CATASTROPHE MODELING APPLICATIONS

RMS® CCRA® Training Program

Certified Catastrophe Risk Analyst

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KEY MODEL OUTPUT

- Event Losses (stochastic, scenario, historical, etc.)
- Year Loss Table
- Return Period Losses
- Average Annual Loss
- Excess Average Annual Loss
- Tail Conditional Expectation

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This discussion is designed to bring clarification around key modeling output terms. Precise definitions and consistent terminology are critical when discussing key issues with colleagues, internal parties and external parties. For instance, you will be confident in what you mean when you say event losses but does the party you are communicating with have that same understanding of event losses? When you are discussing “PML” with an external party (someone from a different company), do you clarify what you mean by “PML” or do you assume that the other party’s definition of PML is the same as yours. Often, “PML” is understood to mean different things by company, business units within a company, or even by colleagues within the same department.

Listed on this slide are the terms that will be defined in the following slides. It is essential to understand completely the terms noted in this slide. You can avoid some confusion if you ask clarifying and probing questions with the other parties in your conversation to ensure that you have a consistent understanding of the terms you are using.

EVENT LOSSES (ELT, SCENARIO, HISTORICAL)

- Definition:

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Use this slide to write down your definition of Event Losses before moving on to the next slide.

EVENT LOSSES (ELT, SCENARIO, HISTORICAL)

- Definition:
  - Single or set of event losses from a specified financial perspective.
  - May represent stochastic or historical events.
  - Output includes event ID, mean loss, standard deviation, event rate, and exposure

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Event Losses are output from a stochastic or historical event analysis. These losses can be a set of event losses or a single event for a specified financial perspective, depending on the input and output specifications or constraints that were used to create the analysis. For example, a Europe windstorm EP analysis will show a set of event losses, while a California earthquake scenario analysis will return one event. The event loss table contains the event ID, the mean loss for the specified perspective, the standard deviation, the annual rate of occurrence, and the amount of exposure that is subject to loss from the event.

It important to note that the event loss output includes annual rates of occurrence for each event, instead of annual probabilities, in order to be consistent with the assumption of a Poisson frequency distribution. In this context, the rate = average number of occurrences per year, while the probability = the probability of at least one event occurring in a year.

EVENT LOSSES (ELT, SCENARIO, HISTORICAL)

- Applications:
  - Post-event loss modeling
  - Alternative risk transfer (ART) deals
    - Industry loss warranties (ILWs)
    - Parametric trigger
  - Capital allocation

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Event losses are used in a variety of ways, three of which are noted here:

1. **Post-event loss modeling:** Modeled event losses can give you an estimate of post-event loss captured in the loss modeling by looking at events in the ELT with similar characteristics to the actual event.
2. **Alternative risk transfer deals:** Alternative risk transfer deals will trigger coverage when a large individual loss occurs. An Industry Loss Warranty is a type of reinsurance through which one party will purchase protection based on the total loss arising from an event to the entire insurance industry rather than their own losses. A parametric trigger refers to a type of insurance that pays an agreed upon amount upon the occurrence of a large, triggering event. This is not a contract of indemnity and does not require the claims to be evaluated. An ELT would be used to understand the number of events and associated chances of triggering the ART deals.
3. **Capital Allocation:** The ELT is useful for allocating catastrophe related capital allocation by allowing you to understand the contribution each business unit make to the company loss from each extreme event. Capital can be allocated in a direct ratio to that contribution. They also provide input to understand which events are large enough to threaten a company’s solvency.

YEAR LOSS TABLE

- Definition:

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Use this slide to write down your definition of Year Loss Table before moving on to the next slide.

YEAR LOSS TABLE

- Definition:
  - A set of simulated years (or periods of years) with sampled event losses at a specified financial perspective.
  - Simplest output includes year (or period) ID, weight, event date, event ID, sampled loss
    - Weight usually = 1 / (# simulated periods)
    - May also include sample ID or additional event characteristics

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The Year Loss Table, or YLT, is an alternative means of representing modeled loss output. Whereas the ELT is a list of events with annual probabilities and the mean loss with distribution for an affected exposure, the YLT provides a set of simulated years with associated events and their sampled loss. In general, YLTs must include more records than an equivalent representation with an ELT because they reflect samples from distributions, rather than the distributions parameterized in an ELT.

Each record in a YLT includes an ID for the simulated year, a weight, an event date and event ID, and the sampled loss for the exposure. The weight is most commonly the inverse of the number of simulated years, but may vary for models requiring very rare events be sampled in the simulation. Note that the weights are NOT simply the inverse of # of years with a loss, as it is common practice to omit years in which no modeled loss occurs.

A given model may include more output than this minimum list. For example, a given simulation may be run multiple times with different severity samples to improve convergence. In this case, an ID associated with the sampling of a given occurrence would be included.

A more generalized form used in RMS(one) is the Period Loss Table, or PLT, in which simulation covers a period of multiple years. For example, an analysis might include 50,000 six-year periods. This allows more flexibility in modeling contracts that cross calendar years or run for longer than one year. A YLT is a PLT using periods that are one year in length.

YEAR LOSS TABLE

- Applications:
  - Treatment of perils or financial structures with temporal elements
    - Clustered or non-Poissonian event distributions
    - Antecedent conditions (e.g. soil saturation in flood models)
    - Annual aggregate deductibles and limits
    - Reinstatements and multi-event coverages
  - Alternative risk transfer (ART) deals
    - Industry loss warranties (ILWs)
    - Parametric triggers
  - Capital allocation and adequacy evaluation

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YLTs and PLTs can be used for most of the same applications as ELTs, including calculation of the various loss metrics. They are especially well suited for representation of perils or re/insurance structures that include time-related characteristics.

Examples for perils:

- Clustering of events with long gaps with no activity in between
- Meteorological perils with seasonal characteristics
- An earthquake triggering another event on an adjacent fault

Examples for re/insurance contracts

- Aggregate deductibles and limits that are eroded by multiple events within a contract period.
- Catastrophe treaty reinstatements. Because each period includes the specific events and simulated losses, it is possible to explore how often reinstatements will be triggered.

They are less well-suited for catastrophe event response than ELTs, however, as results for modeled events similar to a "live" event reflect individual severity samples rather than the full modeled distribution of loss.

RETURN PERIOD LOSSES

- Definition:

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Use this slide to write down your definition of Return Period Losses before moving on to the next slide.

RETURN PERIOD LOSSES

- Definition:
  - Loss corresponding to a point on a loss curve that describes the likelihood of exceeding a loss threshold for a given financial perspective from:
    - …the single largest event (OEP), or
    - …the aggregation of one or more events (AEP)
  - Considers uncertainty if secondary uncertainty is applied.

