	1.92%	1.77%	1.95%
140	23.87%	24.98%	23.69%
150	4.42%	4.32%	4.43%
160	6.76%	6.82%	6.75%
170	0.26%	0.25%	0.26%
180	3.57%	3.55%	3.57%
190	2.07%	2.09%	2.06%
200	1.20%	1.17%	1.20%
210	0.95%	0.95%	0.95%
220	3.30%	3.29%	3.30%
230	2.02%	2.07%	2.02%
240	2.25%	2.28%	2.24%
250	1.34%	1.36%	1.34%
260	0.55%	0.57%	0.55%
270	2.73%	2.80%	2.72%
280	0.40%	0.42%	0.40%
290	0.57%	0.57%	0.57%
300	0.36%	0.36%	0.37%
310	1.39%	1.43%	1.38%
320	0.73%	0.75%	0.73%
330	0.03%	0.04%	0.03%
340	1.11%	1.11%	1.10%
350	0.26%	0.27%	0.25%
360	0.32%	0.36%	0.31%
370	0.01%	0.02%	0.01%
380	0.02%	0.02%	0.02%
390	0.01%	0.01%	0.01%
OW	**0.00%**	**0.01%**	**0.00%**
Grand Total	**100.00%**	**100.00%**	**100.00%**

North Carolina Rate Bureau
Reinsurance Cost Allocation
CY 2023
RMSv23/TSv12

Layer 5: 1181M XS 2316M

Peril/Territory	Premium	Ceded AAL	Reins Margin
HU	**100.00%**	**100.00%**	**100.00%**
110	11.11%	9.01%	11.34%
120	25.72%	26.07%	25.69%
130	1.77%	1.52%	1.80%
140	24.55%	25.80%	24.41%
150	4.18%	3.94%	4.21%
160	7.11%	7.22%	7.09%
170	0.23%	0.22%	0.24%
180	3.52%	3.48%	3.53%
190	2.12%	2.17%	2.12%
200	1.18%	1.19%	1.18%
210	0.95%	0.94%	0.95%
220	3.36%	3.49%	3.35%
230	2.02%	2.13%	2.01%
240	2.23%	2.28%	2.23%
250	1.36%	1.43%	1.35%
260	0.55%	0.58%	0.55%
270	2.80%	2.95%	2.78%
280	0.41%	0.45%	0.41%
290	0.58%	0.60%	0.58%
300	0.36%	0.37%	0.36%
310	1.43%	1.53%	1.42%
320	0.75%	0.79%	0.74%
330	0.04%	0.04%	0.03%
340	1.07%	1.12%	1.07%
350	0.24%	0.27%	0.24%
360	0.31%	0.36%	0.30%
370	0.01%	0.02%	0.01%
380	0.02%	0.02%	0.02%
390	0.01%	0.01%	0.01%
Grand Total	**100.00%**	**100.00%**	**100.00%**

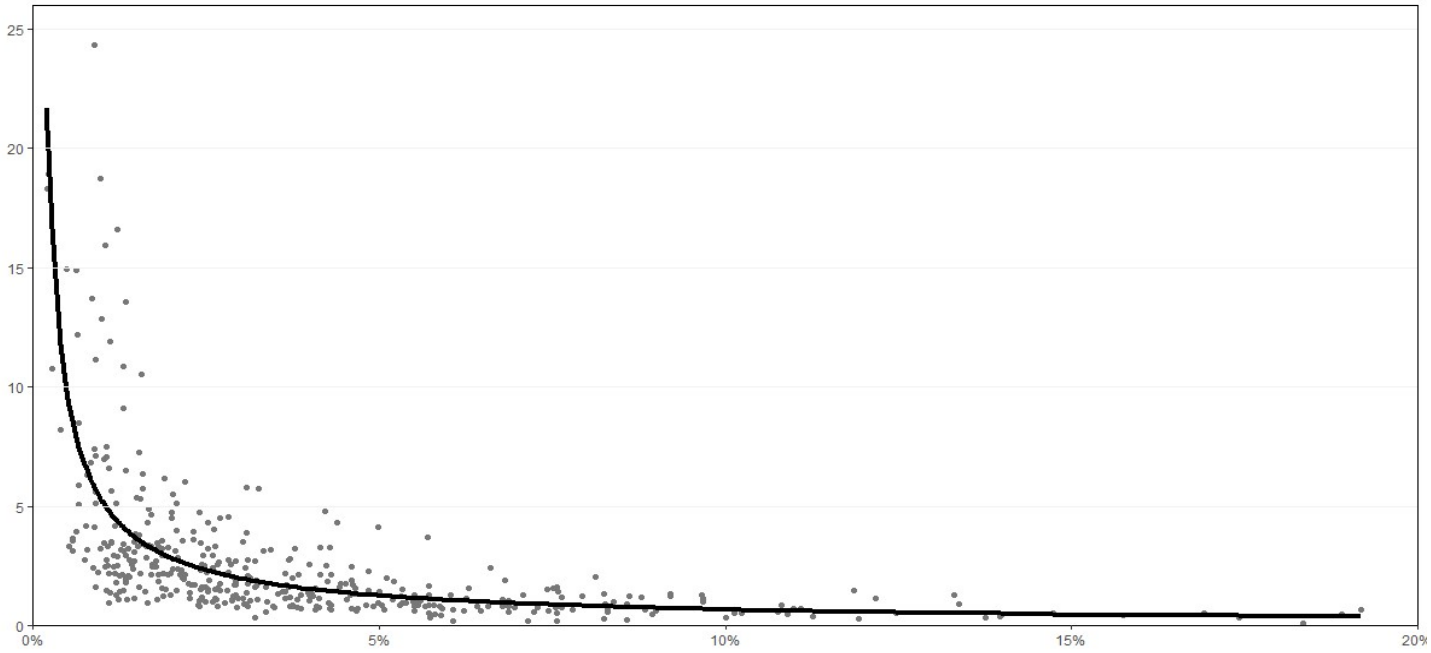
North Carolina Rate Bureau
Reinsurance Margin Allocation
CY 2023
RMSv23/TSv12

Territory	Policy Form 1	Policy Form 2	Total
110	2,667,467	45,089,054	47,756,521
120	10,678,424	63,026,585	73,705,009
130	2,213,111	4,633,086	6,846,197
140	20,798,574	50,765,466	71,564,040
150	5,354,644	9,299,425	14,654,069
160	5,645,817	14,529,345	20,175,162
170	416,745	450,999	867,744
180	4,788,841	6,428,174	11,217,015
190	3,209,495	3,092,305	6,301,800
200	2,285,459	1,325,750	3,611,209
210	1,280,547	1,656,351	2,936,898
220	3,050,986	6,983,422	10,034,408
230	4,422,399	1,668,322	6,090,722
240	3,087,015	3,800,672	6,887,687
250	1,662,332	2,429,970	4,092,301
260	837,435	839,146	1,676,581
270	850,908	7,479,458	8,330,367
280	343,788	867,271	1,211,059
290	547,298	1,157,551	1,704,848
300	720,801	423,935	1,144,736
310	1,190,441	3,070,785	4,261,226
320	810,638	1,526,725	2,337,363
330	61,532	48,162	109,694
340	803,148	3,171,154	3,974,302
350	331,609	655,673	987,283
360	462,100	740,530	1,202,630
370	23,539	25,154	48,692
380	28,623	45,135	73,758
390	17,304	29,216	46,520
Total	**78,591,020**	**235,258,821**	**313,849,841**

North Carolina Insurance Underwriting Association (NCIUA) -- Beach Plan
North Carolina Joint Underwriting Association (NCJUA) -- FAIR Plan

Catastrophe Bond Profit Multiples

Profit Multiples by Probability of Loss



Source: Lane Financial LLC, Annual Securitization Reviews (http://lanefinancialllc.com) and Aon ILS Cat bond data.
Notes: Based on near-term cat bonds issued from January 2016 to March 2025.
Includes all U.S. bonds with a probability of first loss between 0.05% and 20.0%; excludes bonds with no stated profit multiples.

Equation of the fitted curve: $y = 0.09048604\, x^{-0.8817344}$

Equation to determine average Profit Multiple over specific interval: $\text{Avg PM} = \int_a^b 0.09048604^{-0.8817344}\, dx/(b-a)$

North Carolina Insurance Underwriting Association (NCIUA) -- Beach Plan

Summary of 2025 Reinsurance Structure

Risk Finance Structure [1]	Attachment Point ($ Millions)	Exhaustion Point ($ Millions)	Coverage
Reinsurance Layer 1	$2,350	$2,800	100.0%
Reinsurance Layer 2	$2,800	$3,400	100.0%
Reinsurance Layer 3	$3,400	$3,750	100.0%
Reinsurance Layer 4	$3,750	$5,000	100.0%
Reinsurance Layer 5	$5,000	$5,025	100.0%

Source: https://www.ncjua-nciua.org/html/mbr_co.htm

Note: The above reinsurance covers aggregate losses for all Beach Plan accounts combined (Residential & Commercial).

(1) Each layer of reinsurance provides Annual Aggregate coverage, which implies that a reinstatement provision is not applicable.

North Carolina Insurance Underwriting Association (NCIUA) -- Beach Plan

Determination of Average Profit Multiple by Layer of Loss

($ in Millions)

Annual Aggregate Layer	Source of Funding	Total Beach Plan Layer Attachment	Total Beach Plan Layer Exhaustion [1]	Attachment Probability	Exhaustion Probability	Indicated Profit Multiple
$0 to 1,350	Surplus	$0	$1,350	46.78%	7.71%	0.34
$1,350 to 2,350	Company Assessments	$1,350	$2,350	7.71%	4.52%	1.08
$2,350 to 2,800	Reinsurance Layer 1	$2,350	$2,800	4.52%	3.73%	1.51
$2,800 to 3,400	Reinsurance Layer 2	$2,800	$3,400	3.73%	2.99%	1.81
$3,400 to 3,750	Reinsurance Layer 3	$3,400	$3,750	2.99%	2.66%	2.10
$3,750 to 5,000	Reinsurance Layer 4	$3,750	$5,000	2.66%	1.85%	2.58
$5,000 to 5,025	Reinsurance Layer 5	$5,000	$5,025	1.85%	1.84%	3.06
$5,025 & Higher	Policyholder Surcharges	$5,025	$63,308	1.84%	0.001%	15.29

(1) The Layer Exhaustion for the highest layer assumes 100K year return period and is consistent with prior year's analysis.

North Carolina Insurance Underwriting Association (NCIUA) -- Beach Plan
Residential Accounts Only

Illustration of How Hurricane Losses are Funded
Voluntary Market Assessments Limited to $1 Billion on All Beach Plan Accounts Combined
($ in Millions)

	Total Beach Plan			Beach Plan:	Hurricane Losses Funded by:			
Annual Aggregate Layer	Layer Attachment	Layer Exhaustion	Total Losses in Layer	Residential Share of Layer	Beach Plan Surplus	Private Reinsurance	Assessment on Member Companies [1]	Policyholder Surcharges
$0 to 1,350	$0	$1,350	$1,350	$1165.1	$1165.1	-	-	-
$1,350 to 2,350	$1,350	$2,350	$1,000	$863.1	-	-	$863.1	-
$2,350 to 2,800	$2,350	$2,800	$450	$388.4	-	$388.4	-	-
$2,800 to 3,400	$2,800	$3,400	$600	$517.8	-	$517.8	-	-
$3,400 to 3,750	$3,400	$3,750	$350	$302.1	-	$302.1	-	-
$3,750 to 5,000	$3,750	$5,000	$1,250	$1078.8	-	$1078.8	-	-
$5,000 to 5,025	$5,000	$5,025	$25	$21.6	-	$21.6	-	-
$5,025 & Higher	$5,025	$63,308	$58,283	$50,302.0	-	-	-	$50,302.0
Total					$1165.1	$2308.7	$863.1	$50,302.0

(1) Total losses paid by Member Companies ($863.1 M) reflects the Residential portion of the $1 Billion Beach Plan assessment on the total Voluntary Market.

North Carolina Insurance Underwriting Association (NCIUA) -- Beach Plan
Residential Accounts Only

Determination of the Cost of Reinsurance Provided to the NCIUA by the Voluntary Market
Voluntary Market Assessments Limited to $1 Billion on All Beach Plan Accounts Combined
($ in Millions)

Annual Aggregate Layer	Beach Plan: Residential Share of Layer	Potential Assessment Paid by Member Companies [1]	Expected Losses [2] Total	Expected Losses [2] Exposed [3]	Indicated Profit Multiple [4]	Cost of Funding Assessments [5]
$0 to 1,350	$1,165.1	-	$165.44	-	0.34	-
$1,350 to 2,350	$863.1	$863.1	$50.56	$50.56	1.08	$54.80
$2,350 to 2,800	$388.4	-	$15.95	-	1.51	-
$2,800 to 3,400	$517.8	-	$17.37	-	1.81	-
$3,400 to 3,750	$302.1	-	$8.49	-	2.10	-
$3,750 to 5,000	$1,078.8	-	$23.85	-	2.58	-
$5,000 to 5,025	$21.6	-	$0.40	-	3.06	-
$5,025 & Higher	$50,302.0	-	$74.49	-	15.29	-
Total		$863.1	$356.55	$50.56		$54.80

(1) Page 4.
(2) From AIR & RMS hurricane models.
(3) Expected loss subject to Beach Plan assessments of Voluntary Market.
(4) See Page 3.
(5) = Exposed Expected Losses x Profit Multiple (based on Cat Bond data).

North Carolina Joint Underwriting Association (NCJUA) -- FAIR Plan

Summary of 2025 Reinsurance Structure

Risk Structure (1)	Attachment Point (in million)	Exhaustion Point (in million)	Coverage
Reinsurance Layer 1	$175	$320	100.0%
Reinsurance Layer 2	$320	$358	100.0%

Source: https://www.ncjua-nciua.org/html/mbr_co.htm
Notes: The above reinsurance covers aggregate losses for all FAIR Plan accounts combined (Residential & Commercial).
(1) Each layer of reinsurance provides Annual Aggregate coverage, which implies that a reinstatement provision is not applicable.

North Carolina Joint Underwriting Association (NCJUA) -- FAIR Plan

Determination of Average Profit Multiple by Layer of Loss

($ in Millions)

		Total FAIR Plan				
Annual Aggregate Layer	Source of Funding	Layer Attachment	Layer Exhaustion [1]	Attachment Probability	Exhaustion Probability	Indicated Profit Multiple
$0 to 25	Surplus	$0	$25	52.25%	23.36%	0.22
$25 to 175	Company Assessments	$25	$175	23.36%	10.36%	0.45
$175 to 320	Reinsurance	$175	$320	10.36%	6.57%	0.81
$320 to 358	Reinsurance	$320	$358	6.57%	5.88%	1.05
$358 & Higher	Company Assessments	$358	$10,176	5.88%	0.001%	5.97

(1) The Layer Exhaustion for the highest layer assumes 100K year return period and is consistent with prior year's analysis.

North Carolina Joint Underwriting Association (NCJUA) -- FAIR Plan
Residential Accounts Only

Illustration of How Hurricane Losses are Funded
Reflecting Unlimited Industry Exposure to FAIR Plan Assessments
($ in Millions)

	Total FAIR Plan			FAIR Plan:	Hurricane Losses Funded by:		
Annual Aggregate Layer	Layer Attachment	Layer Exhaustion	Total Losses in Layer	Residential Share of Layer	FAIR Plan Surplus	Private Reinsurance	Assessment on Member Companies
$0 to 25	$0	$25	$25	$19.9	$19.9	-	-
$25 to 175	$25	$175	$150	$119.4	-	-	$119.4
$175 to 320	$175	$320	$145	$115.4	-	$115.4	-
$320 to 358	$320	$358	$38	$30.3		$30.3	
$358 & Higher	$358	$10,176	$9,818	$7816.3	-	-	$7,816.3
Total					$19.9	$145.7	$7,935.7

North Carolina Joint Underwriting Association (NCJUA) -- FAIR Plan
Residential Accounts Only

Determination of the Cost of Reinsurance Provided to the NCJUA by the Voluntary Market
Reflecting Unlimited Industry Exposure to FAIR Plan Assessments
($ in Millions)

Annual Aggregate Layer	FAIR Plan: Residential Share of Layer	Potential Assessment Paid by Member Companies [1]	Expected Losses [2] Total	Expected Losses [2] Exposed [3]	Indicated Profit Multiple [4]	Cost of Funding Assessments [5]
$0 to 25	$19.9	-	$5.66	-	0.22	-
$25 to 175	$119.4	$119.4	17.80	$17.80	0.45	$8.09
$175 to 320	$115.4	-	9.49	-	0.81	-
$320 to 358	$30.3	-	1.88		1.05	-
$358 & Higher	$7816.3	$7816.3	28.61	28.61	5.97	$170.95
Total		$7935.7	$63.44	$46.42		$179.03

(1) See Page 8.
(2) From AIR & RMS hurricane models.
(3) Expected loss subject to FAIR Plan assessments of Voluntary Market.
(4) See Page 7.
(5) = Exposed Expected Losses x Profit Multiple (based on Cat Bond data).

North Carolina Insurance Underwriting Association (NCIUA) -- Beach Plan
North Carolina Joint Underwriting Association (NCJUA) -- FAIR Plan
Residential Accounts Only

Determination of the Compensation for Bearing the Risk of Beach Plan & FAIR Plan Assessments
($ in Millions)

(1) Cost of Reinsurance Provided by the Voluntary Market to the Residential Accounts in the NCIUA (Beach Plan):	$54.80
(2) Cost of Reinsurance Provided by the Voluntary Market to the Residential Accounts in the NCJUA (FAIR Plan):	$179.03
(3) Total Cost of Reinsurance Provided by the Voluntary Market to the Residential Accounts in the NCIUA & NCJUA:	$233.83

Policy Form	(4) Estimated 2025 Industry Written Premium @ Manual Rates	(5) = (4) / Total (4) % of Total Industry Premium	(6) = (3) x (5) Allocated Compensation for Risk of Assessment	(7) = (6) / (4) Compensation for Assessment Risk as % of 2025 Manual Premium
Homeowners	$4,931.2	87.7%	$205.15	4.2%
Dwelling Fire & EC	$454.0	8.1%	$18.89	4.2%
MobileHome	$235.5	4.2%	$9.80	4.2%
Total	$5,620.7	100.0%	$233.83	4.2%

(8) Estimated Market Share of Companies that Retain Assessment Risk	50%
(9) Retained Compensation for Assessment Risk Provision:	2.1%

(1) From Page 5.
(2) From Page 9.
(3) = (1) + (2)
(4) Industry Written Premium includes NCIUA and NCJUA.
(8) NCRB Property Rating Sub-Committee selection
(9) = (7) * (8)

PREFILED TESTIMONY
OF
PAUL D. ANDERSON

2025 DWELLING PROPERTY INSURANCE RATE FILING
BY THE NORTH CAROLINA RATE BUREAU

Q. Please state your name and business address.

A. My name is Paul D. Anderson. My business address is 17335 Golf Parkway, Brookfield, WI 53045.

Q. By whom are you employed?

A. I am employed by Milliman, Inc. (Milliman) and have been employed by Milliman since February 1, 2007.

Q. What is your educational background?

A. I received a Bachelor of Science in Actuarial Science from Drake University in Des Moines, Iowa in 1993.

Q. Do you have any additional certifications or qualifications?

A. Yes. I have been a Fellow of the Casualty Actuarial Society (CAS) since 2002 and a Certified Specialist in Predictive Analytics of the CAS Institute (iCAS) since 2018. Since 2002, I have served on several committees of the Casualty Actuarial Society, including the following:

- Syllabus & Examination Committee: April 2004 to July 2006;
- Volunteer Support Task Force: February 2012 to April 2013;
- Volunteer Resources Committee: April 2013 to March 2020;
- Vehicle Technology & Impact on Loss Trends Planning Committee: October 2017 to August 2018;
- Participation Survey Task Force: January 2018 to January 2019;
- Crash Course in Vehicle Technology & Driverless Cars Committee (chairperson): February 2020 to November 2021;
- Volunteer Resources Advisory Committee: June 2020 to November 2021;
- Crash Course Seminar Task Force (volunteer chairperson): November 2021 to October 2024; and
- Volunteer Resources Task Force: November 2021 to Present.

I have also been a member of the American Academy of Actuaries since 2002 and meet all of the continuing education requirements of that organization as well as those of the Casualty Actuarial Society.

Q. What is your employment background?

A. I was employed by Allstate Insurance Company from June 1993 until January 2007. While at Allstate, I held various actuarial roles. I began my career as an Auto Pricing Analyst, and over time, I assumed increasing responsibility in various departments that included Property Pricing, Auto Pricing, Property Research, and Auto Research. On the pricing teams, I assisted in developing rates for property and auto insurance products in most states across the country. On the research teams, I assisted in developing new property and auto risk classification plans to be implemented by Allstate's pricing teams. From 2006 until January 2007, I served as a Senior Manager for Allstate's Eastern region, which included assisting in the oversight of the pricing strategies for approximately half the country, including North Carolina.

In February 2007, I began my career at Milliman. Since 2007, I have completed, managed, or overseen numerous property and auto pricing analyses for a variety of clients. My clients have included small single-state insurance companies, industry-leading national insurance companies, start-up InsurTech insurance companies, government entities, the North Carolina Rate Bureau, and other entities with similar coastal property exposure in states such as Florida, Hawaii, and Texas. These client assignments have included such projects as pricing analyses to evaluate overall rate adequacy, predictive modeling assignments to develop new risk classification plans, and analyses of catastrophe losses to evaluate the adequacy and allocation of property premiums corresponding to catastrophe risk.

Q. What is Milliman?

A. Milliman is among the world's largest providers of actuarial, risk management, and related technology and data solutions. Milliman was founded in Seattle in 1947 as Milliman & Robertson and today has offices in principal cities worldwide, covering markets in North America, Latin America, Europe, Asia and the Pacific, the Middle East, and Africa. Milliman employs more than 5,100 people, including actuaries and specialists ranging from clinicians to economists. The firm has consulting practices in employee benefits, financial services, healthcare, life insurance, and property and casualty insurance. Milliman serves the full spectrum of business, education, financial, governmental, union, and nonprofit organizations.

