2020 Summer National Meeting
Virtual Meeting

CATASTROPHE RISK (E) SUBGROUP
Wednesday, July 29, 2020
11:00 a.m. ET / 10:00 a.m. CT / 9:00 a.m. MT / 8:00 a.m. PT

ROLL CALL

Tom Botsko, Chair                   Ohio
Robert Ridenour, Vice Chair        Florida
Susan Bernard                      California
Mitchell Bronson/Eric Unger        Colorado
Wanchin Chou                       Connecticut
Judy Mottar                        Illinois
Gordon Hay                         Nebraska
Anna Krylova                       New Mexico
Gloria Huberman/Sak-man Luk        New York
Andrew Schallhorn                  Oklahoma
Will Davis                         South Carolina
Miriam Fisk                        Texas

NAIC Support Staff: Eva Yeung

AGENDA

1. Consider Adoption of the Joint Property and Casualty Risk-Based Capital (E) Working Group and Catastrophe Risk (E) Subgroup Minutes—Tom Botsko (OH) Attachment A

2. Hear a Presentation from Karen Clark & Company (KCC) on its Catastrophe Model—Glen Daraskevich (KCC) and Joanne Yammine (KCC) Attachment B

3. Discuss the Possibility of Allowing Additional Third-Party Commercial Vendor Models—Tom Botsko (OH)

4. Discuss the Internal Catastrophe Model Evaluation Process—Wanchin Chou (CT)

5. Discuss Any Other Matters Brought Before the Subgroup—Tom Botsko (OH)

6. Adjournment

W:\National Meetings\2020\Summer\Agenda\tf\capadequacy\pcrbc\072920 cat risk agenda.docx
The Property and Casualty Risk-Based Capital (E) Working Group of the Capital Adequacy (E) Task Force met via conference call Feb. 3, 2020, in joint session with the Catastrophe Risk (E) Subgroup of the Property and Casualty Risk-Based Capital (E) Working Group of the Capital Adequacy (E) Task Force. The following Working Group members participated: Tom Botsko, Chair, and Dale Bruggeman (OH); Richard Ford (AL); Mitchell Bronson, Rolf Kaumann and Eric Unger (CO); Wanchin Chou (CT); Robert Ridenour (FL); Judy Mottar (IL); Anna Krylova (NM); Sak-man Luk (NY); Will Davis (SC); and Randy Milquet (WI). The following Subgroup members participated: Tom Botsko, Chair, and Dale Bruggeman (OH); Robert Ridenour, Vice Chair (FL); Kim Hudson and Laura Clements (CA); Mitchell Bronson, Rolf Kaumann and Eric Unger (CO); Wanchin Chou (CT); Judy Mottar (IL); Anna Krylova (NM); Sak-man Luk (NY); Andrew Schallhorn (OK); and Will Davis (SC). Also participating were: Julie Lederer (MO); and Steve Drutz (WA).

1. Adopted the Catastrophe Risk (E) Subgroup’s 2019 Fall National Meeting Minutes

Mr. Botsko said the Subgroup met Dec. 6, 2019, and took the following action: 1) adopted its Nov. 8, 2019, minutes; 2) adopted proposal 2019-14-CR (2019 U.S. and Non-U.S. Catastrophe Event Lists); 3) heard presentations from the American Academy of Actuaries (Academy) on Wildfires and the Actuaries Climate Index (ACI); 4) discussed the factor of using aggregate exceedance probability (AEP) basis vs. occurrence exceedance probability (OEP) basis; and 5) discussed modeling of projected losses.

Ms. Mottar made a motion, seconded by Mr. Chou, to adopt its Dec. 6, 2019, minutes (see NAIC Proceedings – Fall 2019, Capital Adequacy (E) Task Force, Attachment Four-A). The motion passed unanimously.

2. Adopted the Property and Casualty Risk-Based Capital (E) Working Group’s 2019 Fall National Meeting Minutes

Mr. Botsko said the Working Group met Dec. 8, 2019, and took the following action: 1) adopted its Nov. 8, 2019, minutes; 2) adopted the report of the Catastrophe Risk (E) Subgroup; 3) exposed proposal 2018-19-P (Vulnerable 6 or Unrated Risk Charge); 4) discussed the 2020 property/casualty (P/C) risk-based capital (RBC) working agenda; 5) discussed the possibility of using the NAIC as a centralized location for reinsurer designations; and 6) discussed the possible treatment of the R3 related to the runoff and captive companies.

Mr. Milquet made a motion, seconded by Ms. Mottar, to adopt its Dec. 6, 2019, minutes (see NAIC Proceedings – Fall 2019, Capital Adequacy (E) Task Force, Attachment Four). The motion passed unanimously.