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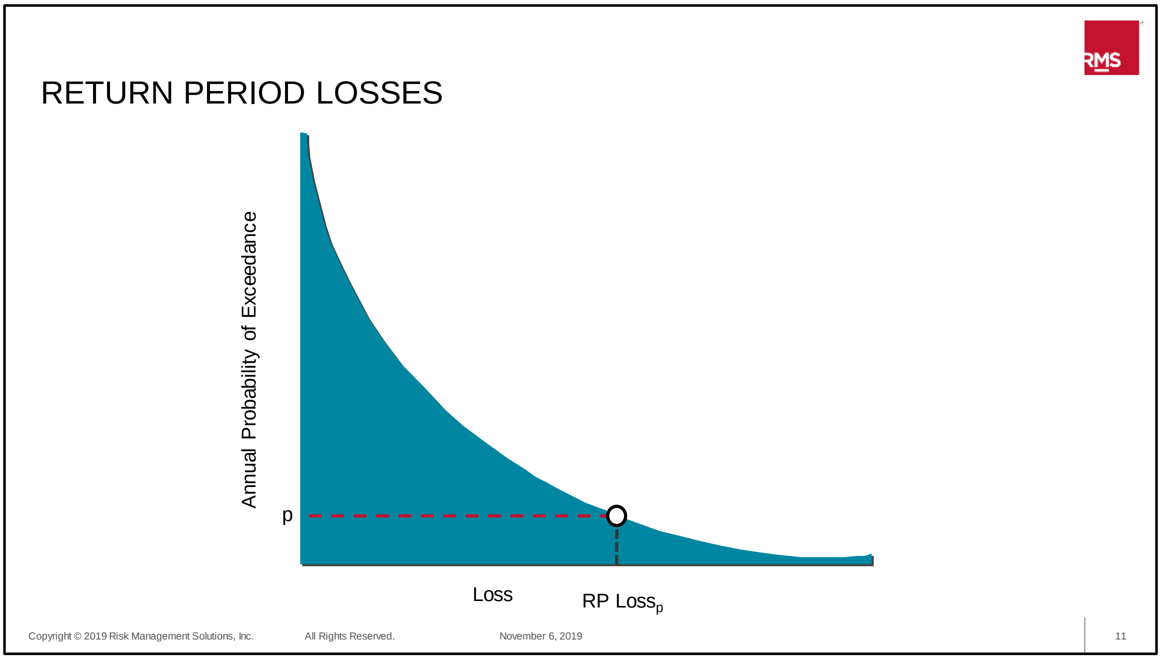
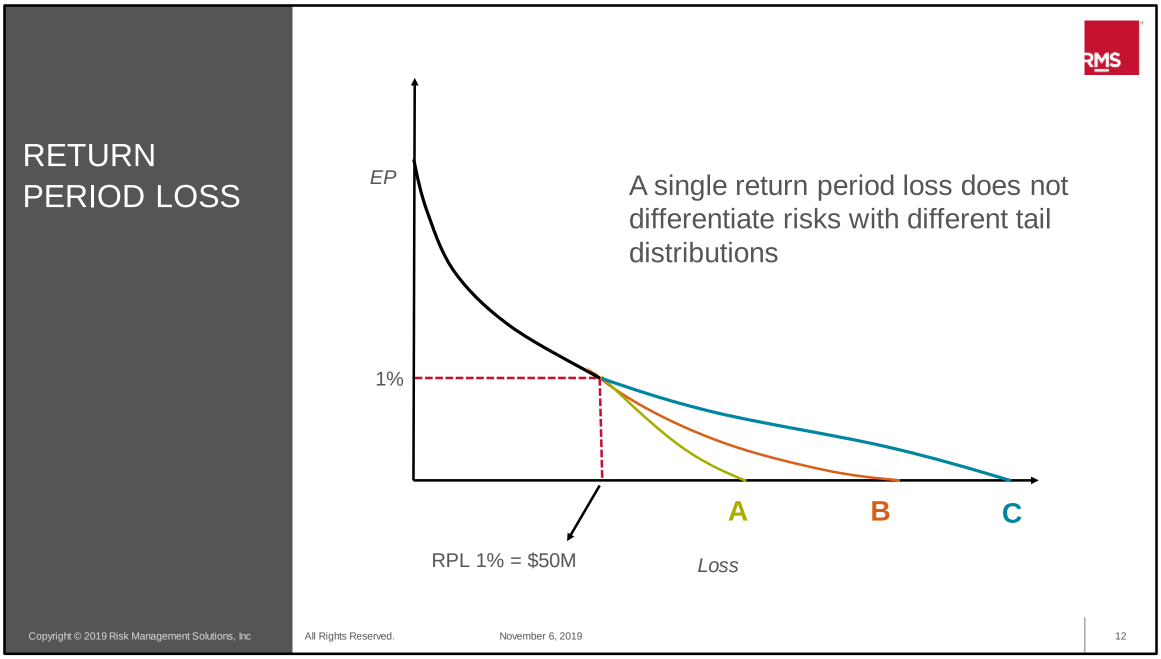
The Event Loss Table (or Year Loss Table) from an analysis is used to create an exceedance probability (EP) curve. EP curves are cumulative distributions showing the probability that losses will exceed a certain amount, from either single or multiple occurrences. These losses are expressed in the occurrence exceedance probability (OEP) and the aggregate exceedance probability (AEP) curves, respectively.

A Return Period Loss (RPL) is a point on that EP curve that represents the annual likelihood that losses will exceed a specified loss threshold, whether from a single event or an aggregation of multiple events. This is the loss whose exceedance probability is the reciprocal of the return period specified as a number of years. As an example, you can say “the 100-year AEP return period loss is $150M,” or, similarly, you can say “The probability of having multiple occurrences with a loss exceeding $150M in one year is 1%.” For an OEP return period loss, you could validly state, “There is a 1-in-100 year chance annually (1% probability) of exceeding a loss of $8.3M from at least one event.”

Since the loss curve includes secondary uncertainty, the return period loss includes uncertainty as well.



The above curve is representative of an AEP curve, with the annual probability of exceedance on the y-axis and loss on the x-axis. The intersection of the probability of interest (p) and the EP curve, is the Return Period Loss (RP Loss$_p$). The standard deviation of the annual loss distribution is a measure of uncertainty. It is used to derive the loss distribution (in this case the AEP curve).