Q. What are your current responsibilities at Milliman?

A. I am responsible for managing and overseeing the personal lines and insurance-related predictive analytics portion of Milliman's Milwaukee Casualty practice. The personal lines and predictive analytics team conducts a variety of property and auto pricing, product development, and predictive modeling assignments, primarily for insurance companies. Over the last five years, we have completed property analyses for nearly every state in the country, including North Carolina.

Q. Were you engaged to provide actuarial services to the North Carolina Rate Bureau (the Rate Bureau) in relation to its 2025 dwelling rate filing?

A. Yes, I was.

Q. What was the scope of that engagement?

A. Milliman was engaged for several aspects of the 2025 dwelling rate filing. My role was to review the contingency provision in this filing. I was also engaged to conduct an independent review and provide feedback on the actuarial analyses underlying the filing. In this role, I participated in many of the discussions in which ISO presented preliminary data and analyses to the Rate Bureau. In addition, my role also included participating in the Rate Bureau's Property Rating Subcommittee meetings in which the 2025 dwelling filing was discussed. During these discussions, I offered feedback and insights to assist in the Subcommittee's selections and decisions related to this filing.

Q. Is your firm being compensated for this engagement?

A. Yes, it is.

Q. Is that compensation in any way contingent on the provision of favorable testimony in support of the proposed filing?

A. No, it is not.

Q. Have you completed your review of the 2025 dwelling rate filing?

A. Yes, I have.

Q. Were there any constraints placed on your review, such as limited or delayed access to data or limited time that may have hindered your complete review?

A. No, I was provided all the data and information that were necessary, and I had adequate time for a complete review. My review was not limited in any way.

Q. What is the overall indicated change in dwelling rates in this filing?

A. This filing shows the need for an overall 68.3% statewide average rate increase. This includes a -2.0% change to fire rates and an 84.8% change to extended coverage rates.

Q. Please describe the overall ratemaking methodology that underlies the filing.

A. The approach in this filing is generally consistent with prior dwelling filings submitted by the Rate Bureau. Consistent with the *Statement of Principles Regarding Property and Casualty Insurance Ratemaking* as published by the Casualty Actuarial Society, the indicated rates reflect the expected value of future costs associated with insuring residential real property on dwelling policies. These expected costs include claims, claim settlement expenses, operational and administrative expenses, and the cost of capital. I also note that the dwelling insurance addressed in this filing is insurance on residential real property using Rate Bureau forms, rules, and rates, and that is what I am addressing when I refer to dwelling insurance in this testimony.

The statewide rate-level indications for dwelling insurance are developed based on a loss cost methodology (instead of a loss ratio methodology). The indicated rate-level change is calculated for each segment by comparing the required base class rate per policy to the current average base class rate. The required base class rate per policy is calculated by first projecting the losses and loss adjustment expenses for the policy period for which the filed rates are expected to be in effect. For extended coverage, losses are projected excluding historical hurricane losses. In addition to the exclusion of historical hurricane losses, the projected losses for extended coverage are adjusted to remove excess losses and an excess factor is applied based on an average of the excess losses over 30 years of historical experience. Base class loss costs are calculated by dividing the adjusted incurred losses and loss adjustment expenses for each historical accident year by the corresponding earned house years and trended average rating factors. The base class loss costs by year are weighted together to develop a weighted trended base class loss cost for fire and a weighted trended non-hurricane base class loss cost for extended coverage. For the extended coverage portion of the filing, a trended modeled hurricane base class loss cost is also developed and added to the weighted trended non-hurricane base class loss cost to determine the total base class loss cost.

Following the development of the base class loss cost, a per-policy fixed expense provision and other expected underwriting expenses associated with issuing dwelling insurance policies are incorporated to determine the required base class rate per policy. These expected underwriting expenses include provisions for underwriting profit, contingencies, dividends, compensation for assessment risk, net cost of reinsurance, and deviations. As mentioned above, the required base class rate per policy is compared to the current average base class rate to develop the overall statewide indicated rate-level change. This comparison of the required and current base class rates is consistent with the *Statement of Principles* referenced above, is commonly used throughout the industry, and as such, is an actuarially sound method of developing an indicated rate-level change.

Q. Are there any changes in the ratemaking methodology or presentation in the filing as compared to prior filings?

A. The 2025 dwelling filing is generally consistent with prior filings, but there is one component of this filing that relies on a different approach as compared to the 2023 dwelling filing and one component that is presented differently than in the 2023 dwelling filing.

In this filing, the Rate Bureau developed loss trend factors using a three-step trend procedure that includes historical trend, "to current" trend, and prospective trend. In prior filings, the Rate Bureau used a two-step trend procedure to develop loss trend factors, which included historical and prospective trends. The "to current" trend was added to the calculation of the loss trend factors in this filing to estimate changes in cost levels following the latest year of the experience period to the most recent time period for which additional external data was available. In this filing, the "to current" trend was applied from July 1, 2023, to June 30, 2025, based on the historical average annual rates of change as well as the average annual rates of change for the Current Cost Index (CCI). In previous filings, the prospective trend would have applied to this time period in addition to the time period from the end of the external data to one year beyond the assumed effective date (July 1, 2027).

This change in approach is reasonable, actuarially sound, and, because the differences between the "to current" trends and prospective trends are nominal, this change has a minimal impact on the rate-level indications.

In addition to this change in approach, the Rate Bureau revised the presentation of the net cost of reinsurance component in the calculation of the extended coverage indicated rate level change on page C-4 of Exhibit RB-1. In this filing, the Rate Bureau included the net cost of reinsurance in row (16), before adjusting the base class loss cost and fixed expenses by the expected loss and fixed expense ratio. In previous filings, the net cost of reinsurance was included after the adjustment for the expected loss and fixed expense ratio. However, the net cost of reinsurance component in previous filings was already adjusted by the same expected loss and fixed expense ratio, so there is no impact to the indicated rate level change due to this change in presentation.

Q. How are the expected losses determined?

A. This filing uses the latest available five years of historical loss experience to determine expected losses other than hurricane losses. These five years include accident years ending December 31, 2019, through December 31, 2023. Using five years of experience is consistent with North Carolina statutes and prior dwelling fire and extended coverage rate filings. It is also consistent with generally accepted ratemaking practices because the use of five years of historical experience balances stability of the overall rate level with responsiveness to the

most recent conditions. Because severe weather-related events can cause volatility in the loss experience, hurricane losses and excess losses (for extended coverage only) have been removed from the historical loss experience. Each year of losses has been developed to ultimate amounts and has been adjusted to a common $500 deductible level. Losses are developed to ultimate because the final incurred losses for an accident year are often different from initial loss estimates due to the late reporting of claims or as yet unknown settlement amounts on known claims.

After these initial adjustments, a provision for excess losses is applied to each accident year for extended coverage, and a provision for loss adjustment expenses is applied to each accident year for all dwelling forms. The excess factor of 1.051 for the extended coverage section of the filing is determined using ISO's standard excess loss procedure, using a 30-year experience period as noted earlier. This procedure evaluates historical non-hurricane loss experience back to 1994 to develop a ratio of the long-term average excess loss ratio to the long-term average normal loss ratio.

Following these additional adjustments, in order to reflect the expected change in costs, the losses are trended from the midpoint of each experience period to the policy period for which the filed rates are assumed to be in effect. Similar to prior dwelling filings, historical claim frequency, loss severity, and pure premium experience were considered in the evaluation of loss trends. The historical experience is adjusted to the prospective period using selected loss trends that are based on the data described above.

In addition to reflecting a loss trend, a premium trend is also determined by combining current amount factors with premium projection factors for each accident year. The current amount factors are developed by comparing the average policy amount relativity for each accident year to the comparable relativity for the most recent year in the experience period. The premium projection factors are calculated based on the fitted annual change in the average policy amount relativity for each policy form.

In my opinion, the selections and methodologies referenced above, including the excess factor, the loss adjustment expense factors, the loss trend factors, and the premium trend factors, are reasonable and actuarially sound.

After adjusting the losses for each of the items mentioned above, each year's trended losses and loss adjustment expenses are divided by the earned house years to determine the average trended loss cost. The average trended loss costs are converted to trended base class loss costs by dividing by the average rating factor applicable to each accident year. Finally, these base class loss costs are weighted together to develop a weighted trended base class loss cost for fire and a weighted trended non-hurricane base class loss cost for extended coverage. The weights applied to each accident year differ between fire and extended coverage

because there tends to be more variation in the extended coverage loss costs as compared to the fire loss costs. As a result, to avoid giving too much weight to an unusually high or low loss cost, an even distribution of weights is applied to the historical experience for extended coverage. By contrast, a distribution that assigns more weight to the more recent years is used for fire, since that segment typically has more stable base class loss costs.

In my opinion, the methodology used to develop average loss costs and the weights assigned to each of the dwelling policy forms are reasonable and are consistent with widely used actuarial ratemaking practices.

Q. In the previous response, you mentioned a loss adjustment expense provision. How are the dwelling provisions for loss adjustment expense determined?

A. The allocated and unallocated loss adjustment expenses are included with non-hurricane losses by applying a trended loss adjustment expense factor. Using information received from the Rate Bureau's data call for expense experience, loss adjustment expenses are summarized for calendar years 2020 through 2024. Consistent with prior dwelling filings, a three-year average is calculated after removing the highest and lowest ratio of expenses to losses from the five years of historical expense experience referenced above. By excluding the highest and lowest ratios observed in the historical experience period, this methodology reduces the volatility in the average loss adjustment expense ratio that may result from variation in the underlying incurred losses from year to year. After the average loss adjustment expense ratio is calculated, it is adjusted to reflect the difference in the loss adjustment expense trend and the loss trend.

A separate provision for hurricane-related loss adjustment expenses is included in the modeled hurricane losses based on data and a recommendation provided by Aon.

Q. In your opinion, are the provisions for loss adjustment expenses reasonable?

A. Yes, the loss adjustment expense provisions are reasonable. It is common practice in the industry to use an average of historical experience to determine a loss adjustment expense provision, and it is reasonable to adjust that provision for expected differences in the loss adjustment expense trend and the loss trend, as we have done here.

Q. Is credibility considered in the rate-level indication?

A. Yes, credibility is considered. At the statewide level, based on the volume of data supporting the statewide rate-level indications, both fire and extended coverage are considered fully credible. The full credibility standards are 500,000 house years

for fire and 330,000 house years for extended coverage. When the territorial rate-level indications are calculated, partial credibility is determined using the square root rule and rounding the credibility down to the nearest 10%. The use of the square root rule to determine partial credibility is a long-standing actuarial methodology used throughout the industry.

Q. How is hurricane exposure reflected in each policy form's rate-level indication?

A. Similar to the Rate Bureau's 2023 dwelling filing, this filing reflects hurricane exposure in the extended coverage rate-level indications by using modeled hurricane losses rather than actual hurricane loss experience. Although there are actual hurricane losses in the experience period, the hurricane and excess losses have been removed from the historical loss experience, as noted in my testimony above. Actual hurricane losses have a significant amount of variability even when evaluating twenty or more years of historical loss experience in a state. As such, it is universally accepted by the property and casualty insurance industry that hurricane models provide the most reliable approach to determining anticipated average annual hurricane losses over an extended time period. Hurricane models can be used to simulate 100,000 or more years of events, which provides a broader perspective on potential insured losses as compared to only evaluating the last several decades of losses. This broader perspective provides a more reliable estimate of the average frequency and severity of insured hurricane losses. Similarly, it provides a more reliable estimate of the frequency and severity of rare but very severe events that may not have occurred within the last 100 years of recorded history, but have the potential to occur next year.

Q. How is the provision for expected hurricane losses determined?

A. The provision for average annual hurricane losses in this filing is consistent with the 2023 dwelling filing in that expected hurricane losses are developed through the use of hurricane models of two independent catastrophe modelers. To facilitate the use of two hurricane models – the AIR model and the RMS model – the Rate Bureau retained Aon to run both models and to develop modeled hurricane losses using the blended results of these two models. I am familiar with the assumptions selected as inputs to each model, and it is my opinion that the assumptions were applied consistently in both the AIR and RMS models such that the resulting output of both models is comparable. However, because Aon ran both models, I am relying on the work and opinion of Minchong Mao of Aon as they relate to specific details about the modeling process. The reliance on Aon to run both models and to develop modeled hurricane losses using the blended results of these two models is consistent with the 2023 dwelling filing.

The Rate Bureau requested that Aon combine the results of the two hurricane models by averaging the results from each model. This approach of giving equal weight to each model is intuitive, easy to understand, and the most reasonable

method of blending two hurricane models. This blending approach (i.e., averaging) is also a common practice among insurance companies that consider multiple hurricane models. Based on my review of the blended model results, it is my opinion that the resulting hurricane losses reflected in this filing are reasonable and can be relied upon for the various purposes for which modeled hurricane losses are used in this filing. Additionally, since both models are equally credible, it is also my opinion that assigning equal weight to each model is the most reliable blending method and the most actuarially sound approach for considering two hurricane models.

Q. What model versions and modeling assumptions were used to develop estimated hurricane losses?

A. The current AIR model is Touchstone v12 and the current RMS model is RiskLink v23. To develop the expected hurricane losses, Aon relied on AIR's Standard hurricane model and on RMS' Historical hurricane model. These models were used instead of AIR's Warm Sea-Surface Temperature (WSST) hurricane model and RMS' Medium-Term Rate hurricane model. Although many primary insurance companies consider the WSST and Medium-Term Rate hurricane models when developing expected hurricane losses for indicated rates in states other than North Carolina, the hurricane models selected for this filing are reasonable and actuarially sound.

Both the AIR and RMS models were run with aggregate demand surge included, which was identified as loss amplification in the RMS model. This standard procedure accounts for the expected additional cost for labor and materials after a hurricane occurs. Historical experience shows that, when catastrophic events occur, the increased demand for building materials, labor, temporary housing, and other basic necessities can exceed the supply of these same items, which consequently increases their cost. Running models with demand surge is consistent with the Rate Bureau's prior dwelling filings and is the common practice by insurance companies when developing rates based on modeled hurricane losses. Although the demand surge component of each model was used in this filing, the storm surge component of each model was not used to develop hurricane losses.

Q. Were any other calculations applied to the hurricane losses derived from the models?

A. Yes. Before providing the blended hurricane losses, Aon applied a hurricane-specific provision for loss adjustment expense. After Aon provided the modeled hurricane losses (including LAE), ISO calculated a trended modeled hurricane base class loss cost for the extended coverage segment of the filing. The trended modeled hurricane base class loss cost has been adjusted for LAE and trended such that the resulting amount is evaluated at a point in time consistent with the amount developed for the weighted trended non-hurricane base class loss cost.

Q. How are the provisions for commission and brokerage determined?

A. The provisions for commission and brokerage are determined based on the latest three-year average of the ratio of each segment's commission and brokerage expense relative to each segment's actual written premium (i.e., written premium including deviations). Deviations are included in the premium amounts underlying this calculation in order to be consistent with the actual calculation of commission and brokerage amounts paid by individual companies within the industry.

Q. In your opinion, are the provisions for commission and brokerage reasonable?

A. Yes, the commission and brokerage provisions are reasonable. It is common practice in the industry to use a three-year average to determine a commission and brokerage provision.

Q. How are the provisions for taxes, licenses, and fees determined?

A. The provisions for taxes, licenses, and fees are determined based on the latest three-year average of the ratio of each segment's taxes, licenses, and fees expense relative to each segment's actual written premium (i.e., written premium including deviations). Deviations are included in the premium amounts underlying this calculation in order to be consistent with the actual calculation of taxes, licenses, and fees paid by individual companies within the industry.

Q. In your opinion, are the provisions for taxes, licenses, and fees reasonable?

A. Yes, the taxes, licenses, and fees provisions are reasonable. As with the commission and brokerage provisions, it is common practice in the industry to use a three-year average to determine a provision for taxes, licenses, and fees.

Q. How are the provisions for other acquisition expense determined?

A. The provisions for other acquisition expense are determined based on the latest three-year average of the ratio of each segment's other acquisition expense relative to each segment's earned premium at current manual level (i.e., earned premium excluding deviations).

The selected other acquisition expense provisions are then added to the selected general expense provisions and trended from the midpoint of the three-year historical experience period to the midpoint of the trend period based on an expense trend derived from cost indices. Following this, the trended fixed expense provisions are adjusted for premium trend and applied to the latest-year average base class rates to develop a trended fixed expense per policy for fire and for extended coverage.

Q. In your opinion, are the provisions for other acquisition expense reasonable?

A. Yes, the other acquisition expense provisions are reasonable. It is common practice in the industry to use a three-year average to determine a provision for other acquisition expense, and to trend fixed expense provisions to account for inflation.

Q. How are the provisions for general expense determined?

A. The provisions for general expense are determined based on the latest three-year average of the ratio of each segment's general expense relative to each segment's earned premium at current manual level (i.e., earned premium excluding deviations).

As noted above, the selected general expense provisions are then added to the selected other acquisition expense provisions and trended from the midpoint of the three-year historical experience period to the midpoint of the trend period based on an expense trend derived from cost indices. The trended fixed expense provisions are adjusted for premium trend and applied to the latest-year average base class rates to develop a trended fixed expense per policy for fire and for extended coverage.

Q. In your opinion, are the provisions for general expense reasonable?

A. Yes, the general expense provisions are reasonable. It is common practice in the industry to use a three-year average to determine a general expense provision, and to trend fixed expense provisions to account for inflation.

Q. Is a provision for dividends included in the filing?

A. Yes, the Rate Bureau reviewed historical data for fire and extended coverage and developed provisions for expected dividends separately for each segment. The Rate Bureau evaluated five years of historical experience and selected provisions for dividends of 0.2% for fire and 0.5% for extended coverage. These provisions were based on five-year average ratios of the total dividends issued by dwelling insurers in North Carolina to the total direct written premium of those same companies.

The Actuarial Standard of Practice (ASOP) No. 29 regarding *Expense Provisions in Property/Casualty Insurance Ratemaking* states:

> The *Statement of Principles Regarding Property and Casualty Insurance Ratemaking* of the Casualty Actuarial Society (CAS) classifies dividends as an expense to operations. When the actuary determines that dividends are a reasonably expected expense and are associated with the risk transfer,

> the actuary may include a provision in the rate for the expected amount of dividends. In making this determination, the actuary should consider the following: the company's dividend payment history, its current dividend policy or practice, whether dividends are related to loss experience, the capitalization of the company, and other considerations affecting the payment of dividends.

As stated in ASOP NO. 29, dividends are classified as an operating expense. In addition to the above excerpt from the *Statement of Principles Regarding Property and Casualty Insurance Ratemaking*, the Statement also provides that indicated rates should reflect the expected costs associated with insuring dwelling policies, including all operating expenses. As such, since dividends are classified as an operating expense, it is consistent with the *Statement of Principles Regarding Property and Casualty Insurance Ratemaking* and ASOP No. 29 to include provisions for dividends in the proposed rates reflected in this filing.

In addition to these actuarial guidelines, in § 58-36-10 of the North Carolina General Statutes, item (2) states that the making and use of rates shall give due consideration "to actual loss and expense experience within this State …; to dividends, savings, or unabsorbed premium deposits allowed or returned by insurers to their policyholders, members, or subscribers; … to past and prospective expenses specially applicable to this State; and to all other relevant factors within this State." The historical data reviewed by the Rate Bureau and used to develop provisions for expected dividends reflects actual expense experience within the State. The provisions for dividends consider past expenses specially applicable to the State. As a result, from my perspective as an actuary, it appears to be consistent with the North Carolina General Statutes to include provisions for dividends, based on actual historical experience, in the proposed rates reflected in this filing.

Q. In your opinion, are the provisions for dividends reasonable?

A. Yes, the provisions for dividends are reasonable. It is reasonable and actuarially sound to calculate a five-year average ratio to determine a provision for dividends, and to treat this provision in a similar manner as a variable underwriting expense.

By reviewing five years of historical experience to determine provisions for dividends, the Rate Bureau is complying with the *Statement of Principles Regarding Property and Casualty Insurance Ratemaking* and the North Carolina General Statutes by considering the dividend payment history and ensuring that the selected provisions are reasonably expected expenses.

Q. Is a contingency provision included in the filing?

A. Yes, the Rate Bureau is including a 1% contingency provision in this filing. This is consistent with the prior dwelling rate filings submitted by the Rate Bureau.

In addition to being consistent with prior Rate Bureau filings, the use of a contingency provision is common within the property and casualty insurance industry. According to the *Actuarial Standard of Practice No. 30: Treatment of Profit and Contingency Provisions and the Cost of Capital in Property/Casualty Insurance Ratemaking,* "the actuary should include a contingency provision if the assumptions used in the ratemaking process produce cost estimates that are not expected to equal average actual costs, and if this difference cannot be eliminated by changes in other components of the ratemaking process." There are several reasons why expected cost estimates may not be equal to actual costs. Some of these reasons include adverse court decisions, extension of coverage for unforeseen or unintended exposures, regulatory delay or reduction in filed rate changes, and unexpected large losses not sufficiently recognized in the normal ratemaking process. For each of these reasons, their impact cannot be easily quantified or they cannot be included in other components of the filing. As such, a contingency provision is appropriate and necessary in my opinion.

In addition to these actuarial guidelines, in § 58-36-10 of the North Carolina General Statutes, item (2) states that the making and use of rates shall give due consideration "to actual loss and expense experience within this State …; to a reasonable margin for underwriting profit and to contingencies; … and to all other relevant factors within this State." As a result, from my perspective as an actuary, it appears to be consistent with the North Carolina General Statutes to include a contingency provision in the proposed rates reflected in this filing.

Although most of the reasons listed above cannot be easily quantified, I determined that one reason – the impact of regulatory delays on rate filings – could be pragmatically quantified and provide insight into the magnitude of a reasonable contingency provision. Included with this filing as Exhibit RB-20 is an exhibit I prepared that summarizes the estimated impact of delays in the filing process within the State of North Carolina. The delay in obtaining rate changes, whether caused by the regulatory review process or other delays inherent in the filing process, is merely one of several items listed above that supports the use of a contingency provision in a rate-level indication. Exhibit RB-20 lists the 25 property rate filings submitted by the Rate Bureau between 2008 and 2024. For each filing, I compared the effective date assumed in the rate filing to the actual effective date. This difference, which reflects the delay due to the filing process, ranges from 0 months in the 2019 dwelling filing, to 22 months in the 2011 dwelling filing. After determining the length of delay for each filing, I applied the net trend (i.e., the loss trend offset by the premium trend) in that filing for the number of months of delay to determine the estimated impact of the delay in the filing process on the overall rate level. The estimated impact of delay varies across the 25 filings, ranging from -1.9% in the 2021 MH(C) mobile homeowners filing to +5.9% in the 2008 MH(C) mobile homeowners filing, with an average impact of +1.0%.