3. Adopted the Property and Casualty Risk-Based Capital (E) Working Group and Catastrophe Risk (E) Subgroup’s E-Vote Minutes

Mr. Botsko said the Working Group and the Subgroup conducted an e-vote to consider adoption of proposal 2019-14-CR (2019 U.S. and Non-U.S. Catastrophe Risk Event Lists).

Mr. Chou made a motion, seconded by Ms. Mottar, to adopt their Jan. 22 minutes (Attachment SixXX). The motion passed unanimously.

4. Adopted Proposal 2018-19-P (Vulnerable 6 or Unrated Risk Charge) and Agreed to Refer the Schedule F Proposal to the Blanks (E) Working Group

Mr. Botsko said the purpose of this proposal is to modify the instructions to reflect that the factors for all uncollateralized reinsurance recoverable from unrated reinsurers be the same for authorized, unauthorized, certified and reciprocal reinsurers.

W. Scott Williamson (Reinsurance Association of America—RAA) said the RAA supports the proposal and the associated Annual Statement changes. He agreed with the Working Group approach to consider moving, over time, towards a charge that is more aligned with risk-indicated factors used by the rating agencies. He also recommended that the Working Group should consider applying different charges for: 1) captives and runoff reinsurers, as they may not obtain financial strength ratings; 2)
reinsurer designation equivalent to categories 1 through 6 to reflect the most recent credit default experience and consistency with reinsurance recoverable credit risk factors in use by the rating agency capital models; and 3) lowering the cushion or margin for operational risk that is embedded in the credit risk factors. Matthew B. Vece (American Property Casualty Insurance Association—APCIA) said he is concerned that this proposal inappropriately combines two groups with inherently different risk characteristics. He recommended an alternative approach to retain the current seven categories for the RBC R3 credit risk charge, with the last two categories being: 1) vulnerable 6; and 2) unrated (whether authorized, unauthorized, certified or reciprocal). Mr. Williamson said that the unrated category includes vulnerable reinsurers in addition to solvent reinsurers. He agreed with the current proposal that eliminates the NAIC-7 designation code.

Mr. Milquet asked if reclassifying NAIC-7 back to NAIC-6 creates more work for filing companies. Mr. Williamson replied that it is necessary to take this action to ensure that future RBC filings are not populated with “legacy” NAIC 7 codes if and when a new definition is adopted.

Mr. Botsko understood the industry concerns. However, it was the Working Group’s intention to evaluate the data annually until reaching any agreed upon change to the factor and the structure. Mr. Botsko recommended that the Working Group consider: 1) adopting proposal 2018-19-P for 2020 RBC filing; 2) forwarding the blanks proposal to the Blanks (E) Working Group for consideration; and 3) documenting the industry concerns in the working agenda for future discussion.

Mr. Milquet made a motion, seconded by Mr. Ridenour, to refer the Schedule F proposal to the Blanks (E) Working Group and adopt proposal 2018-19-P, subject to adoption of the Schedule F blanks proposal from the Blanks (E) Working Group. The motion passed unanimously.

5. **Received Referrals from the Statutory Accounting Principles (E) Working Group**

Mr. Botsko said the Working Group received two referrals from the Statutory Accounting Principles (E) Working Group. The first referral is regarding Ref #2019-49: Retroactive Reinsurance Exception [Attachment XX]. He said this agenda item addresses a request from the Academy Committee on Property and Liability Financial Reporting (COPLFR) Working Group to clarify both the accounting and reporting for retroactive contracts, which are accounted for prospectively. The COPLFR noted that there is diversity in the current practice due to lack of specific guidance. The clarifications requested include: 1) both the ceding entity and assuming entity, where both are members of the same group and are consolidated in the same combined annual statement; and 2) the reporting method to be used if the ceding entity and assuming entity are not in the same group.

Robin Marcotte (NAIC) said the Statutory Accounting Principles (E) Working Group is currently seeking: 1) input related to the RBC impacts; and 2) volunteers to assist with developing guidance. She encouraged volunteers to contact her.

Mr. Botsko said another referral is regarding Ref #2019-40: Reporting of Installment Fees and Expenses [Attachment XX]. Ms. Marcotte said the purpose of this exposure is to include a minor clarification of the current installment fee guidance in Statement of Statutory Accounting Principles (SSAP) No. 53—Property Casualty Contracts–Premiums and request input from the Working Group on the questions that are included in the referral regarding if incurred installment fee expenses should be allowed to be reported in other expenses. Excluding expenses from underwriting can have an impact on underwriting ratios. Mr. Bruggeman encouraged members and interested parties to review this referral and share their thoughts during the Spring National Meeting.

