# PROPERTY AND CASUALTY EXPOSURE RATING

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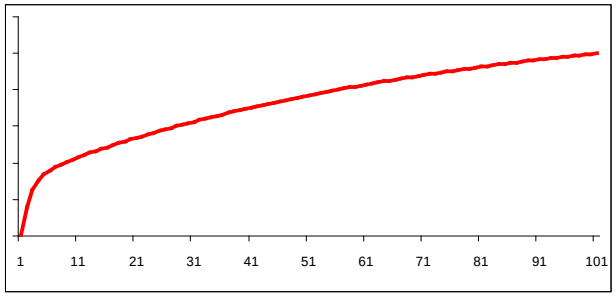
August 12, 2013

# What IS Exposure Rating??

- Pure Exposure Rating – Used by Primary Companies
  - Commonly called “Manual Rating”

- Reinsurance Exposure Rating
  - Allocation of Premium/Loss to Layer through use of some generated curve/equation (model of loss)
    - Based on Industry
    - Based on Company Data



# Pure Exposure Rating

- Premium = Rate * Exposure

**EXAMPLE**

**Rate = $0.01**

**Exposure = Building Value = $100,000**

**Premium = Rate * Exposure**

**= $0.01 * $100,000**

**= $1,000**

Where does the rate come from?

# Pure Exposure Rating

## Manual Rating of Insurance Policies

- Determined by
  - Rating agencies: ISO, NCCI
    - **Many years ago, provided actual rates**
    - **Now provide advisory loss costs, which companies then load for expenses and risk / profit margin**
  - Based on companies' reported data
- Generally subject to regulatory approval

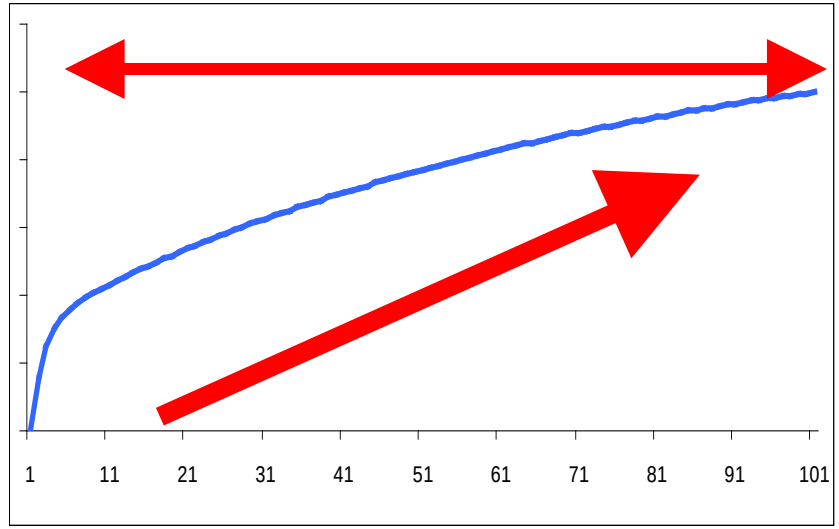
# Pure Exposure Rating

## Increased Limits Factors (ILF's)

- Rating Agencies generally designate a "Basic Limit" size
  - E.g. $100K, $1M
  - "Basic Limits" premium **is** the manual rate

- For higher Limits, **Increased Limits Factors** determine price
  - May be promulgated by a rating agency or determined from company data
  - ILF scale is equivalent to a size of loss (severity) distribution

- Logical tests for ILF tables
  - First derivative $\geq 0$ (non-decreasing)
  - Second derivative $\leq 0$ (increase at a decreasing rate)



# Pure Exposure Rating

## Increased Limits Factors (ILF)

So these are the terms we'll be using when we talk about Pure Exposure Rating

# Pure Exposure Rating

## Increased Limits Factors (ILF)

Premium = Base Rate * ILF * Exposure

Base Rate: Rate at Basic Limit

ILF: Increased Limit Factor

What you multiply Basic Limits premium by, in order to get the premium at the desired limit

Exposure: Varies by Line

# Pure Exposure Rating

## Typical Exposure Bases

**Auto:** Number & Type of Vehicles

**Workers Comp:** Capped Payroll

**GL:** Sales, Revenue / Sq. Ft., # Units

**E&O:** Varies – Usually # of Professionals

**D&O:** Varies – Market Cap, ROL

# Pure Exposure Rating

## Increased Limits Factors (ILF)

| Limit | ILF |
|---|---|
| 100,000 | 1.0 |
| 250,000 | 1.4 |
| 500,000 | 1.7 |
| 1,000,000 | 2.0 |
| 2,000,000 | 2.3 |
| 5,000,000 | 2.5 |

What is the Basic Limit size?