Based on prior filings submitted by the Rate Bureau, my experience with property filings submitted by insurance companies in other states, and the 1.0% estimated impact of delays in the North Carolina filing process, it is my opinion that a 1% contingency provision is reasonable, consistent with common actuarial practice, consistent with the North Carolina General Statutes, and appropriate based on fundamental actuarial principles. Again, the impact of delays in the filing process is only one of many reasons that justifies a contingency provision.

Q. Are you providing expert testimony concerning the underwriting profit provision?

A. No, I am relying on the work and opinion of Dr. Zanjani as to the underwriting profit provision. The scope of my analysis and testimony relates to other aspects of the proposed rate filing.

Q. Are you providing expert testimony concerning the development of the compensation for assessment risk provision?

A. No, I am relying on the work and opinion of Minchong Mao of Aon as to the development of the compensation for assessment risk provision. However, because Milliman developed this provision in previous property filings submitted by the Rate Bureau, I reviewed Aon's methodology and results to ensure that the compensation for assessment risk provision in this filing is consistent with previous filings. The scope of my analysis and testimony relates to other aspects of the proposed rate filing.

Q. In your opinion, is it appropriate to include a 2.1% provision for the compensation for assessment risk in dwelling rates in North Carolina?

A. Yes. Insurance companies writing dwelling policies in North Carolina are exposed to the risk of Beach Plan or FAIR Plan assessments as a result of writing voluntary market property insurance in the state. As such, for those insurance companies that retain this exposure, they are entitled to receive fair compensation for bearing that risk and it is appropriate to include that compensation in the dwelling rates. The current provision is based on an analysis completed by Aon that relies on a widely accepted measure of compensation that will fairly compensate insurers for bearing this additional risk to their capital. Moreover, the North Carolina statutes provide that prospective exposure to non-recoupable assessments shall be considered as an appropriate factor in the making of rates by the Rate Bureau.

Q. Earlier, when describing the overall ratemaking methodology that underlies this filing, you said that the expected underwriting expenses include a provision for the net cost of reinsurance. Can you please explain this issue?

A. Yes. Dwelling insurance is one of several types of coverages that has exposure to potential catastrophic events. In such coverages (dwelling, homeowners, and

other property coverages), individual catastrophic events can result in significant losses that exceed the amount of liability the typical insurer can reasonably assume for solvency and financial stability considerations and that can jeopardize the insurer's ability to pay claims. As a result, in these lines of business, insurers routinely purchase reinsurance to mitigate their exposure to extreme events. In order to accurately reflect the expected costs associated with insuring property policies, as discussed in the *Statement of Principles Regarding Property and Casualty Insurance Ratemaking*, it is appropriate to include the cost of this reinsurance in the ratemaking process for these lines of insurance.

Q. Please elaborate on why it is appropriate to include a provision for the net cost of reinsurance in dwelling rates in North Carolina?

A. Insurance providers writing extended coverage on dwelling policies in North Carolina incur a significant cost for bearing the risk of properties exposed to catastrophic events. Regardless of whether the risk of catastrophic losses is retained by the primary insurer or transferred to a reinsurer, the market cost of bearing that risk is a legitimate cost of the risk transfer inherent in the purchase of property insurance and must be included in the rates. As I mentioned, this is a foundational actuarial principle included in the *Statement of Principles Regarding Property and Casualty Insurance Ratemaking.* As such, the net cost of reinsurance should be included in the North Carolina dwelling rates and the North Carolina statutes specifically authorize the inclusion of this provision.

Q. How does this filing reflect the net cost of reinsurance?

A. For many years, the Rate Bureau has included a provision for the net cost of reinsurance. For this filing, the Rate Bureau engaged Aon, one of the world's largest reinsurance brokers, to develop the provision for the net cost of reinsurance. It is my understanding that Aon was retained by the Rate Bureau based on their ability to access relevant data and experience from the reinsurance market, their expertise with catastrophe-related issues, and their prominence in the reinsurance industry.

Q. In your opinion, is it appropriate to allocate reinsurance costs within North Carolina in a way that is proportional to risk?

A. Yes. The risk associated with insuring properties exposed to catastrophic events varies geographically within North Carolina. As such, the cost for bearing that risk should be allocated proportionally to the measurement of risk. In its analysis of reinsurance costs for this filing, Aon provides the statewide provision for the net reinsurance cost and allocates the reinsurance costs to each policy form and each territory. This allocation is appropriate and consistent with the objective of producing rates that are not inadequate, not excessive, and not unfairly discriminatory across policyholders.

Q. Are you providing expert testimony concerning the development of the net cost of reinsurance provision?

A. No, I am relying on the work and opinion of Minchong Mao of Aon as to the development of the net cost of reinsurance provision.

Q. Is a provision for net deviations included in the filing?

A. No, the Rate Bureau reviewed historical data and considered whether to apply a provision for net deviations but elected not to include one in this filing.

Q. Does the filing review the rate-level adequacy by class?

A. Yes. With this filing, the Rate Bureau developed indicated rate-level changes by class (i.e., Buildings or Contents) using a similar methodology as the statewide indication. A base class loss cost is calculated for each class using the historical loss experience. In addition, a credibility value is assigned to each class based on the number of house years underlying each loss cost. As mentioned above, the full credibility standards are 500,000 house years for fire and 330,000 house years for extended coverage. Using the credibility for each class, a credibility-weighted loss cost is determined by class. Additional calculations are applied to each class to reflect expenses, dividends, and reinsurance in a similar manner as applied at a statewide level. The result of these calculations is an indicated rate change by class.

In my opinion, the methodology used to develop the indicated rate change by class is reasonable and is consistent with widely used actuarial ratemaking practices.

Q. Does the filing review the rate-level adequacy by territory?

A. Yes. With this filing, the Rate Bureau developed indicated rate-level changes by territory using a similar methodology as the statewide indication. A base class loss cost is calculated for each territory using the historical loss experience. In addition, a credibility value is assigned to each territory based on the number of house years underlying each loss cost. As mentioned above, the full credibility standards are 500,000 house years for fire and 330,000 house years for extended coverage. Using the credibility for each territory, a credibility-weighted base class loss cost is determined by territory. Additional calculations are applied to each territory to reflect expenses, dividends, and reinsurance in a similar manner as applied at a statewide level. The result of these calculations is an indicated rate-level change by territory, which is allocated to each class based on the statewide indicated rate change by class.

In my opinion, the methodology used to develop the indicated rate-level change by territory and by class is reasonable and is consistent with widely used actuarial ratemaking practices.

Q. Does the filing review the wind exclusion credits and windstorm loss mitigation credits?

A. Yes. Based on the indicated rates by territory (for Territories 110 to 160) and by class that are being proposed with this filing, the wind exclusion credits and windstorm loss mitigation credits are being updated in a corresponding manner. Using the underlying formula for the statewide rate-level indication, an adjustment is made to the appropriate components of the indication formula to reflect the non-wind losses as a percent of the total losses. The indicated non-wind rate is subtracted from the indicated overall rate to determine the indicated wind exclusion credit for each territory. The windstorm loss mitigation credits for Territories 110 to 160 are being revised in a manner proportional to the wind exclusion credits.

In my opinion, the methodology used to develop the revised wind exclusion credits and windstorm loss mitigation credits is reasonable and is consistent with widely used actuarial ratemaking practices.

Q. Does the filing review any other rating factors used in the premium calculation process?

A. Yes. With this filing, the Rate Bureau proposes a revision to the mobile home construction rating factor for extended coverage. The proposed rating factor is being implemented on a revenue-neutral basis through the application of off-balance factors by class and by territory.

The Rate Bureau's review of the mobile home construction rating factor for extended coverage is discussed and supported in Section F of Exhibit RB-1. In that review, the Rate Bureau evaluated five years of non-hurricane historical loss experience and combined that experience with modeled hurricane losses from the analysis performed by Aon. The non-hurricane loss experience included accident years ending December 31, 2019, through December 31, 2023, which were developed to ultimate and adjusted to the base value for all rating variables except for construction type. A similar analysis was performed for the hurricane peril using modeled losses derived from exposures that were earned during the accident year ending December 31, 2023. Average pure premium relativities by construction type were weighted together to develop an overall indicated mobile home construction relativity.

Based on the Rate Bureau's review of the mobile home construction rating factor for extended coverage, this filing proposes to increase the rating factor from 1.25 to 1.50. The extended coverage rates are being offset by class and by territory for the impact of the revised mobile home construction rating factor to ensure that the combined effect of the base rate changes and rating factor change corresponds to the filed changes shown in Section A of Exhibit RB-1. These offsets are determined separately for each class and each territory and can be found in Section F of Exhibit RB-1 (i.e., pages F-6 and F-7).

In my opinion, the methodology used to develop the filed revision to the mobile home construction rating factor for extended coverage is reasonable and is consistent with widely used actuarial ratemaking practices.

Q. What are the indicated rate levels for this filing?

A. The indicated rate level is the actuarially sound and correct rate level for each territory, each segment, and each class. It is the indicated rate change by territory that is needed to cover the expected losses and expenses while still providing a fair and reasonable profit. The indicated rate level is also the rate level that complies with the statutory requirement that rates not be excessive, inadequate, or unfairly discriminatory.

For extended coverage, the statewide indicated rate-level change is 84.8%. Due to differences by territory in historical loss experience, modeled hurricane losses, and other expenses, the indicated change by territory varies throughout the state. For all of the western territories, the indicated change is less than 84.8%, but for several of the territories closer to the coast, the indicated change is greater than 84.8%. The indicated rate-level change by territory is further divided into an indicated Buildings rate-level change and an indicated Contents rate-level change based on the indicated rate change by class (discussed above) relative to the total indicated rate change. For extended coverage, the statewide indicated Contents rate-level change is significantly lower than the statewide indicated Buildings rate-level change. As such, the indicated Contents rate-level change for each territory is also significantly lower than the corresponding indicated Buildings rate-level change.

For fire, the statewide indicated rate-level change is -2.0%. Similar to the extended coverage segment, the indicated change by territory varies across the state, but the variation is less significant. Also similar to the extended coverage segment, the indicated rate-level change by territory is further divided by class such that the indicated Contents rate-level changes are lower than the indicated Buildings rate-level changes in each territory. When the indicated rate changes for fire and extended coverage are combined, the total statewide indicated dwelling rate-level change is 68.3% and a few territories have a combined indicated rate-level change in excess of 75%.

In my opinion, the Rate Bureau’s indicated rate changes for fire and extended coverage are reasonable, actuarially sound, and appropriately reflect the expected costs for dwelling insurance in North Carolina.

Q. What are the filed rate levels for this filing?

A. In order to mitigate the impact of these indicated rate changes on policyholders, the Rate Bureau has filed the indicated rates to be implemented over a two-year period rather than a one-year period. For both fire and extended coverage, the Year 1 rate change for each territory and each class is equal to half of the indicated rate change, where half of the indicated rate change is equal to the square root of the sum of 1.00 and the indicated rate change, minus 1.00 (e.g., for buildings coverage in Territory 160, half of a 67.5% indicated rate change = sqrt (1 + 0.675) – 1 = 0.294 = 29.4%). Similarly, the Year 2 rate changes for fire and extended coverage are equal to the remaining half of the indicated rate changes.

In my opinion, the Rate Bureau's selected two-year rate changes for fire and extended coverage are reasonable and are an effective strategy to mitigate the impact of this filing on policyholders. However, to the extent the loss trends and premium trends are not projected to the time period reflected by the Year 2 change, it should be noted that the filed rates may not keep pace with the net trends during Year 2.

Q. I understand that you are not providing an opinion concerning the underwriting profit (profit) provision, the compensation for assessment risk (CAR) provision, or the net cost of reinsurance (NCOR) provision. If I ask you to assume that the provisions for profit, CAR, and NCOR are reasonable and actuarially sound, then in your opinion, is the overall rate-level indication shown in the dwelling filing by the North Carolina Rate Bureau reasonable and actuarially sound?

A. Yes, if I assume that the provisions for profit, CAR, and NCOR are reasonable, then in my opinion, the overall dwelling rate-level indication shown by the Rate Bureau, and the rate-level indications for each segment, each class, and each territory, are reasonable and actuarially sound.

Q. Assuming that the provisions for profit, CAR, and NCOR are reasonable, do you have an opinion whether the proposed rates reasonably provide for the expected costs for dwelling insurance in North Carolina?

A. Yes, if I assume that the provisions for profit, CAR, and NCOR are reasonable, then in my opinion, the proposed rates in this filing reasonably reflect the expected costs for dwelling insurance in North Carolina. However, as mentioned above, to the extent the loss trends and premium trends are not projected to the time period reflected by the Year 2 change, the proposed rates do not reflect all expected costs for Year 2. The expected costs for Year 2 can be quantified by projecting the loss trends and premium trends to dates further in the future that correspond to Year 2 and comparing the resulting indicated rate changes to the rate changes included in this filing.

Q. Assuming that the provisions for profit, CAR, and NCOR are reasonable, what is your opinion on whether the proposed dwelling rates are not excessive, not inadequate, and not unfairly discriminatory?

A. If I assume that the provisions for profit, CAR, and NCOR are reasonable, then in my opinion, the proposed dwelling rates in this filing are not excessive, not inadequate, and not unfairly discriminatory. However, to the extent the loss trends and premium trends are not projected to the time period reflected by the Year 2 change, the proposed rates are at risk of being slightly inadequate at the time the Year 2 change is implemented.

Q. Does this conclude your testimony?

A. Yes, it does.

PAUL D. ANDERSON, FCAS, CSPA, MAAA
17335 Golf Parkway - Suite 100
Brookfield, WI 53045
Phone: (262) 641-3531
E-mail: paul.anderson@milliman.com

SUMMARY

Property & Casualty (P&C) actuary with more than 32 years of experience in actuarial applications and related fields including ratemaking, product development, predictive modeling, state pricing, field proposals, rate filings, actuarial and statistical research, classification analysis, data analytics, and economic modeling. Experienced in Private Passenger Automobile (including preferred, standard, and non-standard), Personal Property (including homeowners, renters, condominium owners, mobile home, and dwelling), other miscellaneous Personal Lines (including boats, motorcycles, recreational vehicles, and personal umbrella), and various Commercial Lines of Business. Has sound knowledge of product development, product pricing, product implementation, and project management for Personal Lines products. Has working knowledge of other key insurance functions including claims, corporate finance, marketing, reinsurance, sales, and underwriting. Has demonstrated the ability to lead and manage teams of employees to achieve desired business results in various capacities. Has unique combination of analytic ability, business intuition, project management, leadership, and communication skills.

EMPLOYMENT HISTORY

Milliman, Inc. 2007 - Present
Brookfield, Wisconsin

Principal and Consulting Actuary
Specialize in personal lines insurance company clients and predictive analytics of both personal and commercial lines of insurance. Experience has included ratemaking and pricing analyses for insurance companies, product development and implementation, classification analysis using multivariate statistical techniques, catastrophe reinsurance analysis, loss reserving, segmentation analysis to support sales and marketing initiatives, impact analysis of proposed state and federal legislation, and merger and acquisition analysis. Has also provided expert testimony to support Auto and Property regulatory issues.

Allstate Insurance Company 1993 - 2007
Northbrook, Illinois

Senior Manager – Auto & Property Pricing (2006-2007)
Oversaw and directed all personal lines Auto and Property pricing, rate filings, and other actuarial work related to the pricing function for 10 states accounting for over $4 billion of premium. Assisted in the oversight of all personal lines actuarial work related to the pricing function for an additional 12 states. Served as the primary department expert on all Property pricing initiatives. Directly managed a staff of 10 to 12 employees and participated in the leadership team that oversaw the management of a department with more than 130 employees.

Team Leader – Property & Specialty Lines Research (2005-2006)
Managed all research projects for personal lines Property and for Specialty Lines, all of which were completed using multivariate statistical analyses. Measured the impact of rating algorithm changes as they were implemented in various states. Oversaw the enhancement and improvement of analysis techniques used within the team. Led a team of 8 to 10 staff.

Research Manager (1999-2001, 2003-2005)
At different times, managed research teams for personal lines Auto, Economics & Modeling, and personal lines Property. Oversaw the development of countrywide pricing models based on multivariate statistical techniques, the evaluation of risk characteristics to be used as new rating elements, and the development of implementation tools to be used by pricing teams. Oversaw the development of Auto and Property economic models that measured the lifetime profitability of personal lines insurance customers. Led teams of staff ranging in size from 3 to 6 analysts.

Pricing Manager (1997-1999, 2001-2003)
Managed all personal lines Auto and Property pricing, rate filings, and other actuarial work related to the pricing function for California. Managed all personal lines Property pricing, rate filings, and other actuarial work related to the pricing function for 14 states including Alabama, Florida, Louisiana, and Mississippi. Led teams of staff ranging in size from 3 to 6 analysts.

Pricing Analyst, Research Analyst (1993-1997)
Produced rate proposals, rate filings, and quarterly rate-level indications for various states. Retrieved, manipulated, and analyzed large volumes of data to evaluate countrywide rating plans using multivariate statistical analyses.

EXPERT WITNESS EXPERIENCE

Expert Testimony in Rate Hearing – 2024 Homeowners Insurance Rate Filing submitted by the North Carolina Rate Bureau

Pre-filed Expert Testimony – Various Private Passenger Automobile and Residential Property Insurance Rate Filings submitted by the North Carolina Rate Bureau

- *Private Passenger Automobile Insurance Rate Filings – 2019, 2023, 2025*
- *Homeowners Insurance Rate Filings – 2017, 2018, 2020, 2024*
- *Dwelling Insurance Rate Filings – 2016, 2018, 2019, 2020, 2022, 2023*
- *Mobile Homeowners MH(C) Insurance Rate Filings – 2019, 2021, 2022, 2024*
- *Mobile Homeowners MH(F) Insurance Rate Filings – 2019, 2021, 2022, 2024*

EDUCATION

BS in Actuarial Science from Drake University, Des Moines, Iowa

PROFESSIONAL QUALIFICATIONS

Certified Specialist in Predictive Analytics (CSPA), 2018
Fellow of the Casualty Actuarial Society (FCAS), 2002
Member of the American Academy of Actuaries (MAAA), 2002
Associate of the Casualty Actuarial Society (ACAS), 1998
Member of the Midwest Actuarial Forum, 1998

PROFESSIONAL ACTIVITIES

Member, CAS Volunteer Resources Task Force, 2021 - Present
Volunteer Chairperson, CAS Crash Course Seminar Task Force, 2021 - 2024
Chairperson, CAS Crash Course in Vehicle Technology & Driverless Cars Committee, 2020 - 2021
Member, CAS Volunteer Resources Advisory Committee, 2020 - 2021
Member, CAS Participation Survey Task Force, 2018 - 2019
Member, Vehicle Technology & Impact on Loss Trends Planning Committee, 2017 - 2018
Member, iCAS Predictive Analytics Syllabus Committee, 2017 - 2018
Member, CAS Volunteer Resources Committee, 2013 - 2020
Member, CAS Volunteer Support Task Force, 2012 - 2013
Member, CAS Examination Committee, 2004 - 2006

PUBLICATIONS

"2024 Commercial auto liability statutory financial results", *Milliman Insight*, July 2025.
"2024 Workers' compensation statutory financial results", *Milliman Insight*, July 2025.
"2023 Commercial auto liability statutory financial results", *Milliman Insight*, April 2024.
"Commercial auto liability: Summary of 2022 statutory financial results", *Milliman Insight*, June 2023.
"Commercial auto liability: Summary of 2021 statutory financial results", *Milliman Insight*, August 2022.
"Keep on trucking: COVID-19 and its impact on commercial auto", *Milliman Insight*, April 2020.
"PIP PIP hooray! The changing Michigan auto market", *Milliman Insight*, April 2020.
"Nowhere to drive: The impact of COVID-19 on the auto insurance industry", *Milliman Insight*, March 2020.
"The big one", *Milliman Insight*, November 2009.
"Better Visibility: Predictive modeling helps to steady medical malpractice underwriting", *Best's Review*, February 2008.
"California wildfires: implications for insurers and policyholders", *Milliman Insight*, November 2007.

PRESENTATIONS

Numerous presentations at Casualty Actuarial Society (CAS) and other Property & Casualty insurance industry meetings and seminars from 2007 through the present with a focus on personal lines Auto and Property issues, as well as predictive analytics topics.