It is important to note one limitation of the return period. Given the fact that a return period is, by definition, a single point, it can not differentiate different shapes of the tail of the distribution. In the graphic above, each of the three curves, denoted by A, B, and C, have the same 100-year return period loss of $50M. However, they each have different loss distributions at the tail of the curve. If you were to use only the 100-year return period loss to characterize the curve, you would miss the fact that Curve C is much more susceptible to extreme loss than Curve A.

RETURN PERIOD LOSSES

- Applications:
  - Reinsurance analysis (purchasing, pricing, adequacy)
  - Rating agency reporting
  - Primary layer analysis (limits, attachments, deductibles)

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Return Period Losses are very valuable measures of risk when a single point on the curve is of importance. Three of the applications of this risk measure are:

1. **Reinsurance analysis:** Of interest to parties purchasing and pricing catastrophe treaties is the probability that losses will enter into the cat treaty layer and the probability that losses will exhaust the cat treaty protection. These two probabilities are points on the EP curve and can be restated as return period losses. If you are showing a relatively high probability of exhausting a cat treaty, you may need to consider the adequacy of that treaty for protection and consider alternatives.
2. **Rating agency reporting:** Rating agencies ask that companies report their potential natural catastrophe losses as return period losses.
3. **Primary layer analysis:** Similar to a reinsurance analysis, you can use return period losses to understand the probabilities associated with activating or exhausting a policy layer, and make appropriate risk management decisions based on those probabilities.

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AVERAGE ANNUAL LOSS / PURE PREMIUM

- Definition:

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Use this slide to write down your definition of Average Annual Loss before moving on to the next slide.

AVERAGE ANNUAL LOSS / PURE PREMIUM

- Definition:
  - The expected value of the aggregate loss distribution
  - Premium needed to cover loss from a peril over time
    - Losses from any given year will be higher/lower than the AAL

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The Average Annual Loss (AAL), sometimes called Pure Premium or Burn Cost, is the expected amount of loss from the aggregate loss distribution. It is the pure premium needed to cover modeled loss only from a peril over time. Since this is an average, actual annual losses will be higher and lower than the AAL in a given year. AAL is modeled loss only; it does not include expenses, non-modeled loss, profit or risk load.

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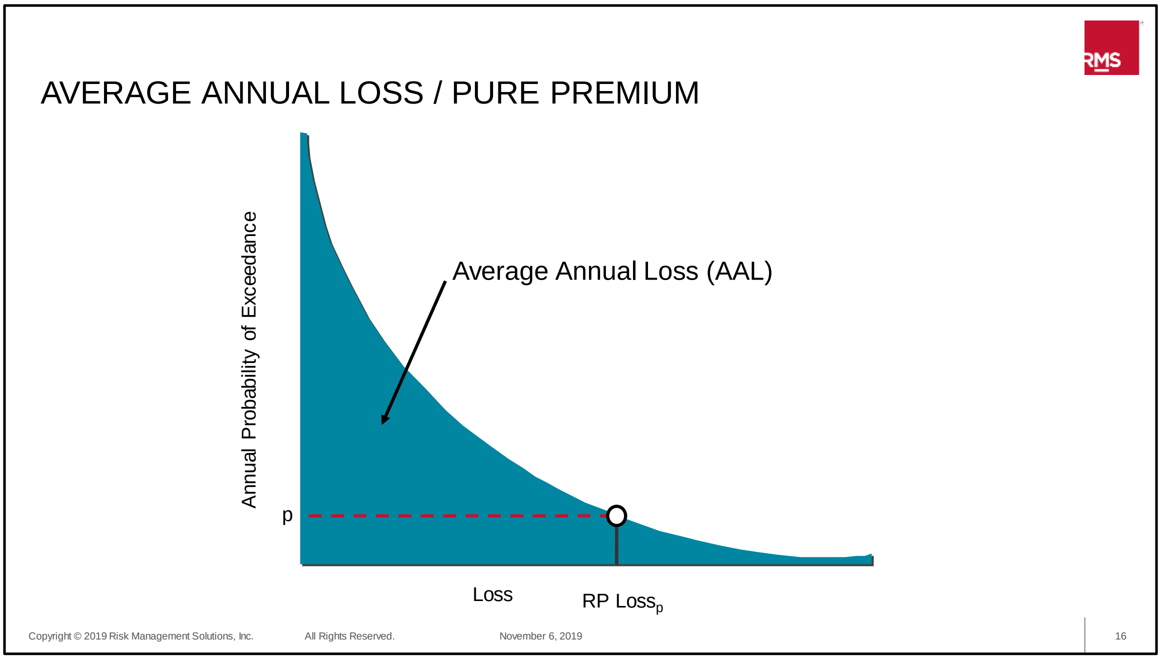

The above curve is representative of an AEP curve, with the annual probability of exceedance on the y-axis and loss on the x-axis. The intersection of the probability of interest (p) and the EP curve, is the Return Period Loss (RP Loss$_p$). The standard deviation of the annual loss distribution is a measure of uncertainty. It is used to derive the loss distribution (in this case the AEP curve).

CALCULATING AVERAGE ANNUAL LOSS

Statistics	Portfolio 1 (USD) Gross Loss
Pure Premium	1,010,697.35
Standard Deviation	2,395,667.42
Coefficient of Variation	2.3703

EventID	Loss	Rate	AAL
437731	8,908,671	0.000015428	137
447873	8,897,851	0.000011518	102
440560	8,871,713	0.000038115	338
449399	8,785,500	0.000011518	101
439540	8,765,031	0.000125310	1,098
438675	8,759,989	0.000011779	103
448281	8,719,097	0.000205780	1,794
446051	8,648,039	0.000085153	736
450599	8,635,487	0.000011518	99
442255	8,613,724	0.000015009	129
441158	8,567,198	0.000015428	132
...			
439272	1,380,074	0.000038569	53
441324	421,752	0.000165580	70
Total			**1,010,697**

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The AAL can also be calculated as the sum-product of the mean losses and the event rates found in the event loss table. The chart above shows the AAL for an example ELT. This is the methodology used in RiskLink for an analysis that does not include any cat treaties or corporate cat treaties.

The two methodologies used by RiskLink to compute the AAL that are mentioned in this and the preceding slide are equivalent. That is, the sum-product of the event losses and rates is equal to the area under the AEP curve, except for the case in which there are cat treaties with a limited number of reinstatements attached to the analysis.