If base rate = $50, what rate will policyholder be charged for a limit of:

100K? 50 * 1.0 = 50

1M? 50 * 2.0 = 100

# ILF Calculations
## Lawyers Professional Liability Example

- Insurance Company Rating Plan
  - Exposure base = # of attorneys
  - Basic Limit = $100,000
  - Base Rate = $1,000 per attorney
  - $1,000,000 ILF is 2.00

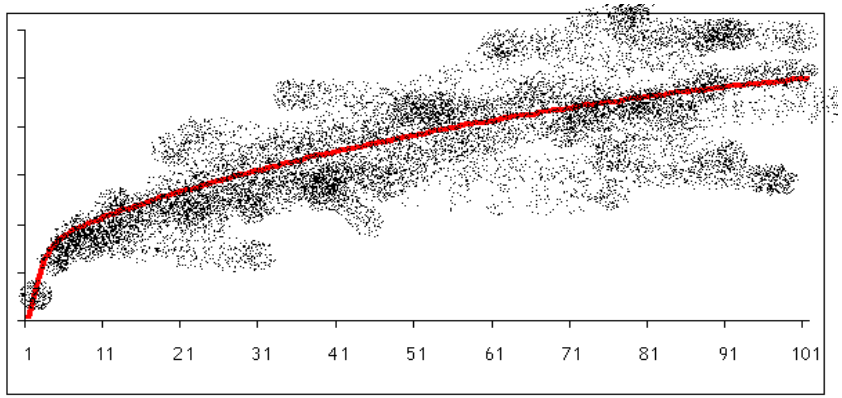
- How much does a $1M policy cost for a firm with 3 attorneys?
  - Premium = Base Rate * ILF * Exposure
    - **Premium = Base Rate * ILF * Exposure**
      = $1000 * 2.00 * 3
      = $6000

# Reinsurance Exposure Rating

– Allocation of Premium/Loss to Layer through use of some generated curve/equation (model of loss)

  - Based on Industry

  - Based on Company Data




$$CDF\_ME(x;\overline{\mu},\overline{w}) = \sum_{i=1}^{8} w_i \left(1 - e^{-\frac{x}{\mu_i}}\right)$$

# Why Do We Exposure Rate?

- Exposure Rating can be used to:
  - Estimate Mean (Expected) Loss
    (for any layer or limit)
  - Estimate Reinsurance Price
  - Create MetaRisk Input file

So Can Experience Rating for that Matter!

# WHEN Do We Exposure Rate?

## When company experience:

- Is approximately like Industry
  - Or another company
- Is insufficient
  - Low volume
  - New LOB
- Is non-credible
  - Mix changes
  - Changing profiles

# When DON’T We Exposure Rate?

<u>When company:</u>

- Experience is <u>not</u> like industry
- Info is not available
  - Company doesn’t provide necessary info
  - No industry data is available

# Exposure Rating by LOB

Although the ideas behind exposure rating never change, the actual mechanics of it differ by LOB

- LIABILITY uses Increased Limits Factors (ILFs)
- PROPERTY uses:
  - First Loss Scales (FLSs), or
  - Size-of-Loss Curves (PSOLD)
- WORKER'S COMP uses Excess Loss Factors (ELFs)