NORTH CAROLINA
DWELLING PROPERTY INSURANCE

Estimated Impact of Delays in Rate Filing Process

NCRB Rate Filing	Policy Type / Coverage	Premium Weight	(1) Assumed Effective Date	(2) Actual Effective Date	(3) # of Months of Delay	(4) Selected Loss Trend	(5) Selected Premium Trend	(6) Estimated Impact of Delay in Filing Process
2024 MH(C)	Mobile Home Structures	$84,347,238	10/1/24	9/1/25	11	8.0%	5.4%	2.3%
	Adjacent Structures	6,844,153	10/1/24	9/1/25	11	14.0%	8.1%	5.0%
	Personal Effects	14,130,305	10/1/24	9/1/25	11	5.0%	7.9%	-2.5%
	Liability	2,848,866	10/1/24	9/1/25	11	9.0%	0.7%	7.5%
	Total	$108,170,562						2.0%
2024 MH(F)	Owners	$56,651,185	10/1/24	9/1/25	11	5.0%	4.7%	0.3%
	Tenants	130,709	10/1/24	9/1/25	11	5.0%	2.3%	2.4%
	Total	$56,781,894						0.3%
2024 HO	Owners	$2,800,629,255	8/1/24	6/1/25	10	6.5%	5.0%	1.2%
	Tenants	80,339,123	8/1/24	6/1/25	10	4.0%	0.0%	3.3%
	Condos	38,624,005	8/1/24	6/1/25	10	4.5%	2.0%	2.0%
	Total	$2,919,592,383						1.3%
2023 Dwelling	Fire	$74,789,801	6/1/24	11/1/24	5	9.0%	5.0%	1.6%
	EC	281,463,075	6/1/24	11/1/24	5	9.0%	5.0%	1.6%
	Total	$356,252,876						1.6%
2022 MH(C)	Mobile Home Structures	$64,510,959	7/1/23	10/1/23	3	12.0%	3.2%	2.1%
	Adjacent Structures	5,337,948	7/1/23	10/1/23	3	6.0%	5.0%	0.2%
	Personal Effects	11,872,318	7/1/23	10/1/23	3	2.8%	4.8%	-0.5%
	Liability	2,467,108	7/1/23	10/1/23	3	8.0%	1.0%	1.7%
	Total	$84,188,333						1.6%
2022 MH(F)	Owners	$47,454,596	7/1/23	10/1/23	3	9.0%	3.8%	1.2%
	Tenants	114,906	7/1/23	10/1/23	3	2.8%	1.2%	0.4%
	Total	$47,569,502						1.2%
2022 Dwelling	Fire	$71,710,360	2/1/23	6/1/23	4	6.5%	5.0%	0.5%
	EC	246,871,993	2/1/23	6/1/23	4	7.0%	5.0%	0.6%
	Total	$318,582,353						0.6%
2020 HO	Owners	$2,161,073,789	8/1/21	6/1/22	10	6.0%	1.1%	4.0%
	Tenants	76,318,464	8/1/21	6/1/22	10	0.5%	-2.0%	2.1%
	Condos	31,251,398	8/1/21	6/1/22	10	5.0%	0.0%	4.1%
	Total	$2,268,643,651						4.0%
2021 MH(C)	Mobile Home Structures	$55,402,780	11/1/21	5/1/22	6	-2.0%	2.7%	-2.3%
	Adjacent Structures	4,435,898	11/1/21	5/1/22	6	10.2%	4.4%	2.7%
	Personal Effects	10,600,963	11/1/21	5/1/22	6	-2.0%	4.4%	-3.1%
	Liability	2,198,331	11/1/21	5/1/22	6	8.0%	0.7%	3.5%
	Total	$72,637,972						-1.9%
2021 MH(F)	Owners	$41,984,133	11/1/21	5/1/22	6	1.0%	2.7%	-0.8%
	Tenants	95,516	11/1/21	5/1/22	6	-2.0%	1.0%	-1.5%
	Total	$42,079,649						-0.8%
2020 Dwelling	Fire	$71,555,474	9/1/21	11/1/21	2	0.0%	1.2%	-0.2%
	EC	229,061,439	9/1/21	11/1/21	2	9.0%	1.5%	1.2%
	Total	$300,616,913						0.9%
2019 Dwelling	Fire	$83,923,771	7/1/20	7/1/20	0	2.0%	1.1%	0.0%
	EC	241,506,295	7/1/20	7/1/20	0	3.2%	0.8%	0.0%
	Total	$325,430,066						0.0%
2019 MH(C)	Mobile Home Structures	$52,069,226	2/1/20	6/1/20	4	3.5%	1.6%	0.6%
	Adjacent Structures	4,212,665	2/1/20	6/1/20	4	4.0%	2.8%	0.4%
	Personal Effects	10,255,303	2/1/20	6/1/20	4	2.0%	4.1%	-0.7%
	Liability	2,410,058	2/1/20	6/1/20	4	5.0%	n/a	1.6%
	Total	$68,947,252						0.5%
2019 MH(F)	Owners	$51,661,941	2/1/20	6/1/20	4	0.7%	-0.5%	0.4%
	Tenants	66,881	2/1/20	6/1/20	4	2.0%	2.1%	0.0%
	Total	$51,728,822						0.4%

NORTH CAROLINA
DWELLING PROPERTY INSURANCE

Estimated Impact of Delays in Rate Filing Process

NCRB Rate Filing	Policy Type / Coverage	Premium Weight	(1) Assumed Effective Date	(2) Actual Effective Date	(3) # of Months of Delay	(4) Selected Loss Trend	(5) Selected Premium Trend	(6) Estimated Impact of Delay in Filing Process
2018 HO	Owners	$2,017,285,314	10/1/19	5/1/20	7	4.6%	1.0%	2.0%
	Tenants	72,370,871	10/1/19	5/1/20	7	-3.1%	-1.4%	-1.0%
	Condos	29,047,171	10/1/19	5/1/20	7	1.9%	0.2%	1.0%
	Total	$2,118,703,356						1.9%
2018 Dwelling	Fire	$102,088,428	6/1/18	2/1/19	8	0.2%	2.3%	-1.3%
	EC	187,663,877	6/1/18	2/1/19	8	0.4%	2.1%	-1.1%
	Total	$289,752,305						-1.2%
2017 HO	Owners	$2,010,516,565	6/1/18	10/1/18	4	3.1%	1.1%	0.7%
	Tenants	62,551,401	6/1/18	10/1/18	4	-3.1%	-1.0%	-0.7%
	Condos	24,591,783	6/1/18	10/1/18	4	1.9%	0.5%	0.5%
	Total	$2,097,659,749						0.6%
2014 HO	Owners	$2,257,970,589	7/1/14	6/1/15	11	5.3%	2.3%	2.7%
	Tenants	45,065,871	7/1/14	6/1/15	11	2.9%	-1.0%	3.6%
	Condos	22,629,842	7/1/14	6/1/15	11	5.4%	0.0%	5.0%
	Total	$2,325,666,302						2.7%
2014 MH(C)	Property	$77,349,418	6/1/15	10/1/15	4	3.0%	2.8%	0.1%
	Liability	1,546,804	6/1/15	10/1/15	4	2.8%	n/a	0.9%
	Total	$78,896,222						0.1%
2014 MH(F)	Owners	$44,750,216	6/1/15	10/1/15	4	4.6%	2.2%	0.8%
	Tenants	100,658	6/1/15	10/1/15	4	2.5%	-0.2%	0.9%
	Total	$44,850,874						0.8%
2012 HO	Owners	$2,168,814,729	6/1/13	7/1/13	1	5.4%	3.0%	0.2%
	Tenants	32,405,190	6/1/13	7/1/13	1	4.0%	0.0%	0.3%
	Condos	18,252,996	6/1/13	7/1/13	1	4.0%	2.0%	0.2%
	Total	$2,219,472,915						0.2%
2011 Dwelling	Fire	$84,664,174	6/1/11	4/1/13	22	3.6%	2.9%	1.3%
	EC	150,823,062	6/1/11	4/1/13	22	4.1%	2.8%	2.3%
	Total	$235,487,236						2.0%
2008 HO	Owners	$1,498,766,325	1/1/09	5/1/09	4	4.4%	3.9%	0.2%
	Tenants	24,074,875	1/1/09	5/1/09	4	0.2%	2.7%	-0.8%
	Condos	13,213,524	1/1/09	5/1/09	4	0.2%	2.9%	-0.9%
	Total	$1,536,054,724						0.1%
2008 MH(C)	Property	$76,284,985	10/1/07	12/1/08	14	7.5%	2.4%	5.9%
	Liability	1,161,840	10/1/07	12/1/08	14	4.0%	n/a	4.7%
	Total	$77,446,825						5.9%
2008 MH(F)	Owners	$43,659,180	10/1/07	12/1/08	14	6.6%	5.8%	0.9%
	Tenants	158,638	10/1/07	12/1/08	14	0.4%	-4.1%	5.5%
	Total	$43,817,818						0.9%
						Average Estimated Impact of Delays in Filing Process:		**1.0%**

(1), (4), (5) From historical NCRB rate filings
(2) From historical NCRB settlement agreements or circulars
(6) = {[1 + (4)] / [1 + (5)]} ^ {[(2) - (1)]/365} - 1

PREFILED TESTIMONY
OF
GEORGE ZANJANI

DWELLING INSURANCE RATE FILING

NORTH CAROLINA RATE BUREAU
OCTOBER, 2025

I. Qualifications and Summary

Q: What is your name, occupation, and business address?

A: My name is George Zanjani. I am Professor of Finance and the holder of the Frank Park Samford Chair of Insurance at the University of Alabama. My business address is 1074 Alderwood Lane NE, Marietta, Georgia 30068.

Q: Please describe your educational and employment background.

A: A complete curriculum vitae is attached as Exhibit RB-22 with this testimony. To summarize, my undergraduate studies were at Stanford University from 1987-1990, where I earned an A.B./B.S in Economics and Biology. I joined the commercial lines actuarial department of Fireman's Fund Insurance Companies in 1990 as an Assistant Actuarial Analyst. Upon leaving in 1994, I was a Senior Actuarial Analyst, an Associate of the Casualty Actuarial Society, and the head of the company's Workers Compensation actuarial unit. I did my graduate studies in Economics at the University of Chicago, earning a Ph.D. in 2000. I joined the Research Department of the Federal Reserve Bank of New York in the Capital Markets Function as a Research Economist in 2000, leaving as a Senior Economist in 2008. I joined the Robinson College of Business of Georgia State University in 2008 as an Associate Professor of Risk Management and Insurance and was honored as the inaugural holder of the AAMGA Distinguished Chair in Risk Management and Insurance in 2011. I started my current position in 2017.

Q: Please elaborate on some of your professional activities.

A: My professional career has been focused on insurance. After four years of actuarial work in commercial lines insurance, my dissertation addressed the economics of insurance pricing. I specialized on insurance issues while at the Federal Reserve Bank of New York. In particular, I served for the Bank on the Presidential Working Group on Financial Markets during its review of the renewal of the Terrorism Risk Insurance Act in 2006 and on the Committee on the Global Financial System Task Force on Institutional Investors, Global Savings, and Asset Allocation.

My academic service activities include 1) service as referee for various academic journals, 2) former service as an associate editor for the *Journal of Insurance Issues* and a senior editor for the *Journal of Risk and Insurance* and 3) current service as a deputy editor-in-chief for the *Journal of Risk and Insurance* and an associate editor for *Insurance: Mathematics and*

Economics. In addition, I have served on the Board of the American Risk and Insurance Association and served as President of that association. I have also served as President of the Risk Theory Society. I currently serve on the International Research Advisory Board of National Chengchi University.

As an academic, I continue to write on insurance pricing, participate in academic conferences on insurance, and engage in various sponsored research and consulting activities related to insurance. The latter activities include two research projects on capital allocation and a third on loss reserving, all sponsored by the Casualty Actuarial Society, and a project on the financial crisis and the insurance industry sponsored by the Society of Actuaries in 2009. In addition, I have taught various courses at the undergraduate and graduate levels over the past decade, including classes on financial risk management, risk modeling, and property-casualty insurance.

Q: Have you published any papers or books?

A: Yes. I have published various articles, book chapters, reviews, and white papers on insurance pricing and other aspects of insurance markets. Published or forthcoming work includes articles on insurance topics in the *American Economic Review*, *Insurance: Mathematics and Economics*, the *Journal of Banking and Finance,* the *Journal of Financial Economics*, the *Journal of Public Economics*, the *Journal of Risk and Insurance*, *Management Science,* the *North American Actuarial Journal*, and *Variance.* My co-authors and I have a chapter in the 2025 edition of the Handbook of Insurance on the theory and practice of insurance pricing. Two papers have won awards for their contributions to the field of actuarial science: I received the 2010 ARIA award from the Casualty Actuarial Society and shared the 2015 Charles A. Hachemeister Prize (also from the Casualty Actuarial Society) with a co-author.

Q: Are you a member of any professional organizations?

A: I am a member of the American Economic Association, the American Finance Association, the American Risk and Insurance Association, and the Risk Theory Society. I am also an Associate of the Casualty Actuarial Society. I served on the Board of Directors of the American Risk and Insurance Association from 2007 to 2014 and served as President in 2012-2013. I served as President of the Risk Theory Society in 2012.

Q: Have you ever testified in insurance rate regulatory proceedings?

A: Yes. I have offered testimony in Workers Compensation insurance rate filings in Florida (2015 and 2017), Massachusetts (2020, and 2022 through 2025), and Virginia (2016). In addition, I have supplied testimony for various rate filings in North Carolina starting in 2019, including Workers Compensation, Private Passenger Auto, Homeowners, Mobile Homeowners, Flood, and Dwelling.

Q: What was the nature of your testimony in those previous cases?

A: In the Florida, Massachusetts, and Virginia cases, I offered testimony on the underwriting profit factors used in the rates. Specifically, I evaluated the suitability of the methods and assumptions used to develop those factors, as well as whether the rate of return on capital implied by those factors was reasonable. For the North Carolina filings, I estimated the rate of

return on capital implied by the selected underwriting profit factors and assessed whether that rate of return was reasonable.

Q: What is the purpose of your testimony?

A: I was asked by the North Carolina Rate Bureau, as a financial economist with expertise in insurance, 1) to assist the Bureau with the underwriting profit factor selection, 2) to determine the expected return on insurance net worth implicit in the filing, and 3) to assess whether the expected return on net worth constitutes a reasonable rate of return and thus whether the selected underwriting profit factor satisfies North Carolina's statutory requirements.

Q: Please summarize the main findings of your testimony.

A: The first task was to determine the range for a reasonable rate of return on capital. I started by creating a set of estimates of the cost of insurance equity relevant for the North Carolina Dwelling Fire and Extended Coverage insurance markets. I consulted various third party estimates of the cost of equity for the property-casualty insurance industry. I also generated my own estimates using a single-factor risk premium approach, where the cost of equity was determined by 1) the historical excess return of the overall stock market over bonds, 2) the historical correlation of the equity prices of the firms serving the North Carolina Dwelling Fire and Extended Coverage markets with the overall stock market, and 3) the current level of bond yields. Finally, I adjusted the cost of equity to account for the significant presence of private companies in the North Carolina market. The cost of equity estimates resulting from this exercise ranged from about 8.9% to 17.7% for the Dwelling Fire market and about 8.8% to 17.7% for the Dwelling Extended Coverage market.

Next, I calculated a weighted average cost of capital (WACC) by estimating the fraction of debt in the typical insurance holding company capital structure and weighting together the cost of equity with the cost of debt based on this fraction. The WACC estimates from this exercise ranged from about 8.2% to 16.2% for the Dwelling Fire and Dwelling Extended Coverage markets.

The next task was to determine the projected rate of return on capital associated with the selected underwriting profit provision. Using a pro forma return model similar to that used in previous filings, I analyzed how the selected underwriting profit provisions used in the filing translate into expected returns on net worth. My calculations, as detailed in Exhibits RB-23 and RB-24, show a total return of 13.54% for Dwelling Fire and 11.03% for Dwelling Extended Coverage.

I next considered adjustments to the model that, in my opinion, produce a more accurate representation of the rates of return produced by the selected underwriting profit factors. Specifically, I adjusted the prospective portfolio yields to reflect current market conditions, as opposed to the average of current market yields and embedded yields, and I also adjusted the portfolio allocation to more closely reflect the assets supporting Dwelling coverages in North Carolina. These changes did not have a significant impact, decreasing the total return for

Dwelling Fire to 13.46% and increasing the total return for Dwelling Extended Coverage to 11.29%.

I then compared the projected returns on capital associated with the selected underwriting factors with the cost of equity and WACC ranges described above. The projected total returns fell comfortably within the range of cost of equity estimates and within the range of WACC estimates. I therefore conclude that the projected total returns in both the Dwelling Fire and Dwelling Extended Coverage markets are reasonable and not excessive. The conclusions still hold after adjusting the prospective yields as described above.

II. Expected Return on Net Worth

Q: In general terms, how did you determine the expected return on net worth implied by the underwriting profit provision used in the filing?

A: I used a *pro forma* return model similar to that used in previous filings in North Carolina. The model accounts for underwriting income, installment payment income, investment income on unearned premium and loss/loss adjustment expense (LAE) reserves and surplus,[1] and taxes as a percentage of premium. Total after-tax income from these sources (as a percentage of premium) is then related to net worth (as a percentage of premium) to obtain an expected return on net worth.

Q: What do you mean by *pro forma*?

A: The model is *pro forma* in the sense that it assumes 1) that the indicated rate change will be implemented and 2) that all loss, expense, and investment return realizations will coincide with their projected expected values.

The results of the model and supporting information are presented in Exhibits RB-23 and RB-24.

Q: Could you state what you mean by "net worth"?

A: Net worth is the book value of equity of a company under Generally Accepted Accounting Principles (GAAP) rather than Statutory Accounting Principles (SAP).

Q: Would you please elaborate on the elements of the return and how they are calculated?

A: The return is composed of underwriting profit (Line 2 of Exhibits RB-23/RB-24, Page 1), installment fee income (Line 3 of Exhibits RB-23/RB-24, Page 1), investment gain on insurance transaction (Line 7 of Exhibits RB-23/RB-24, Page 1), and investment gain on surplus (Line 8 of Exhibits RB-23/RB-24, Page 1). (Please note that, in my exhibits and sometimes in my testimony, I refer to investment income on surplus as a shorthand reference to investment income on

[1] I follow common parlance when referring to investment income on reserves and surplus, but it should be noted that investment income is actually earned on assets, not on liabilities.

capital and surplus.) All of the foregoing income components are adjusted for taxes. The components are discussed in greater detail below:

Underwriting profit - As a matter of arithmetic and definition, the underwriting profit as a percentage of premium matches the underwriting profit provision selected by the NCRB. It is the percentage of premium left over after accounting for the loss and expense provisions, with the projected loss and LAE ratio and fixed expense (Other Acquisition and General) ratios being adjusted to reflect the indicated rate change. Installment fee income is based on the average installment charges as a percentage of premium over the past five years (Exhibits RB-23/RB-24, Page 3). The underwriting profit and installment fee income is assumed to be taxed at the current corporate rate of 21% (Line 4 of Exhibits RB-23/RB-24, Page 1), as revised in the Tax Cut and Jobs Act of 2017. I also account for additional tax liabilities relating to IRS rules regarding the treatment of unearned premium reserves and of loss reserves (Line 5 of Exhibits RB-23/RB-24, Page 1). Details of the calculation of these additional tax liabilities are found on Pages 4 to 6 of Exhibits RB-23/RB-24.

Net Investment Gain on Insurance Transaction – This portion of the return reflects investment income on investible funds generated by the insurance transaction. Specifically, this quantity is estimated as the product of an investment yield and the average loss/LAE and unearned premium reserves. An adjustment is made for investment income on agents' balances (specifically, to account for the fact that agents' balances, which are premiums held by agents and not yet remitted to the company, are not available for investment by the insurance company). In the case of Dwelling Extended Coverage analyzed in Exhibit RB-24, where a provision for reinsurance is included in the rate, I also adjust for investment income on reinsurance balances. This accounts for the additional income that the company receives on funds that have not yet been remitted to the reinsurer, as well as the investment income that it is not able to collect on funds that have not yet been recovered from the reinsurer. The details of the estimation of investible reserves and the pre-tax investment income generated from those reserves are found on Pages 7 to 9 of Exhibits RB-23 and 24. The tax liability is based on a weighted average of estimated tax rates on the different sources of investment income, with the weights based on the composition of the overall North Carolina industry portfolio.

Investment Gain on Surplus – This portion of the return reflects investment income generated from surplus. The pre-tax investment yield is applied to investible surplus, the amount of which is based on the ten-year average premium-to-surplus ratio for groups writing Dwelling insurance in North Carolina from Page 14 of Exhibits RB-23/RB-24. The premium-to-surplus ratio for each year is calculated by taking a premium-weighted average of individual group surplus-to-premium ratios---across all groups writing the coverage in question and using DPW for that coverage for weights---and inverting the result. The individual group surplus-to-premium ratios use written premiums on a net basis for Dwelling Fire and on a direct basis for Dwelling Extended Coverage, in recognition of the accounting for reinsurance costs in the rate in the latter case. The tax liability is again based on a weighted average of estimated tax rates on the different sources of investment income, with the weights based on the composition of the overall North Carolina industry portfolio.

These components of after-tax return, all denominated as a percent of premium, are then summed and related to net worth. This is accomplished by multiplying the returns as percent of premium by the product of the premium-to-surplus ratio from Page 14 of Exhibits RB-23/RB-24 and the inverse of the industry-wide net worth-to-surplus ratio from Page 15 of Exhibits RB-23/RB-24.

Q: Please explain how the investment yield is calculated.

A: My understanding is that the accepted approach in North Carolina, based on a decision by the Commissioner in the 1990's, is to estimate the investment yield as an average of the "embedded yield" based on the industry statutory annual statement reports and a "current yield" based on current market rates. I have followed this convention in the analysis presented in Exhibits RB-23/RB-24, though I contemplate the consequences of this convention in more detail later in my testimony.

For the current yield, I start with the weighted average invested asset portfolio for the North Carolina insurance market (using total North Carolina DPW for weights) and use various sources to estimate the current market yields for those assets. Sources for current market rates, and a summary of the overall calculation, are provided on Page 11 of Exhibit RB-23/RB-24. The distribution across investment categories is based on net admitted assets as reported on Page 2 of the Annual Statement, restricting attention to the categories reported on Page 11.

The allocation to bonds[2] is further divided among "U.S. Government," "Municipal," and "Industrial" subcategories. These subcategories follow the categorization in the Schedule D summary exhibits, with the "Municipal" category being comprised of the Schedule D categories of obligations relating to "U.S. States, Territories, and Possessions," "U.S. Political Subdivisions," and "U.S. Special Revenue and Special Assessment Obligations." Again, the distribution across these categories is based on premium-weighted averages.

For each of the bond subcategories, I obtain a maturity distribution for the North Carolina industry portfolio in that subcategory from the Schedule D summary exhibits and match each maturity level from the exhibits to a corresponding bond yield of similar maturity, so that the average yield shown on Page 11 is a weighted average across maturities according to the North Carolina industry portfolio. The maturity buckets in Schedule D are 0 to 1 years, 1 to 5 years, 5 to 10 years, 10 to 20 years, and over 20 years. For the first four buckets, the midpoint maturity within the range is used; for the final category a maturity of 25 years is used. The bond yields are based on the sources described on Page 11 of Exhibit RB-23/RB-24, with linear interpolation being used in cases where the available bond yields do not match up with the average maturity from a Schedule D bucket. The bond yield curve averages for the "Municipal" and "Federal Government" categories are based on the averages of the yield curves from the listed sources at three dates: 8/15/25, 7/15/25, and 6/15/25, with the curve from the last available trading day used in cases where the date falls on a weekend or holiday. The average yield for Cash is derived by averaging the same three points for the 3-month Treasury bill. The "Industrial" curve is

[2] I adjust the allocation between "Cash & Short-Term Investments" and "Bonds" by adding the investments in short-term bonds from Schedule DA and cash-equivalent bonds from Schedule E to the "Bonds" category and subtracting the same from the "Cash & Short-Term Investments" category.

constructed from the monthly HQM 6-month spot rate and the monthly 2-year, 5-year, 10 year, and 30-year HQM par yields, as reported in FRED, for May, June, and July of 2025.