AVERAGE ANNUAL LOSS / PURE PREMIUM

- Applications:
  - Pricing (primary and reinsurance)
  - Key drivers of loss
  - Underwriting guidelines

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Average Annual Loss, or Pure Premium, is used in many insurance applications. Three of these applications are:

1. **Pricing:** Since AAL is an estimate of long-term annual losses, they are used as a component in pricing and ratemaking. Since AAL only includes loss from modeled perils, a final rate must be adjusted for expenses, non-modeled loss, profit, risk load, or other factors used in the ratemaking process.
2. **Key drivers of loss:** AAL can be useful in understanding geographical areas of loss concentration, such as a county, postal code, or CRESTA Zone. Since AAL uses the entire event loss table in its calculation, it is a very good relative measure when comparing areas of loss concentration when considering the impact of event frequency and severity.
3. **Underwriting guidelines:** AAL is often used as a bridge between understanding of key geographical drivers of loss and underwriting guidelines. These guidelines can be developed to minimize the build-up of current geographical drivers or the creation of new geographical drivers.

EXCESS AVERAGE ANNUAL LOSS (XSAAL)

- Definition:

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Use this slide to write down your definition of Excess Average Annual Loss before moving on to the next slide.

EXCESS AVERAGE ANNUAL LOSS

- Definition:
  - The portion of the AAL caused by losses greater than a specified threshold
  - AAL of losses that are greater than a specified threshold
    - Calculated from mean losses in the ELT
    - May or may not consider secondary uncertainty

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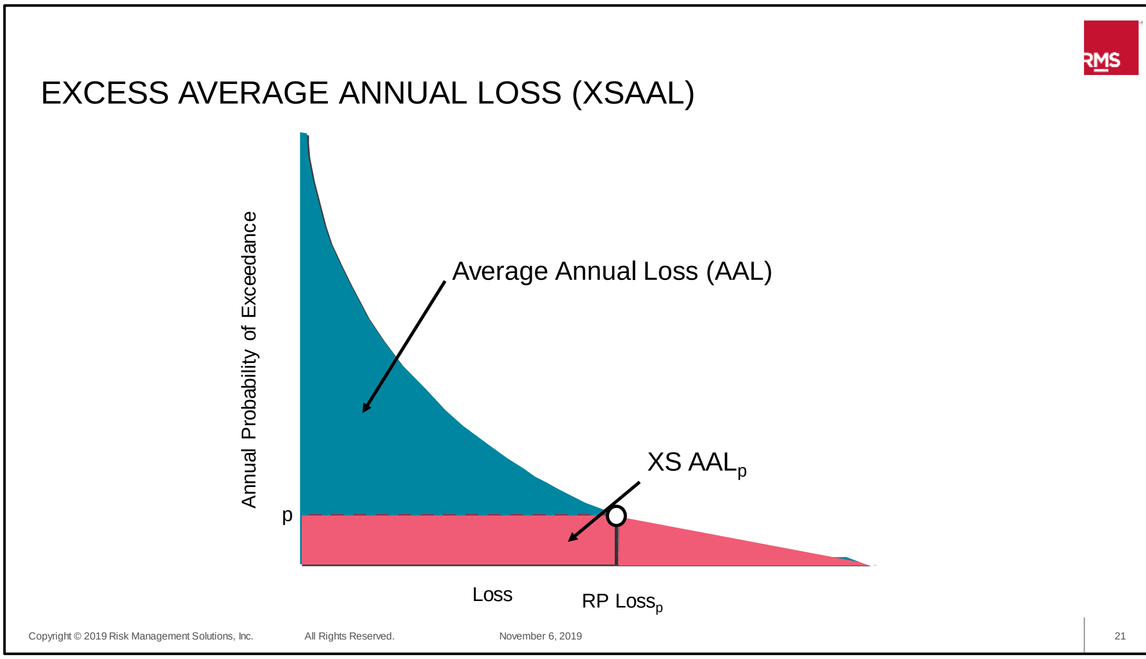
Excess Average Annual Loss (XSAAL) uses only events in the Event Loss Table (ELT) over a specified loss threshold to determine the annual expected losses from that subset of events. XSAAL is calculated as the sum-product of rates and mean losses of this subset of events, and thus excludes secondary uncertainty. As such, XSAAL is a portion of the total AAL. To account for secondary uncertainty in XSAAL calculations, RMS recommends using the method outlined the FAQ "How do I Incorporate Secondary Uncertainty into my XSAAL Calculation?", which can be found on www.rms.com.



The Excess Average Annual Loss is represented by the cross-hatched portion of the blue curve. This is a subset of the pure premium, which is the entire blue area under the curve. The standard deviation of the annual loss distribution is a measure of uncertainty. It is used to derive the loss distribution (in this case the AEP curve).

CALCULATING XSAAL WHILE INCORPORATING SECONDARY UNCERTAINTY

- What is the XSAAL at the $75 loss threshold?
- Solution: RMS FAQ "How do I incorporate secondary uncertainty into my XSAAL calculation?" found on Owl (https://support.rms.com)
- Review: Calculating Mean and CV

$$\mu = \frac{Loss}{Exposure} \qquad CV = \frac{St.Dev.}{Loss}$$

- Review: Calculating alpha and beta

$$\alpha = \frac{(1-\mu)}{CV^2} - \mu \qquad \beta = \frac{\alpha(1-\mu)}{\mu}$$

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If you were to calculate the XSAAL in expected mode, you would be ignoring the secondary uncertainty. Before viewing an example of how to incorporate secondary uncertainty into the XSAAL calculation, let's review the formulas from the Financial Model course listed on this slide.

We can calculate the mean damage ratio (MDR) by dividing the mean loss by the exposure at risk. The MDR is sometimes called 'the mean' and therefore denoted by the Greek Letter, mu (μ). We can also calculate the coefficient of variation (CV) by dividing the standard deviation by the mean loss.

The two parameters that characterize a beta distribution, and define its shape, are noted by the Greek letters alpha (α) and beta (β). To calculate α, we need to use the mean and CV. To calculate β, we need to know the mean (μ) and α. The formulas for α and β are noted on this slide.

Once these two parameters are calculated, you can graph the beta distribution or get a tabular view of the distribution using various statistical tools, such as Microsoft Excel.

CALCULATING XSAAL WHILE INCORPORATING SECONDARY UNCERTAINTY

- What is the XSAAL at the $75 loss threshold?