Mr. Botsko said the Working Group will coordinate with the Casualty Actuarial and Statistical (C) Task Force to determine how to approach these referrals and provide findings during the Spring National Meeting.

6. **Discussed Other Matters**

Mr. Botsko said the Working Group just received another referral [Attachment XX] from the Restructuring Mechanisms (E) Subgroup on Jan. 29. He stated that the purpose of the referral is requesting that the Working Group determine if changes should be made to the P/C formula to better assess companies in runoff. He encouraged interested parties to review the referral; the Working Group will have a more in-depth discussion at the Spring National Meeting.

Mr. Bruggeman said the survey included in the referral provided some example definitions of the runoff companies. He encouraged members and interested parties to review the survey and share their thoughts at the Spring National Meeting.

Mr. Botsko also announced that the time of the Catastrophe Risk (E) Subgroup Spring National Meeting will change to 10:30 a.m. – 12:00 p.m. on March 20, 2020.
Having no further business, the Property and Casualty Risk-Based Capital (E) Working Group and the Catastrophe Risk (E) Subgroup adjourned.

W:\National Meetings\2020\Spring\TF\CapAdequacy\PCRBC\Att01 02-03propertybcwg-catrisksgmin .doc
Karen Clark & Company Model Overview

July 29, 2020

Glen Daraskevich, Senior Vice President
Joanne Yammine, FCAS, Director of Actuarial Services
Agenda

- Introduction to Karen Clark & Company (KCC)
- Innovative risk metrics for identifying threats to solvency
- Introduction to KCC Models
  - KCC US Hurricane Reference Model
  - KCC US Earthquake Reference Model
  - Additional KCC US Reference Models
- How KCC supports regulators
About Karen Clark & Company

- Established in 2008 by insurance industry veterans and pioneers in catastrophe risk management
  - Karen Clark developed the first commercial hurricane model and founded the first catastrophe modeling company, AIR
  - Vivek Basrur architected and led the development of AIR software technology, including CLASIC/2, CATRADER, and ISOHomeValue (now 360Value)
  - Senior staff have extensive experience in catastrophe model development and risk management

- KCC is dedicated to delivering innovative approaches and new scientific tools for addressing current challenges in estimating and managing catastrophe risk
  - Characteristic Event methodology
  - Physical models
  - Live event technology

- KCC supports a diverse client base with consulting services and the RiskInsight® open modeling platform
  - Top 10 US P&C insurers
  - Global reinsurance intermediaries
  - Leading global reinsurers
  - CAT Bond/ILS fund managers
  - Regulators
  - Academia
Opportunities for Improving Catastrophe Risk Management Practices

- More intuitive and operational metrics for identifying threats to solvency
- Improved consistency and stability in the average annual loss estimates used in ratemaking
- Direct access to the data and calculations underlying catastrophe loss estimates
  - Open platform
  - Transparent hazard and vulnerability components
  - Embedded visualization tools
- Innovative tools for delivering actionable information to decision makers
  - Live event reporting
What’s Different about Karen Clark & Company Models?

Based on the same science and components as traditional models.

Provides all the traditional metrics including PMLs, TVaRs, and AALs.

**Advancement:** Additional risk metrics for underwriting and portfolio management

**Advancement:** Unique sampling methodology enabling robust high resolution (location level) loss analyses

**Advancement:** Model components fully transparent

**Advancement:** Built-in tools and high resolution mapping for more efficient internal modeling process

**Advancement:** More accurate model loss estimates
Why New Risk Metrics—EP Curves and PMLs Answer Some but Not All Important Questions

<table>
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<th>Return Period</th>
<th>Loss ($Billions)</th>
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<td>250</td>
<td>205</td>
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<tr>
<td>500</td>
<td>245</td>
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Exceedance Probability (EP) Curve

- 1-in-100 year PML
- 1-in-250 year PML

Probability $p(L)$ that losses will exceed $L$: 1%, .4%
KCC’s Unique Characteristic Events (CEs) Address These Additional Questions

One Chart Summarizes What Decision-Makers Need to Know About Catastrophe Losses

Losses from the 100 year CEs

100-year PML

Market Share of Loss

Landfall Point
CEs Reveal Large Loss Potential Can Be Very Different Between Insurers with Similar PML

- **Company A**: Losses from 100-year hurricane greatly exceed PML.
- **Company B**: Losses from 100-year hurricane greatly exceed PML.
CEs Illustrate How a 20 Year Event Can Cause a Loss Close to the 100 Year PML
More Consistent and Accurate Location-level Loss Estimates is Critical for Ratemaking
Ratemaking – Loss Cost Comparison – Miami, FL
RiskInsight® is a Transparent and Open Model Which Allows Users to Independently Verify Model Assumptions and Better Understand Catastrophe Risk