The calculation of the current yields for other investment categories are described in the notes on Page 11 of Exhibit RB-23/24. The overall pre-tax current yield on the industry portfolio as thus determined is 5.56%. The embedded yield calculations, based on the actual investment income reported by the industry, are shown on Pages 12 and 13 of Exhibits RB-23/RB-24; the pre-tax embedded yield is 4.72%. For the pro forma calculations, I average these two figures to obtain 5.14% (shown on Page 10 of Exhibits RB-23/RB-24).

The tax liability for investment income is determined for each asset class, reflecting tax advantages as appropriate on municipal bond interest, preferred and common stock dividends, and capital gains on stock. The expected return on equity is split into a capital gain and dividend component, for tax purposes, based on the experience of the S&P 500 over the 2000-2024 period.

Q: What is the expected return on net worth?

A: To calculate the implied return on insurance company equity, components of after-tax return are summed and related to net worth, which, as a percentage of premium, is calculated based on the product of the premium-to-surplus ratio from Page 14 of Exhibits RB-23/RB-24 and the inverse of the industry-wide net worth-to-surplus ratio from Page 15 of Exhibits RB-23/RB-24. This approach indicates that the selected underwriting profit factor of 8.5%, if achieved, would yield total returns on net worth of 13.54% and 11.03% in the Dwelling Fire market and Dwelling Extended Coverage market, respectively.

Q: Have you considered the impact of any other alternative assumptions on your estimates?

A: Yes, I have considered the impact of basing the investment yield on current yields alone rather than an average of current yields and embedded yields. I have also considered the impact of basing the portfolio allocation on the actual investment portfolios of companies writing Dwelling Fire and Extended Coverage in North Carolina, based on the premiums written in those lines.

The current yield, in my opinion, is the better indicator of investment yields for a prospective ratemaking exercise, where the relevant questions concern the terms on which money will be invested today and in the future. As for the portfolio allocation, I believe the weighted average allocations of the groups writing Dwelling Fire and Extended Coverage in North Carolina, based on their actual North Carolina Dwelling premiums, gives a closer approximation to the allocation supporting North Carolina Dwelling business. The pre-tax current yield, based on this alternative asset allocation, is 5.21% for Dwelling Fire and 5.55% for Dwelling Extended Coverage.

If we calculate the returns on net worth using this current yield alone, rather than the average of the current yield and embedded yield, the total rate of return decreases to 13.46% in the Dwelling Fire market and increases to 11.29% in the Dwelling Extended Coverage market.

Q: How was the underwriting profit factor determined?

A: The Bureau selected the 8.5% provision for both Dwelling Fire and Dwelling Extended Coverage. I participated in the Bureau's Property Rating Subcommittee meeting for the discussion of the profit portion of the rate review. I described for the Subcommittee my pro forma profit analysis and provided an array of underwriting profit provisions and their associated returns on net worth. The returns shown in that array spanned the ranges for the cost of equity and the WACC that I had established and viewed as reasonable, which I will describe in more detail below. Following my presentation and the Subcommittee discussion, the Subcommittee selected the underwriting profit factor.

III. Rate of Return on Capital

Q: What steps did you take in the course of assessing whether the returns described above would produce a reasonable rate of return on capital?

A: I first established ranges for reasonable estimates of the cost of capital. I then compared the estimated statutory and total returns on net worth determined in Section II above to these cost of capital ranges.

Q: How did you establish ranges for reasonable estimates of the cost of capital?

A: The cost of capital for an industry is a difficult figure to pin down, and part of my approach is based on a belief in the wisdom of consulting multiple sources of information. I started by gathering various third-party estimates of the cost of capital for property-casualty firms associated with publicly traded holding companies. I also made an independent set of estimates of the same tailored specifically for the North Carolina Dwelling markets. I then adjusted all of these estimates to account for the presence of private companies in the North Carolina market.

Q: Please describe the third-party estimate sources and methodologies.

A: Kroll (a consultancy that took over the pioneering Ibbotson Cost of Capital franchise) and Damodaran Online (an open-access website maintained by Aswath Damodaran, a valuation expert affiliated with New York University) both publish estimates for the property-casualty industry. Kroll updates the estimates quarterly (the estimates reported below are from 3/31/2025), while Damodaran Online updates the estimates annually (1/1/2025).

Kroll reports estimates from a variety of methodologies. Some estimates use factor models, where the industry's sensitivity to a pricing factor (or sensitivities to a set of factors) are measured and used to generate a cost of capital. For example, single factor models (such as the CAPM) typically mark the overall stock market return in excess of a "base" fixed income return as the pricing factor. The cost of capital is generated in this case by estimating a risk premium for each factor, adjusting that risk premium to account for the sensitivity of the industry in question to that factor, and then adding the adjusted risk premium to the current yield of the "base" fixed income instrument to produce a cost of capital. In addition to CAPM estimates, Kroll also reports a "CAPM + size premium" estimate to recognize the higher cost of capital endured by smaller firms and thus correct for the average size of firms within an industry. The "Buildup Method" employs a related approach, adding a size premium and an industry premium to the standard market risk premium. The Fama-French-5-factor model extends the single risk factor framework of the CAPM to a five-factor risk framework, thus pricing an industry's equity

on the basis of its sensitivity to four additional factors in addition to overall market returns. Kroll also utilizes discounted cash flow (DCF) models, where free cash flow or dividends are forecasted into the future, with the cost of capital estimate being the implied discount rate on the future cash flows that explains the current equity valuation. In general, the two classes of methods---factor models and DCF models---are perhaps the two most widely accepted and widely deployed methods for estimating the cost of equity.

Damodaran reports estimates from a single-factor risk premium model. However, rather than estimating the risk premium associated with the stock market with simple averages of historical excess returns (as is typically done), he modifies the premium to account for the current level of stock market valuation. This distinction is one example of the substantial variation in implementation of factor models, which can have significant effects on the estimates. There is also substantial methodological variation in implementation of the DCF model, which is estimated with different time period stages and with time-varying growth rates. All of this underscores the importance of consulting multiple sources of estimates and testing sensitivities where possible.

The approaches described above all produce estimates of the cost of equity. In the case of Damodaran Online, I updated the 10-year Treasury yield used as the reference point in the calculation to be consistent with 10-year yield used in the other parts of the filing. In each case, the cost of equity is then weighted together with an estimated cost of debt for the industry to produce a WACC for publicly traded firms. The weights are based on the composition of the capital structure (equity versus debt) for the industry.

Q: Please describe how you derived your independent estimates of the cost of equity capital for publicly traded firms.

A: I used a single factor model, also referred to as a "risk premium" approach in previous filings in North Carolina. This approach estimates the cost of equity as

$$r + \beta * (ERP)$$

where r is the current yield on a reference fixed income instrument, ERP is the estimated expected excess return of the stock market over that fixed income yield, and β is the estimated covariation between the equity of the property-casualty industry and the overall stock market (more precisely, the covariance of property-casualty equities with the S&P 500, divided by the variance of the S&P 500).

For the reference interest rate, I tried four different fixed income assets---the 3-month Treasury Bill, the 10-year Treasury Note, the Moody's Seasoned Aaa Corporate Bond Index, and the Moody's Seasoned Baa Corporate Bond Index. In each case, I estimated the equity risk premium as the average excess return of the S&P 500 over the return on the reference fixed income asset over the 1928-2024 period. To calculate the average returns, I used the formula from Blume (1974)[3] by weighting together the arithmetic average and the geometric average, as in:

[3] Blume, M.E. (1974), "Unbiased Estimates of Long-Run Expected Rates of Return," *Journal of the American Statistical Association* (September), pp. 634-8.

$$\left[\frac{N-T}{N-1}(1+\pi_A)^T+\frac{T-1}{N-1}(1+\pi_G)^T\right]^{\frac{1}{T}}$$

where N is the sample size, T is the return horizon (corresponding to the maturity of the fixed income asset), π_A is the arithmetic average return in the sample, and π_G is the geometric average return in the sample. The data used in the analysis to establish the equity risk premia are included in Exhibit RB-25.

For β (beta), I estimated a weighted average beta for the North Carolina Dwelling Fire and Dwelling Extended Coverage markets. For each publicly traded holding company associated with an operating subsidiary underwriting Dwelling insurance in North Carolina in 2024, I pulled the betas provided by S&P Global (based on 1-year and 3-year daily returns) and adjusted them using a Blume correction (a weighted average of the raw beta and one, with the weight on the raw beta being 0.67). I then calculated weighted averages based on 2024 North Carolina Dwelling Fire DPW and 2024 Dwelling Extended Coverage DPW. The company-level data used in this analysis is included in Exhibit RB-26.

Given current yields for the reference fixed income assets and estimates for the equity risk premium and beta, I then calculate a cost of equity according to the formula given above.

Next, I estimated a WACC for the North Carolina market. For the capital structure, I estimated weighted average debt percentages for the North Carolina Dwelling Fire and Extended Coverage markets. For each publicly traded holding company, I calculated the percentage of debt in the capital structure based on the latest fiscal year report. The company-level capital structure details are included in Exhibit RB-26. For the cost of debt, I used the figure for the industry from Damodaran Online of 4.02%, based on a 4.413% 10-year Treasury rate. I again calculated weighted averages separately for the Dwelling Fire and the Dwelling Extended Coverage markets, based on the North Carolina DPW in those respective markets.

Q: What were the results?

A: The following tables list the cost of equity and the WACC for publicly traded companies, including the estimates I produced and those reported by Kroll and Damodaran Online for the property-casualty industry.

Dwelling Fire - Cost of Capital for Publicly Traded Companies									
Source	Method	Current Yield 8/15/2025	Equity Risk Premium	Cost of Equity		Cost of Debt	% Debt	WACC	
Kroll	CAPM			7.7%		4.16%	11.3%	7.3%	
Kroll	CAPM + Size Premium			7.9%		4.36%	11.3%	7.5%	
Kroll	Build-Up			8.8%		4.38%	11.3%	8.3%	
Kroll	Fama-French 5-factor			9.6%		4.29%	11.3%	9.0%	
Kroll	DCF (1-stage)			14.1%		4.37%	11.3%	13.0%	
Kroll	DCF (3-stage)			13.9%		4.17%	11.3%	12.8%	
Damodaran Online	Implied Premium			7.04%		4.02%	13.39%	6.63%	
				Low	High			Low	High
Zanjani	Risk Premium over T-Bill	4.39%	8.44%	10.83%	10.97%	4.02%	8.22%	10.27%	10.40%
Zanjani	Risk Premium over T-Note	4.41%	6.87%	9.65%	9.76%	4.02%	8.22%	9.19%	9.29%
Zanjani	Risk Premium over Aaa Bond	5.46%	6.01%	10.05%	10.14%	4.02%	8.22%	9.55%	9.64%
Zanjani	Risk Premium over Baa Bond	6.13%	4.76%	9.76%	9.84%	4.02%	8.22%	9.29%	9.36%
* After-tax cost of debt for Kroll is not reported but is inferred based on the cost of equity, % of debt, and the WACC.									

Dwelling Extended Coverage - Cost of Capital for Publicly Traded Companies									
Source	Method	Current Yield 8/15/2025	Equity Risk Premium	Cost of Equity		Cost of Debt	% Debt	WACC	
Kroll	CAPM			7.7%		4.16%	11.3%	7.3%	
Kroll	CAPM + Size Premium			7.9%		4.36%	11.3%	7.5%	
Kroll	Build-Up			8.8%		4.38%	11.3%	8.3%	
Kroll	Fama-French 5-factor			9.6%		4.29%	11.3%	9.0%	
Kroll	DCF (1-stage)			14.1%		4.37%	11.3%	13.0%	
Kroll	DCF (3-stage)			13.9%		4.17%	11.3%	12.8%	
Damodaran Online	Implied Premium			7.04%		4.02%	13.39%	6.63%	
				Low	High			Low	High
Zanjani	Risk Premium over T-Bill	4.39%	8.44%	10.90%	11.08%	4.02%	7.52%	10.38%	10.55%
Zanjani	Risk Premium over T-Note	4.41%	6.87%	9.70%	9.85%	4.02%	7.52%	9.28%	9.41%
Zanjani	Risk Premium over Aaa Bond	5.46%	6.01%	10.09%	10.22%	4.02%	7.52%	9.63%	9.75%
Zanjani	Risk Premium over Baa Bond	6.13%	4.76%	9.79%	9.90%	4.02%	7.52%	9.36%	9.45%
* After-tax cost of debt for Kroll is not reported but is inferred based on the cost of equity, % of debt, and the WACC.									

The ranges associated with my own estimates are driven by differences between the 1-year and 3-year betas.

To illustrate a calculation, the lower bound of the cost of equity for my "Risk Premium over T-Bill" method for Dwelling Extended Coverage is:

$$4.39\% + 0.77123 \times 8.44\% = 10.90\%,$$

where 4.39% is the three month average T-Bill rate on 8/15/2025 (measured as the average of the rate on 8/15, 7/15, and 6/15), .77123 is the 3-year weighted average Blume-corrected beta for the North Carolina Dwelling Extended Coverage market, and 8.44% is the average risk premium of the equity market over the T-Bill rate. The lower bound for the WACC is:

$$(1 - .0752) \times 10.90\% + .0752 \times 4.02\% = 10.38\%,$$

where .0752 is the weighted average share of debt in the capital structure for the North Carolina Dwelling Extended Coverage market, 10.90% is the cost of equity as calculated in the previous step, and 4.02% is the after-tax cost of debt as estimated using Damodaran Online.

Note that the estimates for capital structure and the cost of debt differ across sources, so the relationship between the cost of equity and the WACC for Kroll and Damodaran Online will not follow the exact formula listed above.

Q: Do you believe any adjustments are necessary to the estimated cost of equity in the context of this filing?

A: Yes. All of the foregoing estimates are based on the data of publicly traded companies, which have the easiest access to financing and thus the lowest costs of capital. However, I found that operating companies affiliated with publicly traded holding companies only wrote about 22.6% of the 2024 direct premiums written for North Carolina Dwelling Fire insurance; for Dwelling Extended Coverage, the figure was 23.9%. The remainder in both markets was underwritten by companies associated with private, often mutual, ownership---a segment well-known to have more difficulty in accessing the capital markets. The industry average cost of equity needs to be adjusted upward to account for this non-public ownership.

Q: How much higher is the cost of equity for non-public firms?

A: Research dating back at least as far as the 1960's has demonstrated that private equity trades at a substantial discount to public equity. The discount is thought to derive from a variety of factors, most notably the illiquid nature of private equity stakes (also known as a "lack of marketability") as well as information, monitoring, and control issues. The discount translates into a higher cost of equity. For example, if a public firm's cost of equity is estimated at 10% and the equity of a comparable private firm is selling at a 20% discount to that of the public firm, the private firm's cost of equity would be estimated as:

$$12.5\% = 10\% / (1 - 20\%)$$

The discount is difficult to estimate. Exhibit RB-27 summarizes some of the academic research on the private firm discount. Studies have taken a variety of approaches to measurement. "IPO" studies compare the prices of pre-IPO share transactions in a private company with post-IPO share prices after the company is public. "Acquisition" studies compare the valuations of acquired private companies versus the valuations of acquired public companies. "Restricted stock" and "private placement" studies compare the prices of restricted stock issued by public companies with the prices of their traded shares.

All the approaches have their flaws. IPO studies, for example, are thought to have a bias toward overstating the discount because of the differences in timing of transactions. Restricted stock and private placement studies tend to understate the discount: Since they confine their attention to public companies, they do not account for factors other than the discount for lack of marketability (DLOM), and, moreover, the actual restrictions on marketability for private placements have been loosened significantly over the years by the Securities and Exchange Commission.

On balance, however, the studies point to a substantial discount. For purposes of this testimony, I use a discount of 25%, which is slightly below the average of the averages of the

three groups in Exhibit RB-27 (when taking the midpoint of the ranges for the studies with ranges of estimates).

Q: How would this affect the estimated cost of equity for the industry?

A: Assuming a 25% private company discount and an X% market share for non-public companies (where X% is 22.6% in Dwelling Fire and 23.9% in Dwelling Extended Coverage), I calculate the adjusted estimate of the cost of equity as a weighted average of the private cost of equity and the public cost of equity:

$$(1 - X\%) * \left(\frac{COE}{(1 - 0.25)}\right) + (X\%) * (COE),$$

where COE is the estimated cost of equity for public companies. The adjusted estimate of the cost of equity is then weighted together with the cost of debt to produce an adjusted WACC. The adjusted estimates are as follows:

Dwelling Fire Cost of Capital, Adjusted for Non-Public Ownership

Source	Method	Cost of Equity		WACC	
Kroll	CAPM	9.7%		9.1%	
Kroll	CAPM + Size Premium	9.9%		9.3%	
Kroll	Build-Up	11.1%		10.3%	
Kroll	Fama-French 5-factor	12.1%		11.2%	
Kroll	DCF (1-stage)	17.7%		16.2%	
Kroll	DCF (3-stage)	17.5%		16.0%	
Damodaran Online	Implied Premium	8.86%		8.21%	
		Low	**High**	**Low**	**High**
Zanjani	Risk Premium over T-Bill	13.63%	13.80%	12.84%	13.00%
Zanjani	Risk Premium over T-Note	12.14%	12.28%	11.47%	11.60%
Zanjani	Risk Premium over Aaa Bond	12.64%	12.76%	11.93%	12.04%
Zanjani	Risk Premium over Baa Bond	12.27%	12.37%	11.60%	11.68%

Dwelling Extended Coverage Cost of Capital, Adjusted for Non-Public Ownership

Source	Method	Cost of Equity		WACC	
Kroll	CAPM	9.7%		9.0%	
Kroll	CAPM + Size Premium	9.9%		9.3%	
Kroll	Build-Up	11.0%		10.3%	
Kroll	Fama-French 5-factor	12.0%		11.2%	
Kroll	DCF (1-stage)	17.7%		16.2%	
Kroll	DCF (3-stage)	17.4%		15.9%	
Damodaran Online	Implied Premium	8.83%		8.18%	
		Low	**High**	**Low**	**High**
Zanjani	Risk Premium over T-Bill	13.66%	13.89%	12.94%	13.14%
Zanjani	Risk Premium over T-Note	12.17%	12.35%	11.55%	11.72%
Zanjani	Risk Premium over Aaa Bond	12.65%	12.81%	12.00%	12.15%
Zanjani	Risk Premium over Baa Bond	12.28%	12.40%	11.66%	11.77%

Q: How do these figures speak to the issue of whether or not the pro forma expected return on net worth is reasonable and not excessive?

A: There are at least two schools of thought on this issue.

The first is that the "net worth" in the pro forma return exhibit should be interpreted as an equity investment akin to the equity considered in the cost of equity analysis. Thus, it should be entitled to a similar rate of return. Under this school of thought, the return on net worth calculated in the previous section should be compared directly with the cost of equity figures in the tables above. If one does this, the projected total returns are, in my opinion, reasonable and not excessive. Before making the adjustments to the investment return projections that I believe are appropriate for the North Carolina Dwelling Fire market, the projected total return of 13.54% is within the span of estimates, which range from 8.86% to 17.7%. When adjusting the prospective investment yield to the current yield (rather than the average of current and embedded yields) and accounting for the investment portfolio more closely tailored to the North Carolina Dwelling market, the total return falls to 13.46%. Thus, the previous conclusions are unchanged after considering this adjustment.

For the Dwelling Extended Coverage market, the total return of 11.03% also falls within the span of estimates in the table, which range from 8.83% to 17.7%. Thus, the total return seems reasonable and not excessive. These conclusions also hold after making the prospective adjustments similar to those for the Dwelling Fire market described above.

A second school of thought is that, although the capital of the operating subsidiaries may be fully financed by equity, the holding companies are the source of that equity. Thus, one should

"look through" the operating subsidiaries to the level of the holding companies to determine a cost of capital, which is important because the holding companies---unlike the insurance subsidiaries---typically hold debt in the capital structure. Thus, the cost of capital for the holding company is, under this school of thought, calculated as a weighted average of the cost of equity and the cost of debt, with the weights based on each component's share of the capital structure. The result is the WACC discussed above, which, as can be seen above, is typically lower than the cost of equity due to the lower cost of debt. On the other hand, the market value of the capital of the holding company will be different from the book value of the capital invested in the insurance subsidiaries. Thus, a particular return on net worth at the level of the operating subsidiary will translate into a lower (higher) return on holding company capital if the market value of the holding company capital exceeds (is less than) the net worth of the insurance subsidiaries.

The market-to-net worth ratio of the public companies underwriting Dwelling Insurance in North Carolina is typically well above 1. However, even if one sets this ratio to 1, the total return of 13.54% for Dwelling Fire falls comfortably within the range of estimates (8.21% to 16.2%) for that market. The same assessment applies to the total return of 11.03% for Dwelling Extended Coverage, which also falls comfortably within the range of estimates (8.18% to 16.2%) for that market. By this standard, the total returns are reasonable and not excessive. The same conclusions apply when making adjustments to account for the asset distribution relevant for this line of business and the current yields in the marketplace (rather than embedded yields).

IV. Conclusion

Q: Based on your knowledge and experience and on the studies and analyses you have performed, have you come to any conclusions regarding the underwriting profit factor selected by the Bureau and used in its indicated rate level calculations in this filing?

A: Yes. When using the pro forma return model with inputs selected in a manner consistent with previous filings, I found that the expected total return on net worth implied by the selected 8.5% underwriting profit factor was 13.54%. For Dwelling Extended Coverage, the corresponding figure was 11.03%. When adjusting the prospective investment yield to reflect current market conditions and a portfolio allocation more tailored to the North Carolina Dwelling market, the expected total returns changed to 13.46% and 11.29%, respectively. After reviewing the cost of capital estimates for the industry produced by third parties and producing my own estimates tailored to the North Carolina markets, and adjusting all estimates for the presence of private companies, I found the expected returns on net worth resulting from the selected underwriting profit factors to be consistent with a reasonable and not excessive return on invested capital.