Event ID	Loss	Rate	St Dev	Exp Value	μ	CV	α	β	Over Threshold	XSAAL	AAL
437731	100	0.01	20	1,000	0.100	0.20	22.400	201.60	0.934	0.93	1.0
447873	90	0.02	19	990	0.091	0.21	20.307	203.07	0.838	1.51	1.8
440560	80	0.04	17	970	0.082	0.21	20.236	225.13	0.673	2.15	3.2
449399	70	0.03	18	980	0.071	0.26	13.972	181.63	0.462	0.97	2.1
439540	20	0.09	12	920	0.022	0.60	2.696	121.30	0.005	0.01	1.8
438675	10	0.10	10	840	0.012	1.00	0.98	81.02	0.004	0.00	1.0
448281	5	0.12	7	810	0.006	1.40	0.50	80.64	0.001	0.00	0.6
…											
439272	2	0.59	3	520	0.004	1.50	0.44	113.67	0	0.00	1.2
441324	1	0.63	2	390	0.003	2.0	0.25	96.00	0	0.00	0.6
Total										**5.58**	**15.97**

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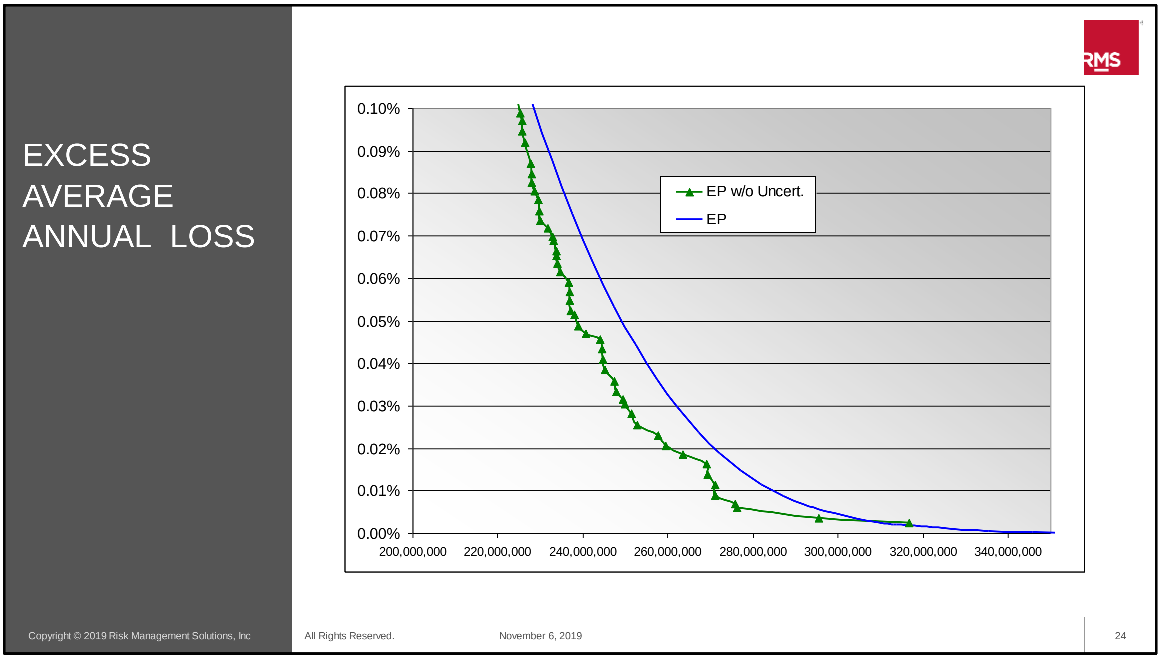
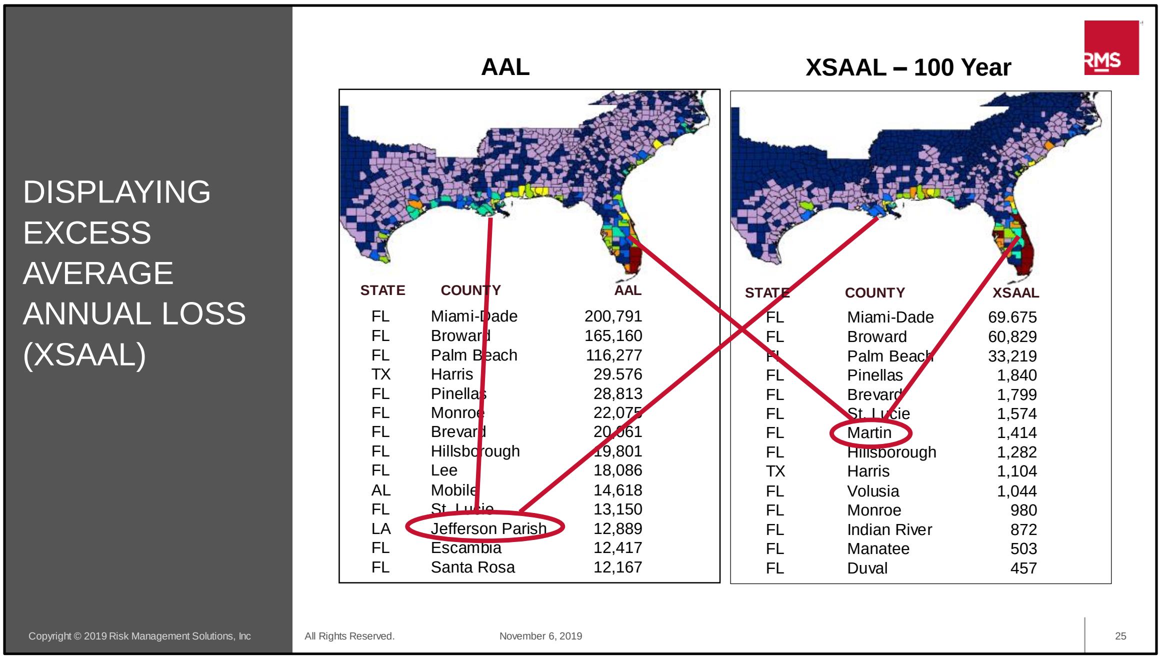
If you were to calculate the XSAAL in expected mode, you would be ignoring the secondary uncertainty. The table on this slide shows an ELT. To calculate the XSAAL with a loss threshold of $75 in expected mode, you would include the top three events in your calculation since each of these has a mean loss amount of $75 or greater. The XSAAL could then calculated as the sumproduct of the rate and the loss for the top 3 events. A limitation of this calculation is that it ignores events with losses near the threshold even though there is a high probability that the losses from these events would exceed the threshold if the event was to occur. Event 4 in the ELT has a loss of nearly $75. If event 4 occurred, the chances of the losses exceed $75 could be significant.

To incorporate secondary uncertainty into our calculation, the ELT is sorted in descending order based on the loss. The approach used to include secondary uncertainty into the XSAAL calculation is to calculate the Over Threshold column which presents a measure of the propensity for the event losses to exceed the threshold of $75. We use a cumulative distribution function for the beta distribution with parameters α and β for the Over Threshold column to calculate the XSAAL because when we multiply it by the mean loss for an event, it gives us the contribution of that event to the XSAAL. We then take the sumproduct of the rate, loss, and over threshold for all events in the ELT to calculate the XSAAL.