# LIABILITY Exposure Rating

## ILF’s

- Auto Liability
- Prem/Ops
- Products
- E&O
- Umbrella

# ILF Calculations

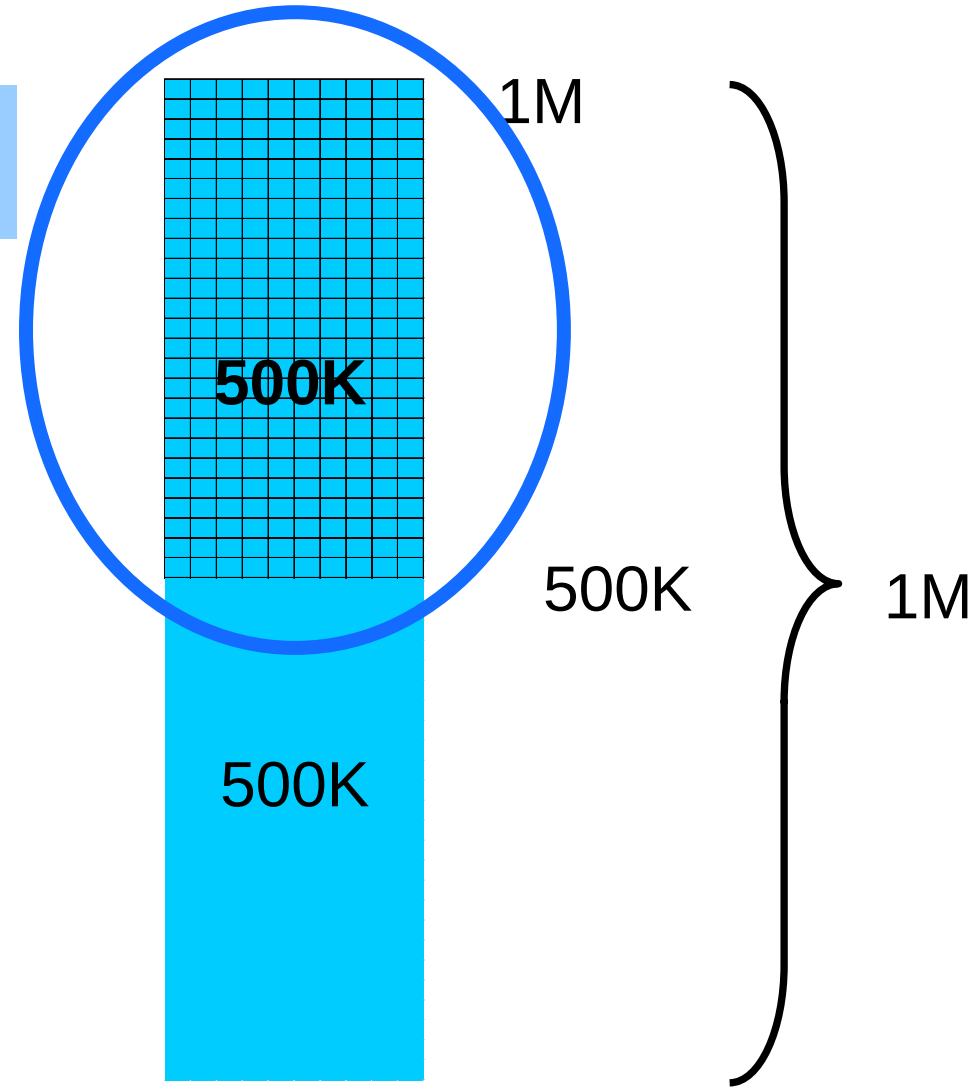
## Example

Policy Limit = 1M

Total Policy Premium = $1000

Goal: estimate premium for a 500 x 500 facultative certificate on a 1M policy

| Limit | ILF |
|---|---|
| 100,000 | 1.0 |
| 250,000 | 1.9 |
| 500,000 | 2.9 |
| 750,000 | 3.6 |
| 1,000,000 | 4.1 |
| 1,250,000 | 4.5 |
| 2,000,000 | 5.4 |



# ILF Calculations

Example

Policy Limit = 1M

Total Policy Premium = $1,000

Goal: estimate premium for a 500 x 500 facultative certificate on a 1M policy

| Limit | ILF |
|---|---|
| 100,000 | 1.0 |
| 250,000 | 1.9 |
| 500,000 | 2.9 |
| 750,000 | 3.6 |
| 1,000,000 | 4.1 |
| 1,250,000 | 4.5 |
| 2,000,000 | 5.4 |