An important caveat to this analysis, however, is that all conclusions are predicated on the assumption that the indicated rate level is achieved. In the event that a lower rate level is implemented, the expected rate of return could be inadequate.

Q. Does that conclude your testimony?

A. Yes.

George Zanjani

University of Alabama
The Culverhouse College of Business
Department of Economics, Finance, & Legal Studies
200 Alston Hall
Box 870224
Tuscaloosa, AL 35487

Mobile: 917-863-9332
Email: ghzanjani@ua.edu

Education

Ph.D., Economics, University of Chicago, 2000
ACAS, Casualty Actuarial Society, 1994
A.B. / B.S., Economics and Biology, Stanford University, 1990

Work Experience

University of Alabama (Tuscaloosa, Alabama)
Professor of Finance and Frank Park Samford Chair of Insurance, 2017-

University of Cologne
Gen Re Visiting Professor, 2023

Georgia State University (Atlanta, Georgia)
AAMGA Distinguished Chair in Risk Management & Insurance, 2011-2017
Associate Professor, 2008-2017

Nanyang Technological University (Singapore)
Visiting Senior Research Fellow, 2011-12, 2013-2014

Federal Reserve Bank of New York (New York, New York)
Senior Economist, 2006-2008
Economist, 2000-2006

Fireman's Fund Insurance Companies (Novato, California)
Senior Actuarial Analyst, 1993-94
Actuarial Analyst, 1991-1993
Assistant Actuarial Analyst, 1990-1991

Publications: Refereed Scholarly

"Pricing Insurance Risk: Reconciling Theory and Practice," (with Daniel Bauer and Richard D. Phillips), in *Handbook of Insurance* (3rd edition), Georges Dionne (ed.), New York: Springer (2025)

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Work in Progress

"Life Insurance and Annuity Pricing During the Financial Crisis, Revisited," (with Daniel Bauer, Lars Powell, and Boheng Su), working paper, 2025

"Dynamic Capital Allocation in General Insurance," (with Daniel Bauer and Qiheng Guo), working paper, 2025

"The Impact of Income Smoothing on Accounting Aggregates: The Case of the Property-Casualty Industry," (with Eren Cifci, Qianlong Liu, Steve Mildenhall, Lars Powell, and Kenny Wunder), working paper, 2025

"Market Discipline and Guaranty Funds in Life Insurance," (with Martin Grace, Shinichi Kamiya, Robert W. Klein, and Kenny Wunder), working paper, 2025

"An Integrated Approach to Measuring Asset and Liability Risks in Financial Institutions," (with Daniel Bauer), working paper, 2023

"Optimal Insurance Contracts with Insurer Background Risk," (with Xiaohu Ping), working paper, 2015

"The Effect of Banking Crises: Evidence from Non-Life Insurance Consumption," (with Shinichi Kamiya and Jackie Li), working paper, 2015

"Bankruptcy in the Core and Periphery of Financial Groups: The Case of the Property-Casualty Insurance Industry" working paper, 2010

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External Research Projects and Consulting

2025	Expert Witness, Insurance Rate Filings, North Carolina
2025	Expert Witness, Workers' Compensation Rate Filing, Massachusetts
2024	Expert Witness, Capstone Associated Services, Ltd. v. United States of America
2024	Expert Witness, Insurance Rate Filings, North Carolina
2024	Expert Witness, Workers' Compensation Rate Filing, Massachusetts
2023	Using Industry Level Experience to Improve Company Loss Reserving, sponsored by CAS
2023	Expert Witness, Insurance Rate Filings, North Carolina

2023 Expert Witness, Workers' Compensation Rate Filing, Massachusetts
2022 Expert Witness, Insurance Rate Filings, North Carolina
2022 Expert Witness, Workers' Compensation Rate Filing, Massachusetts
2021 Expert Witness, Golson v. Provident Life, Alabama
2021 Expert Witness, Insurance Rate Filings, North Carolina
2020 Expert Witness, Insurance Rate Filings, North Carolina
2020 Expert Witness, Workers' Compensation Rate Filing, Massachusetts
2019 NCCI Review of Cost of Capital Methodology
2019 Expert Witness, Insurance Rate Filings, North Carolina
2018 NCCI Review of TCJA
2017 Expert Witness, Workers' Compensation Rate Hearing, Florida
2016 Expert Witness, Assigned Risk Workers' Compensation Rate Hearing, Virginia
2015 Expert Witness, Workers' Compensation Rate Hearing, Florida
2015 NCCI Revision of Underwriting Profit and Contingency Internal Rate of Return Model
2015 An Extension of the Project on the Costs of Holding Capital, sponsored by the CAS
2013 Microinsurance Centre Lessons from History Project
2012 Allocation of the Costs of Holding Capital, sponsored by the CAS,
2011 CRO Risk Index Project, co-sponsored by SOA and Bloomberg, co-founder
2009 "The Financial Crisis and Lessons for Insurers," $50,000 SOA grant, role: report co-author

Papers Presented at Professional Meetings

2023 "Life Insurance and Annuity Pricing During the Financial Crisis, Revisited" EGRIE Annual Seminar, Malaga, Spain
2023 "Life Insurance and Annuity Pricing During the Financial Crisis, Revisited" IME Annual Conference, Edinburgh, UK
2023 "Understanding Loss Reserving Errors in the Liability Catastrophe of 1997-2001," IME Annual Conference, Edinburgh, UK
2023 "Understanding Loss Reserving Errors in the Liability Catastrophe of 1997-2001," Gen Re Seminar, Cologne, Germany
2022 "Understanding Loss Reserving Errors in the Liability Catastrophe of 1997-2001," Conference in Honor of J.David Cummins and Mary Weiss, Temple University**,** Philadelphia
2020 "Life Insurance and Annuity Pricing During the Financial Crisis, Revisited" WRIEC, virtual meeting
2019 "An Integrated Approach to Measuring Asset and Liability Risks in Financial Institutions," EGRIE Annual Meeting, Rome, Italy
2019 "An Integrated Approach to Measuring Asset and Liability Risks in Financial Institutions," ARIA Annual Meeting, San Francisco, CA
2019 "An Integrated Approach to Measuring Asset and Liability Risks in Financial Institutions," RTS Annual Seminar, Tuscaloosa, AL
2017 "The Effect of Government Guarantees on Market Discipline in the Property-Casualty Insurance Industry," NBER Insurance Project Workshop, Boston, MA
2015 "The Marginal Cost of Risk in a Multi-Period Model," NBER Insurance Project Workshop, Stanford, CA
2015 "The Marginal Cost of Risk in a Multi-Period Model," CAS Annual Meeting, Philadelphia, PA
2015 "Dynamic Capital Allocation," IME Annual Conference, Liverpool UK
2015 "What Drives Tort Reform Legislation? Economics and Politics of the State Decisions to Restrict Liability Torts," ASSA Annual Meeting, Boston, MA
2014 "The Marginal Cost of Risk in a Multi-Period Model," CAS Centennial, New York, NY
2014 "Market Discipline and Guaranty Funds in Life Insurance," EGRIE Annual Seminar, St. Gallen, CH
2014 "Dynamic Capital Allocation with Irreversible Investments," EGRIE Annual Seminar, St. Gallen, CH
2014 "What Drives Tort Reform Legislation? Economics and Politics of the State Decisions to Restrict Liability Torts," ARIA Annual Meeting, Seattle, WA
2014 "The Marginal Cost of Risk in a Multi-Period Model," ARIA Annual Meeting, Seattle, WA
2014 "Market Discipline and Guaranty Funds in Life Insurance," ARIA Annual Meeting, Seattle, WA

2014 "The Marginal Cost of Risk in a Multi-Period Model," IME Conference, Shanghai, CN
2014 "The Effect of Banking Crises: Evidence from Non-Life Insurance Consumption," Risk Theory Seminar, Munich, Germany
2013 "The Effect of Banking Crises: Evidence from Non-Life Insurance Consumption," ASSA Annual Meeting, Philadelphia, PA
2013 "Optimal Insurance Contracts with Insurer Background Risk," EGRIE Annual Meeting, Paris, FR
2013 "The Effect of Banking Crises: Evidence from Non-Life Insurance Consumption," ARIA Annual Meeting, Washington D.C.
2013 "The Marginal Cost of Risk, Risk Measures, and Capital Allocation," IRFRC Catastrophe Risk Conference, Singapore
2013 "Optimal Insurance Contracts with Insurer Background Risk," ARIA Annual Meeting, Washington D.C.
2013 "The Marginal Cost of Risk, Risk Measures, and Capital Allocation," CEAR/ETH Indices of Risk and New Risk Measures Conference, Zurich, CH
2012 "The Marginal Cost of Risk, Risk Measures, and Capital Allocation," CAS Spring Meeting, Phoenix, AZ
2012 "The Marginal Cost of Risk, Risk Measures, and Capital Allocation," Symposium: Risk and Catastrophic Events, State College, PA
2012 "The Marginal Cost of Risk, Risk Measures, and Capital Allocation," ASSA Annual Meeting, Chicago, IL
2011 "The Marginal Cost of Risk, Risk Measures, and Capital Allocation," NBER Insurance Project Workshop, Cambridge, MA
2010 "Bankruptcy in the Core and Periphery of Financial Groups: The Case of the Property-Casualty Insurance Industry," ASSA Annual Meeting, Atlanta, GA
2009 "Bankruptcy in the Core and Periphery of Financial Groups: The Case of the Property-Casualty Insurance Industry," Risk Management and Corporate Governance Conference, Loyola University of Chicago
2009 "Bankruptcy in the Core and Periphery of Financial Groups: The Case of the Property-Casualty Insurance Industry," ARIA Annual Meeting, Providence, RI
2008 "An Economic Approach to Capital Allocation," Risk Theory Society, Annual Meeting, Fort Collins, CO
2007 "Federal Financial Exposure to Catastrophic Risk," ARIA Annual Meeting, Quebec City, CA
2007 "Catastrophe Bonds, Reinsurance, and the Optimal Collateralization of Risk Transfer," EFMA Annual Meeting, Vienna, AT
2007 "Catastrophe Bonds, Reinsurance, and the Optimal Collateralization of Risk Transfer," 5th Infiniti Conference on International Financial Integration, Dublin, IE
2007 "Federal Financial Exposure to Catastrophic Risk," NBER Conference on Measuring and Managing Federal Financial Risk, Evanston, IL
2006 Insuring Catastrophic Losses: The Status of TRIA and Proposed Natural Disaster Backstops, Wash., D.C.
2006 "Catastrophe Bonds, Reinsurance, and the Optimal Collateralization of Risk Transfer," Risk Theory Society, Annual Meeting, Richmond,VA
2006 "Public versus Private Underwriting of Catastrophe Risk: Lessons from the California Earthquake Authority," Berkeley Symposium on Real Estate, Catastrophic Risk, and Public Policy
2006 "Catastrophe Bonds, Reinsurance, and the Optimal Collateralization of Risk Transfer," NBER Insurance Project Workshop, Cambridge, MA
2005 "Regulation, Capital, and the Evolution of Organizational Form in U.S. Life Insurance," NBER Insurance Project Workshop, Cambridge, MA
2004 "The Rise and Fall of the Fraternal Life Insurer: Law and Organizational Form in U.S. Life Insurance," NBER Insurance Project Workshop, Cambridge, MA
2004 "Regulation, Capital, and the Evolution of Organizational Form in U.S. Life Insurance," American Finance Association, Annual Meeting, San Diego, CA
2003 "Insurance, Self-Protection, and the Economics of Terrorism," Risk Theory Society, Annual Meeting, Atlanta, GA
2003 "Terrorism Insurance Policy and the Public Good," St. John's Journal of Legal Commentary 10th Annual Legal Symposium: Terrorism and its Impact on Insurance: Legislative Responses and Coverage Issues, Queens, NY
2003 "Insurance, Self-Protection, and the Economics of Terrorism," NBER Insurance Project Workshop, Cambridge, MA

2002 "Pricing and Capital Allocation in Catastrophe Insurance," CAS Risk and Capital Management Seminar, Toronto, CA
2002 "Market Discipline and Government Guarantees in U.S. Life Insurance," Risk Theory Society, Annual Meeting, Urbana-Champaign, IL
2001 "Pricing and Capital Allocation in Catastrophe Insurance," Risk Theory Society, Annual Meeting, Montreal

Other Conferences Talks and Panel Participation

2018 Surplus Lines Automation Conference, Florida
2017 International Conference on Business Sciences, Cairo University, Egypt
2016 IIF Insurance Colloquium, Basel, Switzerland
2016 Surplus Lines Association of California, California (keynote)
2014 Surplus Lines Automation Conference, Florida
2011 PRMIA Annual Risk Leadership Conference, Atlanta, GA
2011 7th International Microinsurance Conference, Rio de Janeiro, Brazil
2010 Property Loss Research Bureau Eastern Adjusters Conference, Atlanta, GA (keynote)
2008 NCOIL Annual Meeting, Duck Key, FL
2007 Capital Markets Symposium on Securitizing Insurance Risk, New York, NY
2006 Insuring Catastrophic Losses: The Status of TRIA and Proposed Natural Disaster Backstops, Wash., D.C.
2006 Catastrophe Bonds and Insurance Linked Securities Summit, New York, NY
2005 12th Annual International Conference Promoting Business Ethics, New York, NY

Service Activities in Academic and Professional Organizations

Deputy Editor-in-Chief, *Journal of Risk and Insurance* (2024-)
Associate Editor, *Insurance: Mathematics and Economics* (2022-)
Senior Editor, *Journal of Risk and Insurance* (2019-2024)
International Research Advisory Board, Risk and Insurance Research Center, NCCU, Taiwan
American Risk & Insurance Association President (2012-13)
Risk Theory Society President (2011-2012)
American Risk & Insurance Association Board Member (2007-2014)
Editorial Board, *Journal of Insurance Issues* (2012-2014)
Huebner Colloquium Panelist (2016-2019)

External Committees
American Risk & Insurance Association Program Committee, various years; ARIA Nominations Committee, 2015, 2016, 2018; Kulp-Wright Book Award Committee, 2005; ARIA Mehr Award Committee, 2019 - 2025

Discussant: *ARIA Annual Meeting, Denver, 2024; EGRIE Annual Seminar, Malaga, 2023; ARIA Annual Meeting, Los Angeles, 2022; WRIEC 2020; EGRIE Annual Meeting, Rome, 2019; ARIA Annual Meeting, San Francisco, 2019; ARIA Annual Meeting, Chicago, 2018; ARIA Annual Meeting, Boston, 2016; SIFR Insurance Conference, Stockholm, 2015; EGRIE Annual Seminar, St. Gallen, 2014*; *ARIA Annual Meeting, Seattle, 2014; ARIA Annual Meeting, San Diego, 2011; CEAR Workshop on Insurance for the Poor, Atlanta, 2010*; *CEAR Workshop on Risk Perception and Subjective Beliefs, Atlanta, 2010*; *Midwest Finance Association Annual Meeting, Chicago, 2009; 5th Infiniti Conference, Dublin, 2007; EFMA Annual Meeting, Vienna, 2007; AEA Annual Meeting, San Diego, 2004*

Session Chair: *ARIA Annual Meeting, Chicago, 2018, ARC, Atlanta, 2017; IME, Atlanta, 2017; ARIA Annual Meeting, San Diego, 2011; Midwest Finance Association Annual Meeting, Chicago, 2009; ARIA Annual Meeting, Quebec City, 2007; EFMA Annual Meeting, Vienna, 2007;*

Referee for *Asia-Pacific Journal of Risk and Insurance, Astin Bulletin, Australian Social Monitor*, *Contemporary Economic Policy, Current Issues in Economics and Finance, Defense and Peace Economics, European Economic Review, Financial Review, Geneva Papers: Issues and Practice, Geneva Risk and Insurance Review, Health Affairs, Insurance: Mathematics and Economics, Journal of Banking and Finance, Journal of Business*, *Journal of Finance, Journal of Financial Intermediation*, *Journal of Financial Services Research, Journal of Financial and Quantitative Analysis, Journal of Law and Economics, Journal of Mathematical Economics, Journal of Money, Credit, and Banking, Journal of Political Economy, Journal of Risk and Insurance, Management Science, Mathematical Social Sciences, North American Actuarial Journal, Proceedings of the National Academy of Sciences, Review of Financial Studies, Risk Management and Insurance Review, Scandinavian Actuarial Journal,* and *Science.*

Working Group Participation

Committee on the Global Financial System, Working Group on Institutional Investors, Global Savings, and Asset Allocation (2006); *Presidential Working Group on Financial Markets, Working Group on Terrorism Insurance* (2006)

Continuing Education Activities

2004-2007	Central Banking Seminar, Federal Reserve Bank of New York, Topics: Introduction to U.S. Financial Markets; Introduction to Non-bank Financial Institutions
2009	Texas Farm Bureau Program, Georgia State University, Topic: Securitization, the Insurance Industry, and the Panic of 2007
2009-2012	Horst K. Jannott Visiting Fellows Program, Georgia State University, Topics: Securitization, the Insurance Industry, and the Panic of 2007; Introduction to Statistics

NCRB - Pro Forma Statutory Rate of Return
Dwelling Fire

		Pre-Tax	Tax Liability	Post-Tax
1	**Premiums**	100.00%		
	Loss & LAE	65.79%		
	Commissions	11.20%		
	Other Acquisition & General	9.72%		
	Taxes, Licenses, & Fees	2.70%		
	Policyholder Dividends	0.20%		
	Compensation for Assessment Risk	1.89%		
2	**Pro Forma Underwriting Profit**	8.50%		
3	**Installment Fee Income**	0.52%		
4	**Regular Tax**		1.89%	
5	**Additional Tax Due to IRS Treatment of Reserves**		-0.03%	
6	**Total Return from Underwriting Post-Tax**			7.15%
7	**Investment Gain on Insurance Transaction**	6.46%		
	Less Investment Income on Agents Balances	0.99%		
	Net Investment Gain on Insurance Transaction	5.46%	0.91%	4.56%
8	**Investment Gain on Surplus**	6.23%	1.04%	5.20%
9	**Total Return as a Percent of Premium (post-tax)**			16.91%
10	**Premium-to-Net Worth Ratio**			0.80
11	**Total Return as a Percent of Net Worth (post-tax)**			13.54%

Lines (1) to (8) are expressed as a percentage of premium.

Assumptions and Parameters

(a)	Underwriting Income Tax Rate	21.00%
(b)	Investment Income Tax Rate	16.62%
(c)	Pre-tax Investment Yield	5.14%
(d)	Premium-to-Surplus Ratio	0.89
(e)	Net Worth-to-Surplus Ratio	1.11
(f)	Installment Fee Income	0.52%
(g)	Additional Tax Due to IRS Treatment of Loss Reserves and UEPR	-0.03%
(h)	Compensation for Assessment Risk	1.89%

Notes to Exhibit RB-23 Page 1

1 The expense provisions are those used in the filing, adjusted for the indicated rate change.

2 Selected by North Carolina Rate Bureau

3 See Exhibit RB-23, Page 3

4 [(2) + (3)] x (a)

5 See Exhibit RB-23, Pages 4-6

6 (2) + (3) - (4) - (5)

7 Investment income on agents balances is calculated as 0.1891 x 1.02 x (c) , where 0.1891 is the factor for agents balances held for less than 90 days and 1.02 is a factor to correct for overdue balances. The figures are sourced from North Carolina Rate Bureau and ISO.

8 (c) x [1/ (d) + 0.1831 x 0.4812], where 0.1831 is the prepaid expense ratio from Page 7 and 0.4812 is the UEPR ratio from Page 7.

9 (6) + (7) + (8)

10 (d) / (e)

11 (9) x (10)

Assumptions

(a) Current corporate tax rate, based on the Tax Cut and Jobs Act of 2017.
(b) See Exhibit RB-23 , Pages 11-13. Calculated as 1- average post-tax yield/average pre-tax yield.
(c) See Exhibit RB-23, Page 10
(d) See Exhibit RB-23, Page 14
(e) See Exhibit RB-23, Page 15
(f) See Exhibit RB-23, Page 3
(g) See Exhibit RB-23, Pages 4-6
(h) Compensation for Assessment Risk based on the analysis incorporated in the filing, adjusted for the indicated rate change.