As noted earlier, the calculation of XSAAL does not include the impact of secondary uncertainty. This is not an issue for Average Annual Loss since the area under the AEP curve (with secondary uncertainty) and the sum-product of the mean losses and the event rates are equivalent, unless there are cat treaties with a limited number of reinstatements present in the analysis results. However, XSAAL only uses a subset of events, so the area under the curve and the sum-product are not equivalent.

This graph here shows why XSAAL without the inclusion of secondary uncertainty can be an issue. This zoomed-in view of the EP curves are calculated from the same ELT – the green curve excludes secondary uncertainty while the blue curve includes it. As you can see, the area under the green curve is smaller than the area under the blue curve, so the exclusion of secondary uncertainty will understate the XSAAL.



Next we will compare an example of using AAL and XSAAL together. These maps show the AAL and 100 year return period XSAAL for a hurricane portfolio. The charts under the maps show the top 14 drivers for each measurement.

Let’s assume that a decision has been made to no longer add any more exposure to the top 14 AAL drivers by county. We will look at the impact of that decision as it relates to two counties, Jefferson Parish, LA and Martin County, FL.

Jefferson Parish, LA contributes a relatively high amount of loss to portfolio AAL (ranked 12th). However, Jefferson Parish is ranked outside of the top 14 within our portfolio in terms of XSAAL. Given the strategy of not writing any additional exposure within our top-14 AAL counties, we could miss out on additional business opportunities in this county, since adding exposure to that county would not significantly impact the tail of the curve (excess portion of curve).

Martin County, FL is identified as having a moderate contribution to total AAL, but does not fall within our top 14 counties. However, we can tell Martin County contributes a significant proportion of XSAAL to our portfolio. Had we implemented a policy of writing additional business in counties that are not key AAL drivers (i.e. top 14), we may have expanded our market in a high-risk area and disproportionately increased our portfolio-level risk.

EXTRACTING EXCESS AVERAGE ANNUAL LOSS (XSAAL)

Impact of new Jefferson Parish account

Analysis	State	Parish	TIV	Gross AAL	XSAAL
Original	LA	Jefferson	$5.43M	$12,889	$149
Revised	LA	Jefferson	$7.93M	$16,914	$181
			+46%	+31%	+21%

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This is the analysis of adding a Jefferson Parish account. As you can tell, we have significantly increased our total insured values by $2.5M (+46%) and added less that ten percentage points less XSAAL than AAL.

If our goal was to grow our business without significantly impacting our severe losses identified, we could write this account.

EXTRACTING EXCESS AVERAGE ANNUAL LOSS (XSAAL)

Impact of new Martin County account

Analysis	State	County	TIV	Gross AAL	XSAAL
Original	FL	Martin	$1.78M	$9,917	$1,414
Revised	FL	Martin	$4.28M	$16,648	$2,655
			+140%	+67%	+88%

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This is the analysis of adding business within Martin County. Again, we have significantly increased our total insured values by $2.5M, since Martin county did not fall in our top-15 AAL drivers. Unfortunately, we have increased our county AAL by ~67% and disproportionately increased XSAAL. Had we implemented a strategy of writing policies solely based on our top-15 AAL drivers, we would have unnecessarily increased our risk.

We should not “over-depend” on any one metric when analyzing a risk. If we only focused on key AAL drivers, without also focusing on XSAAL, we may have written this high-risk account.

EXCESS AVERAGE ANNUAL LOSS (XSAAL)

- Applications:
  - Key drivers of “tail risk” (severe losses)
  - Capital allocation
  - Portfolio / risk comparison

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Excess Average Annual Loss is very beneficial when you want to understand the tail of the EP curve in better detail and the impact that it has. Three applications of XSAAL are:

1. **Key drivers of tail risk:** Due to its calculation process, XSAAL can easily be calculated for multiple locations and accounts within an analysis – as long as you can differentiate the ELT and map the portfolio XSAAL events to each location and account. You can then compare the location/account XSAAL to the overall portfolio XSAAL. You can also group these losses by geographic regions to understand which regions are driving your overall loss. This differs from AAL drivers of loss, as XSAAL focuses on the tail risk and can be calculated to include secondary uncertainty.
2. **Capital allocations:** XSAAL is very useful in allocating capital to different business units within a company, based on each business unit’s susceptibility to severe catastrophe losses. Allocating reinsurance costs based on each unit’s contribution to the company 250 year return period XSAAL is one example.
3. **Portfolio/risk comparison:** To compare portfolios, or large accounts, on a severity measure, XSAAL is a useful tool.

TAIL CONDITIONAL EXPECTATION (TCE)

- Definition:

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Use this slide to write down your definition of Tail Conditional Expectation before moving on to the next slide.

TAIL CONDITIONAL EXPECTATION (TCE)

- Definition:
  - The conditional expectation of losses that are greater than a specified return period loss (RPLα, where α is the selected risk tolerance threshold)
  - The expected value of loss given that a loss at least as large as the RPLα has occurred.
    - Measures not only the probability of exceeding a certain loss level, but also the average severity of losses in the tail of the distribution.
    - Sub-additive: TCE(a) + TCE(b) $\geq$ TCE(a+b)