- Visually verify event footprints
- Interrogate event parameters and underlying data
- View vulnerability functions and secondary uncertainty assumptions
- Intuitive dashboards summarize key portfolio insights
Introduction to KCC Models – KCC US Hurricane Reference Model

The Innovation and Technology Leader in Catastrophe Risk Modeling
Modeling the Frequency and Severity of US Hurricanes
The CE Methodology Avoids Spatial Biases and “Blind Spots” Present in Traditional Random Sampling Methodologies
Important CE Concept: Along the Coast the Event Changes to Keep the Hazard Probability the Same!

The CE Wind Speed Changes Along the Coastline

Blue bar charts represent historical frequency of SS Category storms in each region
Unique CE Profile Delivers Clearer Insight into Tail Risk and Threats to Solvency

100 Year CE Profile

Losses from the 100 year CEs

Market Share of Loss

100-year PML

Landfall Point
Developing a Complete and Spatially Unbiased Set of Potential Storms Across All Intensities

![Map of Florida with landfall points marked]

Simulated Intensities by Landfall Point - KCC Model

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<tr>
<th>Landfall Point</th>
<th>Number of Hurricanes</th>
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Simulated Intensities by Landfall Point - Monte Carlo Simulation

![Graph showing simulated intensities]

The Innovation and Technology Leader in Catastrophe Risk Modeling
Enhances Pricing with More Consistent and Accurate Location-level Loss Estimates

- AALs based on uniform exposure on a 1 KM grid (open terrain)
- Logical relation to risk
- No spatial bias
KCC Live Event Tracking Provides Valuable Real-Time Data to Decision Makers

### Real-Time Events Validate and Verify Underlying Model Assumptions

<table>
<thead>
<tr>
<th>Date and Time (EDT)</th>
<th>NHC Advisory</th>
<th>Projected Wind Speed at Landfall (mph)</th>
<th>KCC Industry Loss Estimate ($ billion)</th>
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<td>7</td>
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<tr>
<td>10/11, 11:00 AM</td>
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<td>155</td>
<td>8</td>
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</tbody>
</table>

### Information Made Available as Storms Develop

#### Maps of Losses and Claims

#### Numbers of claims and average severity by intensity band

#### Losses and claims information by ZIP

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Evolution of USGS Hazard Maps

1996
Peak Acceleration (%) with 2% Probability of Exceedance in 50 Years
USGS, NEHRP B-C Boundary

2002
Peak Acceleration (%) with 2% Probability of Exceedance in 50 Years
USGS Map, Oct. 2002

2008
PGA with 2% in 50 year PE. BC rock, 2008 USGS

2014
Two percent probability of exceedance in 50 years map of peak ground acceleration
USGS Report Evolution: Improve Best Estimation and Better Handling of Uncertainty
KCC CEs are Based on USGS MFDs and Account for Location Uncertainty

- Select the CE Magnitude
  - Use fault MFD (from UCERF3 in CA)
- Calculate the rupture area
  - (Wells-Coppersmith)
- Calculate the rupture length
  - Depending on depth
- Assign the ruptures
KCC CEs Account for “Location Effect” by Generating Background Events on a Uniform Grid (Aligned with USGS)
CEs Enable High-Resolution, Location-Level Risk Metrics, and Avoid Surprise Losses

100 year Events:

“Characteristic Event” losses from the 100 year magnitude earthquake
Model Comparison: Postal code Loss Costs (GU)
RAA 2018 Vendor Model Comparison Session: California EQ EP Curves

**AEP GROUND-UP LOSSES**

### Key Loss Metrics ($M)

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<th>AIR</th>
<th>AEP - TVar</th>
<th>RMS</th>
<th>AEP - TVar</th>
<th>KCC</th>
<th>AEP - TVar</th>
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<td>AEP</td>
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<td>AEP</td>
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Introduction to KCC Models – Additional KCC US Reference Models
Other Major US Perils Supported

Coastal Flood

Inland Flood

Tornado/Wind

Wildfire

Winterstorm

Hail
Challenges with Traditional Statistical Approaches to Modeling - Historical Hail Reports
Issues with Reporting: Forecast Offices
- Reflectivity is measured in dbZ
  
  \[ Z = \int_{0}^{\phi} n(D)D^6 dD \]