NORTH CAROLINA
Dwelling Fire
INSTALLMENT CHARGES AS A PERCENT OF PREMIUM

Year	Percentage
2024	0.42%
2023	0.44%
2022	0.55%
2021	0.57%
2020	0.63%
Average	0.52%

Source: NCRB

North Carolina
Dwelling Fire
Calculation of Additional Tax Liability

1. Collected Earned Premium for Current Year	100.00%
2. Unearned Premium Reserve 12/31/Current	51.09%
3. Unearned Premium Reserve 12/31/Prior	52.26%
4. Increase: (2) - (3)	-1.17%
5. 20% of Increase = Taxable Income	-0.23%
6. Additional Tax Liability due to Unearned Premium Reserve	-0.05%
7. Unpaid Loss Current Year	40.05%
8. Discounted Unpaid Loss Prior Year	39.03%
9. Unpaid Loss Prior Year	40.97%
10. Discounted Unpaid Loss Prior Year	40.05%
11. Additional Income	0.10%
12. Additional Tax Liability due to Loss Reserve Discounting	0.02%
13. Total Additional Tax Liabilities (6) + (12)	-0.03%

NORTH CAROLINA
Dwelling Fire
Calculation of Taxable Income

Calculation of Unpaid Loss for Current Accident Year (AY)					Calculation of Discounted Unpaid Loss for Current AY			Calculation of Discounted Unpaid Loss for Prior AY			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
AY Avg Acc Date	AY Pay Pattern	Percent Unpaid	Total Losses	Unpaid Losses	AY at 12/31 yr t	Discount Factor	Discounted Unpaid Loss	AY at 12/31/yr t-1	Unpaid Losses	Discount Factor	Discounted Unpaid Loss
0.5	55.61%	44.39%	65.787	29.20	2024	0.973675	28.4310				
1.5	89.33%	10.67%	67.293	7.18	2023	0.971719	6.9753	2023	29.868	0.977793	29.2051
2.5	94.67%	5.33%	68.834	3.67	2022	0.985999	3.6199	2022	7.343	0.971719	7.1350
3.5	100.00%	0.00%	70.411	0.00	2021	0.984834	0.0000	2021	3.755	0.986826	3.7060
4.5	100.00%	0.00%	72.023	0.00	2020	0.984785	0.0000	2020	0.000	0.985999	0.0000
5.5	100.00%	0.00%	73.673	0.00	2019	0.985513	0.0000	2019	0.000	0.984834	0.0000
6.5	100.00%	0.00%	75.360	0.00	2018	0	0.0000	2018	0.000	0.984785	0.0000
7.5	100.00%	0.00%	77.086	0.00	2017	0	0.0000	2017	0.000	0.985513	0.0000
								2016	0.000	0	0.0000
Totals				40.05			39.03		40.97		40.05

Notes to Pages 4 and 5

Page 4

2 Page 8, line (2) divided by Page 8, line (1)
3 (2) divided by 1 plus the 10 year average growth rate of Dwelling Fire premiums in North Carolina.
4 (2) - (3)
5 (4) x 20%
6 (5) x current corporate tax rate
7 Unpaid current-year losses at year-end as a percent of current year premium.
Sum of Page 5, Column (5)
8 Discounted unpaid current-year losses at year-end as a percent of current year premium.
Sum of Page 5, Column (8)
9 Unpaid prior-year losses at year-end as a percent of current year premium.
Sum of Page 5, Column (10)
10 Discounted unpaid prior-year losses at year-end as a percent of current year premium.
Sum of Page 5, Column (12)
11 Change in loss reserve discount: [(7) - (8)] - [(9) - (10)]
12 (11) x current corporate tax rate
13 (6) + (12)

Page 5

1 Midpoint of number of years since end of accident period
2 Special Property payout pattern from IRS Rev. Proc 2016-58
3 1 - (2)
4 Latest period losses are based on projected loss ratio from Page 1. For previous years,
losses are detrended at the 10 year average premium growth rate for Dwelling Fire in North Carolina.
5 (3) x (4)
6 Accident Year at current year end
7 IRS discount factors for Special Property from Rev. Proc 2025-15
8 (5) x (7)
9 Accident Year at prior year end
10 Column (3), previous period x Column (4), current period
11 IRS discount factors for Special Property from Rev. Proc 2023-41
12 (10) x (11)

NCRB Investment Income Calculation
Dwelling Fire

Projected Investment Earnings on Loss, Loss Adjustment Expense and Unearned Premium Reserves

A. UNEARNED PREMIUM RESERVES		
1. Direct Earned Premiums		1,000,000
2. Mean Unearned Premium Reserve	48.12%	481,200
3. Deductions for Prepaid Expenses		
Commissions & Brokerage	11.20%	
Taxes, Licenses, & Fees (5/6)	2.25%	
Other Acquisition & General (1/2)	4.86%	
Total	18.31%	
4. Deduction for Prepaid Expense: (2) x (3)		88,108
5. Net Unearned Premium Reserve Subject to Investment (2) - (4)		393,092
B. Loss and Loss Expense Reserves		
1. Direct Earned Premiums		1,000,000
2. Expected Incurred Loss & LAE-to-Premium Ratio	65.79%	657,866
3. Expected Mean Loss and LAE Reserve-to-Incurred Ratio	130.99%	861,741
C. Net Policyholder Funds Subject to Investment (A5 + B3)		1,254,833
D. Average Rate of Return		5.14%
E. Investment Earnings from Net Reserves: (C) x (D)		64,554
F. Average Rate of Return as a Percent of Direct Earned Premiums: (E) / (A1)		6.46%

NORTH CAROLINA
Dwelling Fire

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line A-1
Calculations displayed are per million of direct earned premiums.

Line A-2
The mean unearned premium reserve (UEPR) is determined by multiplying the direct earned premiums in line A-1 by the ratio of the mean unearned premium reserve to the direct earned premium for the current calendar year ended 12/31. The data are for North Carolina Fire insurance (from statutory Page 14 of the Annual Statement) for all companies which wrote Dwelling Fire in the most recent calendar year.

1	NC Fire Direct Earned Premium for most recent calendar year	384,024,306
2	NC Fire UEPR at end of most recent calendar year	196,183,802
3	NC Fire UEPR at end of previous calendar year	173,409,728
4	Mean NC Fire UEPR	184,796,765
5	Ratio [(4) / (1)]	48.12%

Line A-3
Deduction for prepaid expenses
Certain production expenses, such as commissions and reinsurance, are assumed to be incurred when the policy is written and before the premium is paid. In addition, half of Other Acquisition and General expenses and 5/6 of Taxes, Licenses and Fees are assumed to be prepaid.

NORTH CAROLINA
Dwelling Fire

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line B-2
The expected loss and loss adjustment expense ratio is consistent with the expense provisions used in the filing.

Line B-3
The mean loss reserve is calculated by multiplying the incurred losses in line B-2 by the ratio for mean loss reserves to incurred losses. The latter figures are based on total statutory Page 14 figures for North Carolina Fire direct losses incurred and direct losses unpaid for all companies writing Dwelling Fire in North Carolina in 2024. The adjustment for loss expense reserves is based on nationwide industry aggregates for the Homeowners line.

6	Direct Losses Incurred	2020	104,935,680
7	Direct Losses Incurred	2021	712,873,576
8	Direct Losses Incurred	2022	149,939,371
9	Direct Losses Incurred	2023	170,645,536
10	Direct Losses Incurred	2024	332,607,579
11	Direct Losses Unpaid	2019	51,559,349
12	Direct Losses Unpaid	2020	61,323,461
13	Direct Losses Unpaid	2021	683,476,545
14	Direct Losses Unpaid	2022	338,501,386
15	Direct Losses Unpaid	2023	102,796,647
16	Direct Losses Unpaid	2024	276,215,859
17	Mean Loss Reserve	2020	56,441,405
18	Mean Loss Reserve	2021	372,400,003
19	Mean Loss Reserve	2022	510,988,966
20	Mean Loss Reserve	2023	220,649,017
21	Mean Loss Reserve	2024	189,506,253
22	Ratio	2020	0.538
23	Ratio	2021	0.522
24	Ratio	2022	3.408
25	Ratio	2023	1.293
26	Ratio	2024	0.570
27	Average Loss Reserve		1.266
28	Ratio of LAE Reserves to Loss Reserves		0.169
29	Ratio of Incurred LAE to Incurred Loss		0.130
30	Loss & LAE Reserve [(27) x (1+(28))/(1+(29))]		1.310

NORTH CAROLINA
Dwelling Fire

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line E

The average rate of return is the average of the pretax current yield calculated on Page 11 and the pretax embedded yield. The embedded yield (see Page 12) is the sum of the ratio of investment income to invested assets for the most recent year plus the ten year average ratio of capital gains to invested assets (see Page 13). The current yield is the estimated currently available rate of return (including both income and capital gains) on the industry investment portfolio (see Page 11).

Embedded Yield	4.72%
Current Yield	5.56%
Average	5.14%

Portfolio Yield and Tax Rate - Current Yield

Investable Asset	Percent of Assets	Estimated Prospective Pre-Tax Return	Tax Rate	Estimated Prospective Post-Tax Return
Bonds				
US Gov't	13.52%	4.11%	21.00%	3.25%
Municipal	19.90%	2.75%	5.25%	2.60%
Industrial	35.77%	4.67%	21.00%	3.69%
Preferred Stock	0.34%	6.53%	13.13%	5.67%
Common Stock	17.38%	12.83%	19.44%	10.34%
Mortgage Loans	1.15%	6.76%	21.00%	5.34%
Real Estate	0.65%	6.47%	21.00%	5.11%
Cash & Short-term Investments	3.79%	4.39%	21.00%	3.47%
Other Long Term Investments	7.51%	7.32%	18.71%	5.95%
Rate of Return Before Expenses	100.00%	5.86%	18.69%	4.77%
Investment Expenses		0.30%	21.00%	0.23%
Portfolio Rate of Return		5.56%	18.57%	4.53%

Sources

Preferred Stock	Current yield on iShares Preferred Stock Index ETF, 8/15/25
Real Estate	REIT Sector WACC; source: Damodaran Online, https://www.stern.nyu.edu/~adamodar/pc/datasets/wacc.xls, using 4.413 for Treasury bond yield
Cash	3 month Treasury rate, averaged over 3 months (source: US Treasury)
Municipal	Maturity weighted avg of 3 month avg MBIS Investment Grade yield curve; linearly interpolated
Industrial	Maturity weighted avg of 3-month average HQM par yields (source: FRED); linearly interpolated
Treasury	Maturity weighted avg of 3 month avg Treasury yields; linearly interpolated (source: US Treasury)
Common Stock	0.0844 equity risk premium (See Exhibit 25) plus 3 month average Treasury Rate
Other LTI	Average of yields on bond portfolio, preferred stock, common stock, mortgages, and real estate.
Investment Expenses	Investment Expenses from statutory Page 12 of the Annual Statement (Exhibit of Net Investment Income) divided by the average of the last two years' Cash and Invested Assets from statutory Page 2 of the Annual Statement (Assets), as compiled in A.M. Best's Aggregates and Averages.

Portfolio Yield and Tax Rate
Embedded Yield

		Income	Tax Rate
Bonds			
	Taxable	51,054,529	21.00%
	Non-Taxable	4,733,898	5.25%
Stocks			
	Taxable	9,375,922	13.13%
	Non-Taxable	3,396,135	5.25%
Mortgage Loans		2,017,674	21.00%
Real Estate		1,837,148	21.00%
Contract Loans		6,054	21.00%
Cash & Short Term Inv		14,625,584	21.00%
All Other		9,258,862	21.00%
Total		96,305,806	18.90%
Inv. Expenses		7,532,312	21.00%
Net Inv. Income		88,773,494	18.72%
Mean Invested Assets		2,456,888,663	
Inv. Inc. Yield Rate		3.61%	18.72%
Capital Gains (10 yr. avg.) (% of Inv. Assets)		1.11%	0.00%
Invest. Yield Rate (pre-tax)		4.72%	14.32%
Invest. Yield Rate (post-tax)		4.05%	

Source: A.M. Best's Aggregates and Averages, 2025 Edition, statutory Page 12 of the Annual Statement - Exhibit of Net Investment Income (Column 2 - Earned During Year). For capital gains, see Exhibit RB-23, Page 13.

Realized Capital Gains or Losses
As a Percentage of Mean Invested Assets
(Amounts in Thousands of Dollars)

Calendar Year	Mean Invested Assets	Realized Capital Gains Amount	Percent
2015	1,567,611,077	9,887,732	0.63%
2016	1,596,937,470	8,086,268	0.51%
2017	1,676,831,258	15,725,303	0.94%
2018	1,733,729,297	10,825,733	0.62%
2019	1,822,857,949	11,238,484	0.62%
2020	1,975,605,647	10,933,304	0.55%
2021	2,156,355,790	18,153,320	0.84%
2022	2,251,339,204	2,090,986	0.09%
2023	2,305,242,991	50,414,662	2.19%
2024	2,456,888,663	79,755,725	3.25%
Total	19,543,399,342	217,111,517	1.11%

"Mean Invested Assets" is the average of current and prior year values for Cash & Invested Assets from statutory Page 2 of the Annual Statement (Assets). Source for data is 2015-2025 editions of A.M. Best's Aggregates and Averages. Figures are net of capital gains taxes.

North Carolina

Dwelling Fire

Premium-to-Surplus Ratios

Year	Ratio
2024	0.77
2023	1.13
2022	1.05
2021	0.87
2020	0.87
2019	0.93
2018	0.82
2017	0.86
2016	0.80
2015	0.78
Average	0.89

Data from NAIC Statutory Filings for all groups writing Dwelling Fire insurance in North Carolina. Weighted average is calculated using North Carolina Dwelling Fire insurance premiums.

North Carolina
Dwelling Fire
Calculation of Ratio of GAAP Net Worth to Statutory Surplus

	2019	2020	2021	2022	2023
Policyholder Surplus	847,278,658,173	910,066,482,410	1,028,834,642,825	958,964,082,808	1,013,452,561,011
+ Deferred Acquisition Costs	46,002,606,289	48,118,482,109	51,883,319,641	54,714,320,843	60,500,602,221
+ Non-Admitted DTA Provision	6,045,409,090	6,001,020,602	5,674,496,962	6,641,006,360	6,637,837,705
+ Non-admitted Assets (non-tax part)	50,520,441,190	51,971,123,366	62,815,925,708	54,765,183,036	56,459,331,836
+ Provision for Reinsurance	2,944,031,835	3,290,710,172	3,665,749,561	2,962,166,230	3,153,445,256
+ Provision for FASB 115(after-tax)	32,483,869,271	57,249,505,836	30,528,918,187	(69,664,596,475)	(41,952,605,672)
- Surplus Notes	(11,606,263,627)	(13,225,869,920)	(13,699,558,971)	(15,548,449,729)	(16,242,205,955)
GAAP-adjusted Net Worth	973,668,752,221	1,063,471,454,574	1,169,703,493,912	992,833,713,073	1,082,008,966,402
Ratio of Net Worth to Surplus	1.149	1.169	1.137	1.035	1.068
Five Year Average	1.112				

Source: ISO

NCRB - Pro Forma Statutory Rate of Return
Dwelling Insurance - Extended Coverage

		Pre-Tax	Tax Liability	Post-Tax
1	**Premiums**	100.00%		
	Loss & LAE	36.94%		
	Commissions	9.10%		
	Other Acquisition & General	3.91%		
	Taxes, Licenses, & Fees	2.30%		
	Policyholder Dividends	0.50%		
	Net Cost of Reinsurance	37.74%		
	Compensation for Assessment Risk	1.01%		
2	**Pro Forma Underwriting Profit**	8.50%		
3	**Installment Fee Income**	0.52%		
4	**Regular Tax**		1.89%	
5	**Additional Tax Due to IRS Treatment of Reserves**		0.06%	
6	**Total Return from Underwriting Post-Tax**			7.06%
7	**Investment Gain on Insurance Transaction**	2.06%		
	Less Investment Income on Agent and Reinsurance Balances	0.61%		
	Net Investment Gain on Insurance Transaction	1.45%	0.24%	1.21%
8	**Investment Gain on Surplus**	5.83%	0.97%	4.86%
9	**Total Return as a Percent of Premium (post-tax)**			13.13%
10	**Premium-to-Net Worth Ratio**			0.84
11	**Total Return as a Percent of Net Worth (post-tax)**			11.03%

Lines (1) to (8) are expressed as a percentage of premium.

Assumptions and Parameters

(a)	Underwriting Income Tax Rate	21.00%
(b)	Investment Income Tax Rate	16.62%
(c)	Pre-tax Investment Yield	5.14%
(d)	Premium-to-Surplus Ratio	0.93
(e)	Net Worth-to-Surplus Ratio	1.112
(f)	Installment Fee Income	0.52%
(g)	Additional Tax Due to IRS Treatment of Loss Reserves and UEPR	0.06%
(h)	Net Cost of Reinsurance	37.74%
(i)	Compensation for Assessment Risk	1.01%

Notes to Exhibit RB-24 Page 1

1 The expense provisions are those used in filing, adjusted for the indicated rate change.

2 Selected by North Carolina Rate Bureau

3 See Exhibit RB-24, Page 3

4 [(2) + (3)] x (a)

5 See Exhibit RB-24, Pages 4-6

6 (2) + (3) - (4) - (5)

7 Investment income on agents balances is calculated as 0.1688 x 1.021 x (c) , where 0.1688 is a factor for agents balances held for less than 90 days and 1.021 is a factor to correct for overdue balances. From this figure, we deduct investment income on net reinsurance balances, which which we estimate at 0.113 of the total cost of reinsurance times (c). The estimate for net reinsurance balances is based on ceded balances payable plus funds held plus other amounts due reinsurers minus reinsurance recoverables. These amounts are taken from the aggregated Schedule F as reported in the latest available edition of A.M. Best Aggregates & Averages.

8 (c) x [1/ (d) + 0.1297 x 0.4771], where 0.1297 is the prepaid expense ratio minus the total cost of reinsurance from Page 7 and 0.4771 is the UEPR ratio from Page 7.

9 (6) + (7) + (8)

10 (d) / (e)

11 (9) x (10)

Assumptions

(a) Current corporate tax rate, based on the Tax Cut and Jobs Act of 2017.
(b) See Exhibit RB-24 , Pages 11-13. Calculated as 1- average post-tax yield/average pre-tax yield.
(c) See Exhibit RB-24, Page 10
(d) See Exhibit RB-24, Page 14
(e) See Exhibit RB-24, Page 15
(f) See Exhibit RB-24, Page 3
(g) See Exhibit RB-24, Pages 4-6
(h) Net Cost of Reinsurance based on the analysis incorporated in the filing, adjusted for the indicated rate change.
(i) Compensation for Assessment Risk based on the analysis incorporated in the filing, adjusted for the indicated rate change.

NORTH CAROLINA
Dwelling Insurance - Extended Coverage
INSTALLMENT CHARGES AS A PERCENT OF PREMIUM

Year	**Percentage**
2024	0.42%
2023	0.44%
2022	0.55%
2021	0.57%
2020	0.63%
Selected Value	0.52%

Source: NCRB

North Carolina
Dwelling Insurance - Extended Coverage
Calculation of Additional Tax Liability

1. Collected Earned Premium for Current Year	100.00%
2. Unearned (Net) Premium Reserve 12/31/Current	25.93%
3. Unearned (Net) Premium Reserve 12/31/Prior	24.75%
4. Increase: (2) - (3)	1.18%
5. 20% of Increase = Taxable Income	0.24%
6. Additional Tax Liability due to Unearned Premium Reserve	0.05%
7. Unpaid (Net) Loss Current Year	16.42%
8. Discounted Unpaid (Net) Loss Prior Year	16.00%
9. Unpaid (Net) Loss Prior Year	15.66%
10. Discounted Unpaid (Net) Loss Prior Year	15.30%
11. Additional Income	0.07%
12. Additional Tax Liability due to Loss Reserve Discounting	0.01%
13. Total Additional Tax Liabilities (6) + (12)	0.06%

NORTH CAROLINA
Dwelling Insurance - Extended Coverage
Calculation of Taxable Income

Calculation of Unpaid Loss for Current Accident Year (AY)					Calculation of Discounted Unpaid Loss for Current AY			Calculation of Discounted Unpaid Loss for Prior AY			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
AY Avg Acc Date	AY Pay Pattern	Percent Unpaid	Total Losses	Unpaid Losses	AY at 12/31 yr t	Discount Factor	Discounted Unpaid Loss	AY at 12/31/yr t-1	Unpaid Losses	Discount Factor	Discounted Unpaid Loss
0.5	55.61%	44.39%	36.938	16.40	2024	0.973675	15.9635				
1.5	89.33%	10.67%	35.217	3.76	2023	0.971719	3.6505	2023	15.631	0.977793	15.2843
2.5	94.67%	5.33%	33.577	1.79	2022	0.985999	1.7658	2022	3.582	0.971719	3.4804
3.5	100.00%	0.00%	32.013	0.00	2021	0.984834	0.0000	2021	1.707	0.986826	1.6849
4.5	100.00%	0.00%	30.522	0.00	2020	0.984785	0.0000	2020	0.000	0.985999	0.0000
5.5	100.00%	0.00%	29.100	0.00	2019	0.985513	0.0000	2019	0.000	0.984834	0.0000
6.5	100.00%	0.00%	27.745	0.00	2018	0	0.0000	2018	0.000	0.984785	0.0000
7.5	100.00%	0.00%	26.452	0.00	2017	0	0.0000	2017	0.000	0.985513	0.0000
								2016	0.000	0	0.0000
Totals				21.94			21.38		20.92		20.45

Notes to Pages 4 and 5

Page 4

2	[Page 8, line (2) divided by Page 8, line (1)] times one minus the Cost of Reinsurance from Page 7
3	(2) divided by 1 plus the 10 year average growth rate of Dwelling Insurance - Extended Coverage premiums in North Carolina.
4	(2) - (3)
5	(4) x 20%
6	(5) x current corporate tax rate
7	Unpaid current-year losses at year-end as a percent of current year premium. Sum of Page 5, Column (5) x (ratio of the net loss and LAE ratio from Page 7 to the direct loss and LAE ratio from Page 1)
8	Discounted unpaid current-year losses at year-end as a percent of current year premium. Sum of Page 5, Column (8) x (ratio of the net loss and LAE ratio from Page 7 to the direct loss and LAE ratio from Page 1)
9	Unpaid prior-year losses at year-end as a percent of current year premium. Sum of Page 5, Column (10) x (ratio of the net loss and LAE ratio from Page 7 to the direct loss and LAE ratio from Page 1)
10	Discounted unpaid prior-year losses at year-end as a percent of current year premium. Sum of Page 5, Column (12) x (ratio of the net loss and LAE ratio from Page 7 to the direct loss and LAE ratio from Page 1)
11	Change in loss reserve discount: [(7) - (8)] - [(9) - (10)]
12	(11) x current corporate tax rate
13	(6) + (12)

Page 5

1	Midpoint of number of years since end of accident period
2	Special Property payout pattern from IRS Rev. Proc 2016-58
3	1 - (2)
4	Latest period losses are based on projected loss ratio from Page 1. For previous years, losses are detrended at the 10 year average premium growth rate for Dwelling Insurance - Extended Coverage in North Carolina.
5	(3) x (4)
6	Accident Year at current year end
7	IRS discount factors for Special Property from Rev. Proc 2025-15
8	(5) x (7)
9	Accident Year at prior year end
10	Column (3), previous period x Column (4), current period
11	IRS discount factors for Special Property from Rev. Proc 2023-41
12	(10) x (11)

NCRB Investment Income Calculation
Dwelling Insurance - Extended Coverage

Projected Investment Earnings on Loss, Loss Adjustment Expense and Unearned Premium Reserves

A. UNEARNED PREMIUM RESERVES		
1. Direct Earned Premiums		1,000,000
2. Mean Unearned Premium Reserve	47.71%	477,100
3. Deductions for Prepaid Expenses		
Commissions & Brokerage	9.10%	
Taxes, Licenses, & Fees (5/6)	1.92%	
Other Acquisition & General (1/2)	1.95%	
Cost of Reinsurance	47.04%	
Total	60.01%	
4. Deduction for Prepaid Expense: (2) x (3)		286,308
5. Net Unearned Premium Reserve Subject to Investment (2) - (4)		190,792
B. Loss and Loss Expense Reserves		
1. Direct Earned Premiums		1,000,000
2. Expected Net Incurred Loss & LAE-to-Direct Premium Ratio	27.64%	276,429
3. Expected Mean Loss and LAE Reserve-to-Incurred Ratio	75.73%	209,327
C. Net Policyholder Funds Subject to Investment (A5 + B3)		400,119
D. Average Rate of Return		5.14%
E. Investment Earnings from Net Reserves: (C) x (D)		20,584
F. Average Rate of Return as a Percent of Direct Earned Premiums: (E) / (A1)		2.06%

NORTH CAROLINA
Dwelling Insurance - Extended Coverage

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line A-1
Calculations displayed are per million of direct earned premiums.