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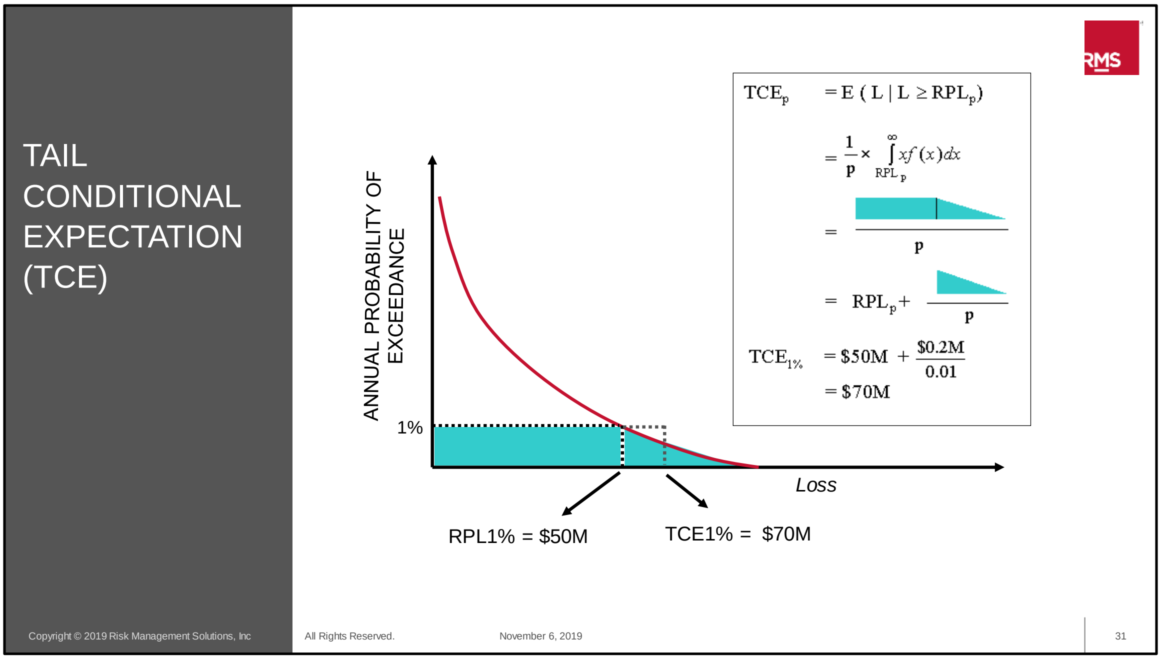
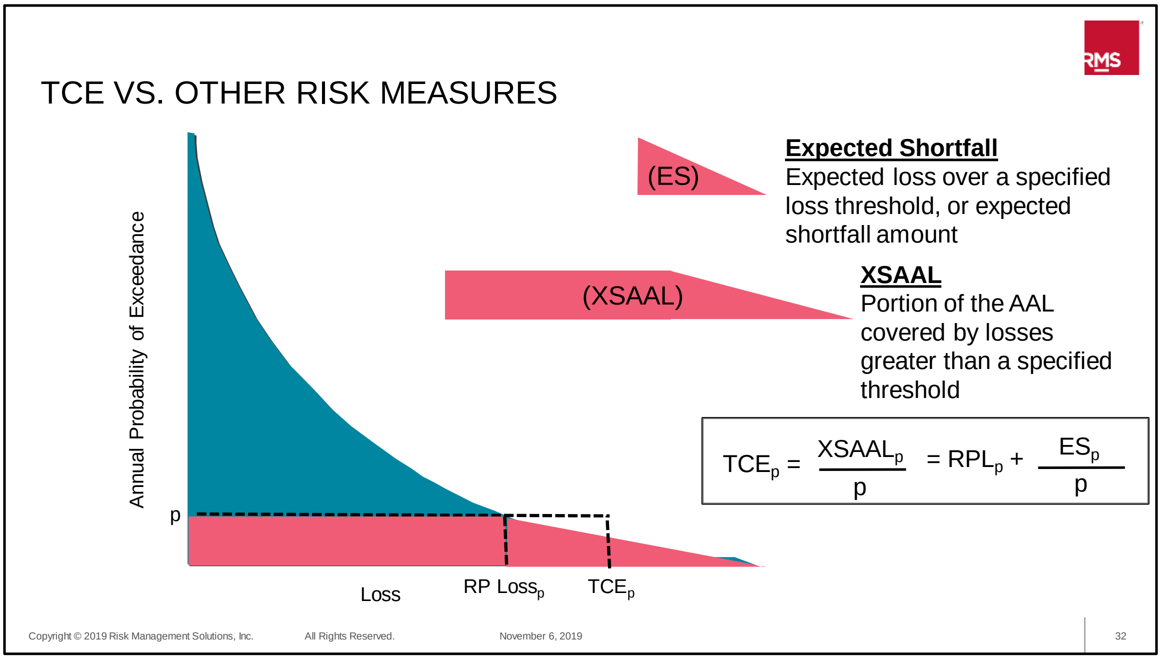
Tail Conditional Expectation (TCE) is the conditional expectation of losses that are greater than a specified return period loss (RPLα, where α is the selected risk tolerance threshold).

In other words, it is the expected value of loss given that a loss at least as large as RPL_p has occurred. This measures not only the probability of exceeding a certain loss level, but also the average severity of losses in the tail of the distribution. TCE is sub-additive. Formulaically, this means that: TCE(a) + TCE(b) $\geq$ TCE(a+b).



This is the analysis of adding business within Martin County. Again, we have significantly increased our total insured values by $2.5M, since Martin county did not fall in our top-15 AAL drivers. Unfortunately, we have increased our county AAL by ~67% and disproportionately increased XSAAL. Had we implemented a strategy of writing policies solely based on our top-15 AAL drivers, we would have unnecessarily increased our risk.

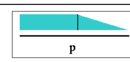
We should not “over-depend” on any one metric when analyzing a risk. If we only focused on key AAL drivers, without also focusing on XSAAL, we may have written this high-risk account.



The ES is the expected loss over a predetermined loss threshold, or the expected value of the shortfall amount. The ES considers the magnitude of losses exceeding a threshold, ignoring the probability of exceeding that threshold. TCE combines the elements of the RPL and the ES into one risk measure. TCE differs from ES in that it captures the expectation of all losses beyond the threshold amount, not just the shortfall amount. TCE is a more valuable statistic than ES for catastrophe modeling, because as the return period threshold increases, TCE also increases, which is intuitive. Conversely, as the return period increases, ES decreases.

Although different, TCE and XSAAL are related statistics. As noted above, XSAAL is the product of the TCE and its associated probability of exceedance.

TCE VS. XSAAL

	Excess Average Annual Loss (XSAAL)	Tail Conditional Expectation (TCE)
Definition	Portion of the total AAL covered by losses greater than a specified threshold.	Average severity of losses that are greater than a specified threshold.
How are they similar?	They both focus on the tail of the loss distribution.	
How are they used differently?	Identify regions or accounts that are driving the tail. Used for allocation purposes since it is additive.	TCE can be used as a measure that accounts for the tail of the loss distribution.
	TCEp = 	= XSAALp

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Although TCE and XSAAL are related, they are different in a very subtle way. Both focus on the tail of the loss distribution, but their difference comes in how this tail is used. XSAAL uses all events in the ELT over a specified loss threshold to determine the annual expected losses from that subset of events. TCE is the expected size of a single event, given the event has already exceeded a specified threshold.

Due to its calculation process, XSAAL can easily be calculated for a multiple locations and accounts within an analysis – as long as you can differentiate the ELT for each location and account. It is much tougher to do that level of data mining for TCE, since you can not compute TCE from the ELT directly without making some approximations.