- Radars scan at different tilts (angles)
- Base reflectivity is the lowest 0.5° tilt
- Composite reflectivity is the maximum reflectivity at any tilt
- Is combined with NWP to identify hail forming regions (MESH)
Validation of KCC Simulated Hail Intensity with SPC Hail Reports and Claims Data

Legend
- SPC Reports
- Simulated Hail Intensity

Legend
- Hail Claims
- Simulated Hail Intensity
KCC Employs a Composite Index to Capture the Physical Variables Driving Tornado and Straight-line Wind Behavior

- **CAPE, SHEAR, and SRH** are very useful, but SCS require many ingredients
- **Composite Index** – combine multiple parameters

\[
\text{EH} = f(\text{CAPE, SRH})
\]

\[
\text{SCP} = f(\text{CAPE, SRH, SHEAR})
\]

\[
\text{STP} = f(\text{CAPE, SRH, SHEAR, LCL, CIN})
\]

**Enhanced Significant Tornado Parameter**

\[
\text{ESTP} = f(\text{SRH, CAPE, SHEAR, LCL, CIN})
\]
Innovation is Essential to Improving Catastrophe Risk Decision Making

![Graph showing modeled average annual loss vs. actual paid loss for severe convective storms over the years 2014 to 2018 and the 5-year average. The graph compares Model A, Model B, Model C, and actual indemnity paid.](image-url)
KCC Physical Models Enable Daily Loss and Claims Estimates for Hail and Tornado/Wind

Hail Intensity Footprint

Tornado/Wind Intensity Footprint

Hail and Tornado/Wind Claims and Losses by State and ZIP

<table>
<thead>
<tr>
<th>State</th>
<th>LOSS Gross</th>
<th>Pot of Total TIV</th>
<th>Pot of Total LOSS</th>
<th>Claims</th>
<th>Avg Claim</th>
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<th>State</th>
<th>LOSS Gross</th>
<th>Pot of Total TIV</th>
<th>Pot of Total LOSS</th>
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<th>Pot of Total LOSS</th>
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<th>Avg Claim</th>
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<tr>
<th>ZIP</th>
<th>LOSS Gross</th>
<th>Pot of Total TIV</th>
<th>Pot of Total LOSS</th>
<th>Claims</th>
<th>Avg Claim</th>
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Leveraging Real Time Losses

- Improve claims handling
- Notify Insured of possible damage
- Detect possible fraudulent claims
Flood Reference Model - Modeling Inland Flooding

- Two major types of inland flooding are **fluvial** (riverine) and **pluvial**, or surface flooding

- **Many areas in the US are susceptible** to riverine flooding (major river floodplains, areas with topography)

- Regions that are flat are more susceptible to surface flooding
Flood Reference Model - What Makes Modeling Inland Flood Challenging?

- There is no single meteorological definition of an event occurring on a large spatial scale.
- Data on flood inundation is scarce, especially for surface flooding.
- Hazard occurs on a very small scale but over a large area.
Flood Reference Model – Cellular Automata Supports High Resolution Pluvial Flood Modeling

Different methods have been applied to modeling pluvial flooding

1. **Solving the full shallow water equations (SWEs)**
   - Generally applied in single-catchment studies
   - Difficulty simulating flood inundation in large catchments
   - Non-economical for large spatial scales or large event sets

2. **Rapid Flood Model (RFM)**
   - Faster to run than SWEs by orders of magnitude
   - Disregards temporal evolution of flood
   - Requires substantial pre- and post-processing and tuning

3. **Cellular Automata**
   - Accuracy is comparable to the SWE approach for pluvial flooding (e.g. Ghimire et al., 2013; Guidolin et al., 2016; Jamali et al., 2019)
   - Higher computational burden than the RFM but more efficient than the SWE approach
   - Represents the physics of water flowing over topography
Flood Reference Model - Validation of the High-Resolution Footprints using Flood Reports

Two vehicles drove into flooded drainage ditch.

Homes in the Centre Lake Community had at least 1 foot of water inside.

Water reported in homes.
How KCC Can Support Regulators

- More intuitive and operational CE metric for identifying threats to solvency
- Improved consistency and stability in the average annual loss estimates used in ratemaking
- Increased transparency and direct access to the data and calculations underlying catastrophe loss estimates
  - Open platform
  - Transparent hazard and vulnerability components
  - Embedded visualization tools
- Innovative tools for delivering actionable information to decision makers
  - Live event reporting
  - Analyze impacts to the entire market
How CEs Can Assist Rating Agencies and Regulators in Evaluating Threats to Surplus

1) Gross losses by landfall point
2) Gross losses net of FHCF and private reinsurance
3) Net surplus (surplus – step 2)
4) Normalized net surplus ratio (step 3 / surplus)
Questions?