Line A-2
The mean unearned premium reserve (UEPR) is determined by multiplying the direct earned premiums in line A-1 by the ratio of the mean unearned premium reserve to the direct earned premium for the current calendar year ended 12/31. The data are for North Carolina Allied Lines insurance (from statutory Page 14 of the Annual Statement) for all companies which wrote Dwelling Insurance - Extended Coverage in the most recent calendar year.

1	NC Allied Lines Direct Earned Premium for most recent calendar year	470,442,260
2	NC Allied Lines UEPR at end of most recent calendar year	230,308,551
3	NC Allied Lines UEPR at end of previous calendar year	218,597,541
4	Mean NC Allied Lines UEPR	224,453,046
5	Ratio [(4) / (1)]	47.71%

Line A-3
Deduction for prepaid expenses
Certain production expenses, such as commissions and reinsurance, are assumed to be incurred when the policy is written and before the premium is paid. In addition, half of Other Acquisition and General expenses and 5/6 of Taxes, Licenses and Fees are assumed to be prepaid.

NORTH CAROLINA
Dwelling Insurance - Extended Coverage

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line B-2
Ratio is calculated as the expected direct loss and LAE ratio from Page 1 minus the difference between the total cost of reinsurance from Line A-3 and the net cost of reinsurance from Page 1.

Line B-3
The mean loss reserve is calculated by multiplying the incurred losses in line B-2 by the ratio for mean loss reserves to incurred losses. The latter figures are based on total statutory Page 14 figures for NC Allied Lines direct losses incurred and direct losses unpaid for all companies writing Dwelling Insurance - Extended Coverage in North Carolina in 2024. The adjustment for loss expense reserves is based on nationwide industry aggregates for the Homeowners line.

6	Direct Losses Incurred	2020	130,492,323
7	Direct Losses Incurred	2021	99,395,485
8	Direct Losses Incurred	2022	167,505,638
9	Direct Losses Incurred	2023	154,364,342
10	Direct Losses Incurred	2024	783,301,946
11	Direct Losses Unpaid	2019	140,237,570
12	Direct Losses Unpaid	2020	109,778,079
13	Direct Losses Unpaid	2021	94,123,057
14	Direct Losses Unpaid	2022	111,185,329
15	Direct Losses Unpaid	2023	95,763,921
16	Direct Losses Unpaid	2024	520,072,796
17	Mean Loss Reserve	2020	125,007,825
18	Mean Loss Reserve	2021	101,950,568
19	Mean Loss Reserve	2022	102,654,193
20	Mean Loss Reserve	2023	103,474,625
21	Mean Loss Reserve	2024	307,918,359
22	Ratio	2020	0.958
23	Ratio	2021	1.026
24	Ratio	2022	0.613
25	Ratio	2023	0.670
26	Ratio	2024	0.393
27	Average Loss Reserve		0.732
28	Ratio of LAE Reserves to Loss Reserves		0.169
29	Ratio of Incurred LAE to Incurred Loss		0.130
30	Loss & LAE Reserve [(27) x (1+(28))/(1+(29))]		0.757

NORTH CAROLINA
Dwelling Insurance - Extended Coverage

ESTIMATED INVESTMENT EARNINGS ON UNEARNED PREMIUM RESERVES AND ON LOSS RESERVES

EXPLANATORY NOTES

Line E

The average rate of return is the average of the pretax current yield calculated on Page 11 and the pretax embedded yield. The embedded yield (see Page 12) is the sum of the ratio of investment income to invested assets for the most recent year plus the ten year average ratio of capital gains to invested assets (see Page 13). The current yield is the estimated currently available rate of return (including both income and capital gains) on the industry investment portfolio (see Page 11).

Embedded Yield	4.72%
Current Yield	5.56%
Average	5.14%

Portfolio Yield and Tax Rate - Current Yield				
Investable Asset	Percent of Assets	Estimated Prospective Pre-Tax Return	Tax Rate	Estimated Prospective Post-Tax Return
Bonds				
US Gov't	13.52%	4.11%	21.00%	3.25%
Municipal	19.90%	2.75%	5.25%	2.60%
Industrial	35.77%	4.67%	21.00%	3.69%
Preferred Stock	0.34%	6.53%	13.13%	5.67%
Common Stock	17.38%	12.83%	19.44%	10.34%
Mortgage Loans	1.15%	6.76%	21.00%	5.34%
Real Estate	0.65%	6.47%	21.00%	5.11%
Cash & Short-term Investments	3.79%	4.39%	21.00%	3.47%
Other Long-Term Investments	7.51%	7.32%	18.71%	5.95%
Rate of Return Before Expenses	100.00%	5.86%	18.69%	4.77%
Investment Expenses		0.30%	21.00%	0.23%
Portfolio Rate of Return		5.56%	18.57%	4.53%

Sources

Preferred Stock	Current yield on iShares Preferred Stock Index ETF, 8/15/25
Real Estate	REIT Sector WACC; source: Damodaran Online, https://www.stern.nyu.edu/~adamodar/pc/datasets/wacc.xls, using 4.413 for Treasury bond yield
Cash	3 month Treasury rate, averaged over 3 months (source: US Treasury)
Municipal	Maturity weighted avg of 3 month avg MBIS Investment Grade yield curve; linearly interpolated
Industrial	Maturity weighted avg of 3-month average HQM par yields (source: FRED); linearly interpolated
Treasury	Maturity weighted avg of 3 month avg Treasury yields; linearly interpolated (source: US Treasury)
Common Stock	0.0844 equity risk premium (source: Exhibit 25) plus 3 month average Treasury Rate
Other LTI	Average of yields on bond portfolio, preferred stock, common stock, mortgages, and real estate.
Investment Expenses	Investment Expenses from statutory Page 12 of the Annual Statement (Exhibit of Net Investment Income) divided by the average of the last two years' Cash and Invested Assets from statutory Page 2 of the Annual Statement (Assets), as compiled in A.M. Best's Aggregates and Averages.

Portfolio Yield and Tax Rate
Embedded Yield

		Income	Tax Rate
Bonds			
	Taxable	51,054,529	21.00%
	Non-Taxable	4,733,898	5.25%
Stocks			
	Taxable	9,375,922	13.13%
	Non-Taxable	3,396,135	5.25%
Mortgage Loans		2,017,674	21.00%
Real Estate		1,837,148	21.00%
Contract Loans		6,054	21.00%
Cash & Short Term Inv		14,625,584	21.00%
All Other		9,258,862	21.00%
Total		96,305,806	18.90%
Inv. Expenses		7,532,312	21.00%
Net Inv. Income		88,773,494	18.72%
Mean Invested Assets		2,456,888,663	
Inv. Inc. Yield Rate		3.61%	18.72%
Capital Gains (10 yr. avg.) (% of Inv. Assets)		1.11%	0.00%
Invest. Yield Rate (pre-tax)		4.72%	14.32%
Invest. Yield Rate (post-tax)		4.05%	

Source: A.M. Best's Aggregates and Averages, 2025 Edition, statutory Page 12 of the Annual Statement - Exhibit of Net Investment Income (Column 2 - Earned During Year). For capital gains, see Exhibit RB-24, Page 13.

Realized Capital Gains or Losses
As a Percentage of Mean Invested Assets
(Amounts in Thousands of Dollars)

Calendar Year	Mean Invested Assets	Realized Capital Gains Amount	Percent
2015	1,567,611,077	9,887,732	0.63%
2016	1,596,937,470	8,086,268	0.51%
2017	1,676,831,258	15,725,303	0.94%
2018	1,733,729,297	10,825,733	0.62%
2019	1,822,857,949	11,238,484	0.62%
2020	1,975,605,647	10,933,304	0.55%
2021	2,156,355,790	18,153,320	0.84%
2022	2,251,339,204	2,090,986	0.09%
2023	2,305,242,991	50,414,662	2.19%
2024	2,456,888,663	79,755,725	3.25%
Total	19,543,399,342	217,111,517	1.11%

"Mean Invested Assets" is the average of current and prior year values for Cash & Invested Assets from statutory Page 2 of the Annual Statement (Assets). Source for data is 2015-2025 editions of A.M. Best's Aggregates and Averages. Figures are net of capital gains taxes.

North Carolina

Dwelling Insurance - Extended Coverage

Premium-to-Surplus Ratios

Year	Ratio
2024	1.13
2023	1.15
2022	1.04
2021	0.86
2020	0.82
2019	0.88
2018	1.05
2017	0.85
2016	0.78
2015	0.78
Average	0.93

Data from NAIC Statutory Filings for all groups writing Dwelling Insurance - Extended Coverage insurance in North Carolina. Weighted average is calculated using North Carolina Dwelling Insurance - Extended Coverage insurance premiums.

North Carolina
Dwelling Insurance - Extended Coverage
Calculation of Ratio of GAAP Net Worth to Statutory Surplus

	2019	2020	2021	2022	2023
Policyholder Surplus	847,278,658,173	910,066,482,410	1,028,834,642,825	958,964,082,808	1,013,452,561,011
+ Deferred Acquisition Costs	46,002,606,289	48,118,482,109	51,883,319,641	54,714,320,843	60,500,602,221
+ Non-Admitted DTA Provision	6,045,409,090	6,001,020,602	5,674,496,962	6,641,006,360	6,637,837,705
+ Non-admitted Assets (non-tax part)	50,520,441,190	51,971,123,366	62,815,925,708	54,765,183,036	56,459,331,836
+ Provision for Reinsurance	2,944,031,835	3,290,710,172	3,665,749,561	2,962,166,230	3,153,445,256
+ Provision for FASB 115(after-tax)	32,483,869,271	57,249,505,836	30,528,918,187	(69,664,596,475)	(41,952,605,672)
- Surplus Notes	(11,606,263,627)	(13,225,869,920)	(13,699,558,971)	(15,548,449,729)	(16,242,205,955)
GAAP-adjusted Net Worth	973,668,752,221	1,063,471,454,574	1,169,703,493,912	992,833,713,073	1,082,008,966,402
Ratio of Net Worth to Surplus	1.15	1.17	1.14	1.04	1.07
Five Year Average	1.112				

Source: ISO

Risk Premiums and Market Returns, 1928-2024

	Annual Returns on Investments in				
Year	S&P 500	US 3 mo	US 10 yr	Baa Corp	AAA Corp
1928	43.81%	3.08%	0.84%	3.22%	3.28%
1929	-8.30%	3.16%	4.20%	3.02%	4.14%
1930	-25.12%	4.55%	4.54%	0.54%	5.86%
1931	-43.84%	2.31%	-2.56%	-15.68%	-1.56%
1932	-8.64%	1.07%	8.79%	23.59%	11.07%
1933	49.98%	0.96%	1.86%	12.97%	5.30%
1934	-1.19%	0.28%	7.96%	18.82%	10.15%
1935	46.74%	0.17%	4.47%	13.31%	6.90%
1936	31.94%	0.17%	5.02%	11.38%	6.33%
1937	-35.34%	0.28%	1.38%	-4.42%	2.17%
1938	29.28%	0.07%	4.21%	9.24%	4.31%
1939	-1.10%	0.05%	4.41%	7.98%	4.28%
1940	-10.67%	0.04%	5.40%	8.65%	4.93%
1941	-12.77%	0.13%	-2.02%	5.01%	1.93%
1942	19.17%	0.34%	2.29%	5.18%	2.71%
1943	25.06%	0.38%	2.49%	8.04%	3.42%
1944	19.03%	0.38%	2.58%	6.57%	3.09%
1945	35.82%	0.38%	3.80%	6.80%	3.48%
1946	-8.43%	0.38%	3.13%	2.51%	2.61%
1947	5.20%	0.60%	0.92%	0.26%	0.46%
1948	5.70%	1.05%	1.95%	3.44%	3.46%
1949	18.30%	1.12%	4.66%	5.38%	4.62%
1950	30.81%	1.20%	0.43%	4.24%	1.80%
1951	23.68%	1.52%	-0.30%	-0.19%	-0.23%
1952	18.15%	1.72%	2.27%	4.44%	3.35%
1953	-1.21%	1.89%	4.14%	1.62%	1.61%
1954	52.56%	0.94%	3.29%	6.16%	5.10%
1955	32.60%	1.72%	-1.34%	2.04%	0.78%
1956	7.44%	2.62%	-2.26%	-2.35%	-1.78%
1957	-10.46%	3.22%	6.80%	-0.72%	3.26%
1958	43.72%	1.77%	-2.10%	6.43%	1.63%
1959	12.06%	3.39%	-2.65%	1.57%	0.14%
1960	0.34%	2.87%	11.64%	6.66%	6.41%
1961	26.64%	2.35%	2.06%	5.10%	3.79%
1962	-8.81%	2.77%	5.69%	6.50%	5.86%
1963	22.61%	3.16%	1.68%	5.46%	3.36%
1964	16.42%	3.55%	3.73%	5.16%	3.64%
1965	12.40%	3.95%	0.72%	3.19%	2.56%
1966	-9.97%	4.86%	2.91%	-3.45%	-0.70%
1967	23.80%	4.29%	-1.58%	0.90%	-0.45%
1968	10.81%	5.34%	3.27%	4.85%	4.32%
1969	-8.24%	6.67%	-5.01%	-2.03%	-2.18%
1970	3.56%	6.39%	16.75%	5.65%	8.27%
1971	14.22%	4.33%	9.79%	14.00%	10.35%
1972	18.76%	4.06%	2.82%	11.41%	8.44%
1973	-14.31%	7.04%	3.66%	4.32%	3.00%
1974	-25.90%	7.85%	1.99%	-4.38%	-0.12%
1975	37.00%	5.79%	3.61%	11.05%	9.54%
1976	23.83%	4.98%	15.98%	19.75%	14.23%

	Annual Returns on Investments in				
Year	S&P 500	US 3 mo	US 10 yr	Baa Corp	AAA Corp
1977	-6.98%	5.26%	1.29%	9.95%	6.58%
1978	6.51%	7.18%	-0.78%	3.14%	2.01%
1979	18.52%	10.05%	0.67%	-2.01%	-0.25%
1980	31.74%	11.39%	-2.99%	-3.32%	-2.55%
1981	-4.70%	14.04%	8.20%	8.46%	7.94%
1982	20.42%	10.60%	32.81%	29.05%	27.89%
1983	22.34%	8.62%	3.20%	16.19%	7.85%
1984	6.15%	9.54%	13.73%	15.62%	14.80%
1985	31.24%	7.47%	25.71%	23.86%	25.97%
1986	18.49%	5.97%	24.28%	21.35%	18.95%
1987	5.81%	5.78%	-4.96%	2.81%	-0.85%
1988	16.54%	6.67%	8.22%	14.38%	12.87%
1989	31.48%	8.11%	17.69%	15.95%	14.39%
1990	-3.06%	7.50%	6.24%	6.28%	7.72%
1991	30.23%	5.38%	15.00%	18.93%	14.98%
1992	7.49%	3.43%	9.36%	11.31%	9.84%
1993	9.97%	3.00%	14.21%	15.47%	14.30%
1994	1.33%	4.25%	-8.04%	-0.97%	-2.78%
1995	37.20%	5.49%	23.48%	21.29%	21.16%
1996	22.68%	5.01%	1.43%	3.42%	2.83%
1997	33.10%	5.06%	9.94%	12.75%	11.26%
1998	28.34%	4.78%	14.92%	7.63%	10.20%
1999	20.89%	4.64%	-8.25%	0.91%	-3.39%
2000	-9.03%	5.82%	16.66%	9.39%	10.99%
2001	-11.85%	3.40%	5.57%	8.54%	11.09%
2002	-21.97%	1.61%	15.12%	12.14%	10.42%
2003	28.36%	1.01%	0.38%	12.32%	9.54%
2004	10.74%	1.37%	4.49%	10.35%	7.14%
2005	4.83%	3.15%	2.87%	5.30%	6.73%
2006	15.61%	4.73%	1.96%	5.20%	3.75%
2007	5.48%	4.36%	10.21%	4.84%	5.84%
2008	-36.55%	1.37%	20.10%	-3.54%	10.97%
2009	25.94%	0.15%	-11.12%	20.21%	-0.09%
2010	14.82%	0.14%	8.46%	9.41%	8.83%
2011	2.10%	0.05%	16.04%	12.26%	13.99%
2012	15.89%	0.09%	2.97%	9.33%	4.59%
2013	32.15%	0.06%	-9.10%	-0.98%	-3.43%
2014	13.52%	0.03%	10.75%	10.78%	11.56%
2015	1.38%	0.05%	1.28%	-1.50%	1.13%
2016	11.77%	0.32%	0.69%	11.52%	4.53%
2017	21.61%	0.93%	2.80%	9.23%	8.40%
2018	-4.23%	1.94%	-0.02%	-3.27%	-0.93%
2019	31.21%	2.06%	9.64%	15.25%	12.08%
2020	18.02%	0.35%	11.33%	10.60%	10.23%
2021	28.47%	0.05%	-4.42%	0.93%	-1.93%
2022	-18.04%	2.02%	-17.83%	-15.14%	-12.88%
2023	26.06%	5.07%	3.88%	8.74%	5.09%
2024	24.88%	4.97%	-1.64%	1.74%	-1.03%

Arithmetic Average Historical Return					
1928-2024	11.79%	3.36%	4.79%	6.90%	5.64%

Geometric Average Historical Return					
1928-2024	9.94%	3.31%	4.50%	6.62%	5.46%

Blume-Weighted Average Historical Return (10 yr horizon for stocks)					
1928-2024	11.63%	3.35%	4.76%	6.87%	5.62%

Blume Risk Premium				
	US 3 month	US 10 yr	Baa Bond	Aaa Bond
1928-2024	8.44%	6.87%	4.76%	6.01%

Notes: Source is Damodaran Online. Blume Risk Premium calculated as difference between Blume-Weighted Averages except for the US 3 month, which is based on the difference in Arithmetic Averages.

Public Company Level Capital Market Data

Group Name	Ultimate Parent Ticker	2024 NC Dwelling Fire DPW	1-year Beta	3-year Beta	Debt%
Munich Re	MUV2	5,153,579	0.866973	0.828651	7.92%
The Progressive Corporation	PGR	1,700,616	0.614207	0.594284	4.63%
Cincinnati Financial Corporation	CINF	1,005,945	0.815117	0.853408	3.48%
Chubb Limited	CB	529,504	0.536018	0.598803	14.83%
The Travelers Companies, Inc.	TRV	389,017	0.680408	0.666315	11.78%
Horace Mann Educators Corporation	HMN	217,101	0.654397	0.650223	22.62%
Universal Insurance Holdings, Inc.	UVE	193,287	0.693143	0.740395	12.69%
Kemper Corporation	KMPR	156,133	0.863534	0.901631	30.02%
The Travelers Companies, Inc.	TRV	46,656	0.680408	0.666315	11.78%
Dwelling Fire - Premium Weighted Averages			0.779787	0.763648	8.22%

Group Name	Ultimate Parent Ticker	2024 NC Dwelling Extended Coverage DPW	1-year Beta	3-year Beta	Debt%
Munich Re	MUV2	14,258,267	0.866973	0.828651	7.92%
The Progressive Corporation	PGR	4,701,114	0.614207	0.594284	4.63%
Cincinnati Financial Corporation	CINF	2,741,147	0.815117	0.853408	3.48%
The Travelers Companies, Inc.	TRV	1,055,024	0.680408	0.666315	11.78%
Universal Insurance Holdings, Inc.	UVE	695,204	0.693143	0.740395	12.69%
Horace Mann Educators Corporation	HMN	537,203	0.654397	0.650223	22.62%
The Travelers Companies, Inc.	TRV	118,988	0.680408	0.666315	11.78%
Kemper Corporation	KMPR	81,312	0.863534	0.901631	30.02%
Chubb Limited	CB	76,334	0.536018	0.598803	14.83%
The Hartford Insurance Group, Inc.	HIG	251	0.815117	0.853408	3.48%
Dwelling Extended Coverage - Premium Weighted Averages			0.792377	0.77123	7.52%

Betas are based on daily returns over the indicated horizon and are Blume-adjusted (with a weight of 0.67 on the raw beta and a weight of 0.33 on one. Debt percentage is estimated as the Total Debt divided by the sum of Total Debt and the most recent available equity market capitalization. Only publicly traded companies are included. Source is S&P Global

Sample of Findings on the Private Company Discount

Study	Years	Discount	Type
Emory (1994)	1992-1993	45%	IPO
Willamette Management Associates (various)	1975-1997	29% to 60%	IPO
Garland and Reilly (2004)	1998-2002	35%	IPO
Larcker et al. (2018)	2017	39% to 47%	IPO
Koeplin et al. (2000)	1984-1998	20% to 30%	Acquisitions
Block (2007)	1999-2006	20% to 25%	Acquisitions
Officer (2007)	1979-2003	15% to 30%	Acquisitions
Paglia and Harjoto (2010)	1993-2008	65% to 70%	Acquisitions
Jaffe et al. (2018)	1985-2014	0%	Acquisitions
Lohrey (2020)	2005-2015	48% to 62%	Acquisitions
Goetz (2021)	1997-2014	13%	Acquisitions
Silber (1991)	1981-1988	34%	Restricted Stock
Johnson (1999)	1991-1995	20%	Restricted Stock
Bajaj et al. (2001)	1990-1995	7%	Private placements
Comment (2012)	2004-2010	5% to 6%	Private placements
Finnerty (2013)	1991-1997	21%	Private placements
Finnerty (2013)	1997-2007	15%	Private placements
Chen et al. (2015)	1999-2012	10%	Private placements
Umar et al. (2023)	2002-2016	8%	Private placements

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