TCE IN RISKLINK

EP	Return Period	OEP	TCE-OEP
0.02%	5,000	271,073,112	289,945,694
0.05%	2,000	249,284,169	271,384,787
0.10%	1,000	228,646,077	254,744,393
0.20%	500	203,026,786	234,787,788
0.40%	250	172,317,082	210,538,013
0.50%	200	161,554,352	201,788,294
1.00%	100	126,522,138	171,962,814
2.00%	50	93,833,130	139,906,759
4.00%	25	66,125,834	108,997,324
10.00%	10	34,324,730	71,986,344
20.00%	5	16,236,916	47,857,812
50.00%	2	2,189,062	23,486,490

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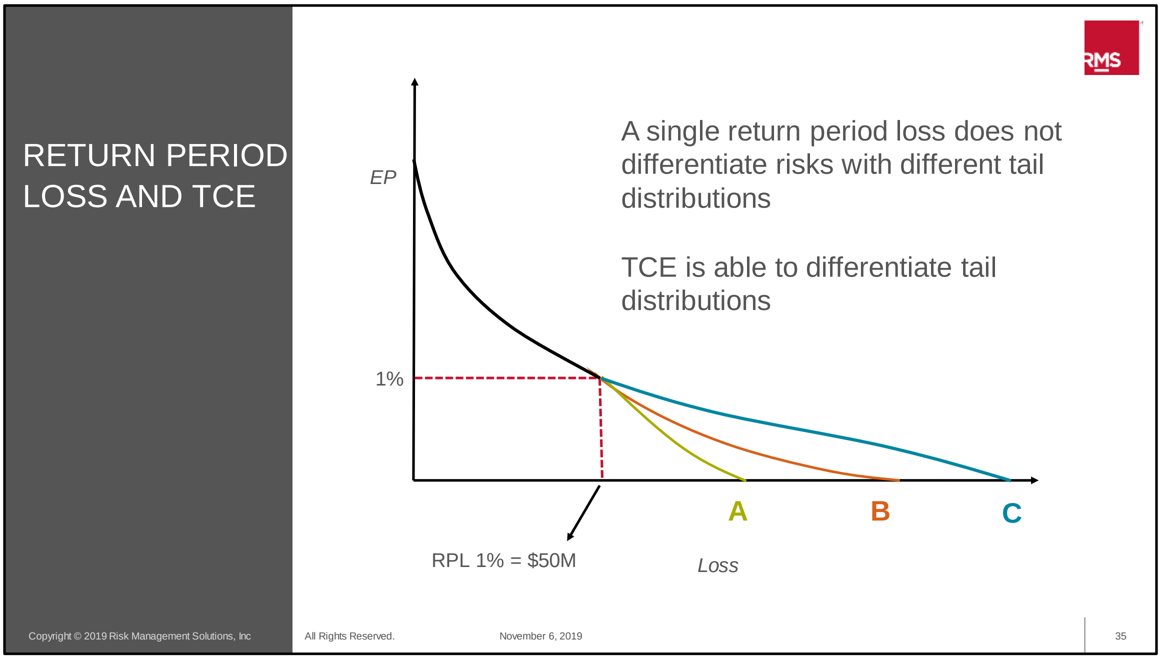
When looking at TCE in RiskLink, it is important to note both the EP and TCE values. The highlighted portion above, shows the OEP and TCE-OEP amounts for a 100 year return period.

You can describe these amounts by saying there is a 1% chance that the maximum loss in a year will exceed $126,522,138 (OEP). Given that this happens, $171,962,814 (TCE-OEP) is the average severity of the loss.

Another way to state this is to say that if you experience a maximum loss of at least $ 126,522,138 (your 1-in-100 year OEP return period loss amount) from at least one event in a given year, the average maximum size of the loss will be $171,962,814.



We noted earlier that one limitation of the return period loss is that it can not differentiate different shapes of the tail of the distribution. In the graphic above, each of the three curves, denoted by A, B, and C, have the same 100 year return period loss of $50M. However, they each have different loss distributions at the tail of the curve. If you were to use only the 100 year return period loss to characterize the curve, you would miss the fact that Curve C is much more susceptible to extreme loss than Curve A.

However, TCE removes that limitation. When looking at the 100 year return period TCE statistic, it would accurately differentiate between the three curves by noting the different average event sizes given that a maximum loss of at least $50M has occurred.

TAIL CONDITIONAL EXPECTATION (TCE)

- Applications:
  - Solvency evaluation
  - Portfolio management / risk differentiation
  - Reinsurance needs assessment

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TCE is a very useful statistic for:

1. Solvency evaluation. Total capital needed to support the risk carried by an insurance entity should be expressed as a function of a risk measure or a combination of risk measures. The risk tolerance level can be found and maintained so that the TCE for the insurance company at that specific probability level is equal to the capital carried. TCE is a recommended risk measure for fulfilling capital or solvency requirements since it takes into account the potential extent of tail losses, reflecting a policyholder's interest.
2. Portfolio management/risk differentiation. By summarizing the tail of a loss distribution into a single statistic, TCE provides a more comprehensive view of risk than a single return period loss that only measures the loss exceedance threshold at a specific probability level. As such, it is a more convenient metric for comparing the riskiness of different portfolios.
3. Reinsurance needs assessment. Insurers have traditionally assessed their catastrophe reinsurance needs using return period losses. For example, an insurer's management might decide to buy reinsurance up to the 200-year loss for their overall portfolio. TCE provides an alternative approach for determining reinsurance needs. Its applicability relative to return period loss measures will depend on the logic used by an insurer in determining reinsurance needs.

KEY MODEL OUTPUT

- Definitions are important
  - Terms feel "picky' but are important for proper usage
  - Ask for clarifications when discussing with colleagues
- Defining and applying these terms should be a part of your exam preparation

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As discussed at the onset of this course, consistent definitions and terminology are critical when discussing key issues with colleagues, internal parties and external parties. At times, you may feel like these terms are too picky or too precise, but it is essential for accurate communication to completely understand the different measures of risk that were defined in this course. You can avoid some confusion if you ask some clarifying and probing questions with the other parties in your conversation to ensure that you have a consistent understanding of the terms you are using.

A thorough understanding of these terms will not only help you be more efficient in your profession, but successfully defining and appropriately applying these terms will help you towards your goal of earning a passing score on the CCRA exam.

GROUP PROJECT

- Work in assigned teams
- Questions will come from both insurer and reinsurer perspectives
- Approximately 2 hours to complete answers to both sections (1 hour each)
- Save your presentations to your desktop with you team name (e.g. Model_Apps_TEAMNAME.pptx)
  - Team name should be fun and creative
- Working through lunch is optional, but may be necessary to complete the project on time
- Projects will be presented to the class this afternoon

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Continue the course by completing the exercise.