Step 1: Calculate $Prem_{Base}$

$Prem_{Base} * ILF_{1M} = Prem_{1M}$

$Prem_{Base} * 4.1 = 1000$

$Prem_{Base} = 1000 / 4.1$

$Prem_{Base} = 244$

Step 2: Calculate $Prem_{500K}$

$Prem_{Base} * ILF_{500K} = Prem_{500K}$

$244 * 2.9 = 708$

Step 3: Calculate $Prem_{layer}$

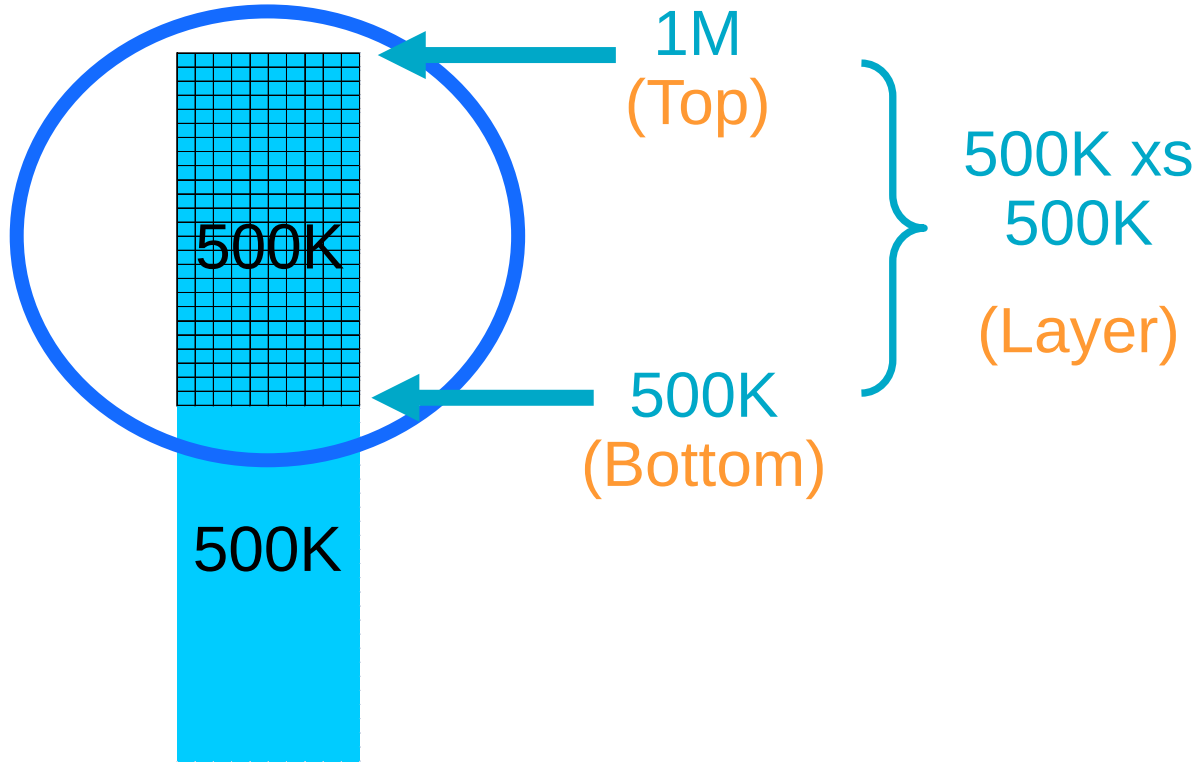
$Prem_{1M} - Prem_{500K} = Prem_{layer}$

$1000 - 708 = 292$

# ILF Calculations

## Allocation Shortcut Formula

$$Prem_{Base} * (ILF_{Top} - ILF_{Bottom}) = Prem_{Layer}$$



# ILF Calculations

## Example – Shortcut

Policy Limit = 1M

Policy Prem = $1000

Goal: estimate premium for a 500 x 500 facultative certificate on a 1M policy

| Limit | ILF |
|---|---|
| 100,000 | 1.0 |
| 250,000 | 1.9 |
| 500,000 | 2.9 |
| 750,000 | 3.6 |
| 1,000,000 | 4.1 |
| 1,250,000 | 4.5 |
| 2,000,000 | 5.4 |

Step 1: Calculate $Prem_{Base}$

$Prem_{Base} * ILF_{1M} = Prem_{1M}$

$Prem_{Base} * 4.1 = 1000$

$Prem_{Base} = 1000 / 4.1$

$Prem_{Base} = 244$

Step 2: Calculate $Prem_{layer}$

$Prem_{Base} * (ILF_{1M} - ILF_{500K}) = Prem_{layer}$

$244 * ( 4.1 - 2.9 ) = 292$

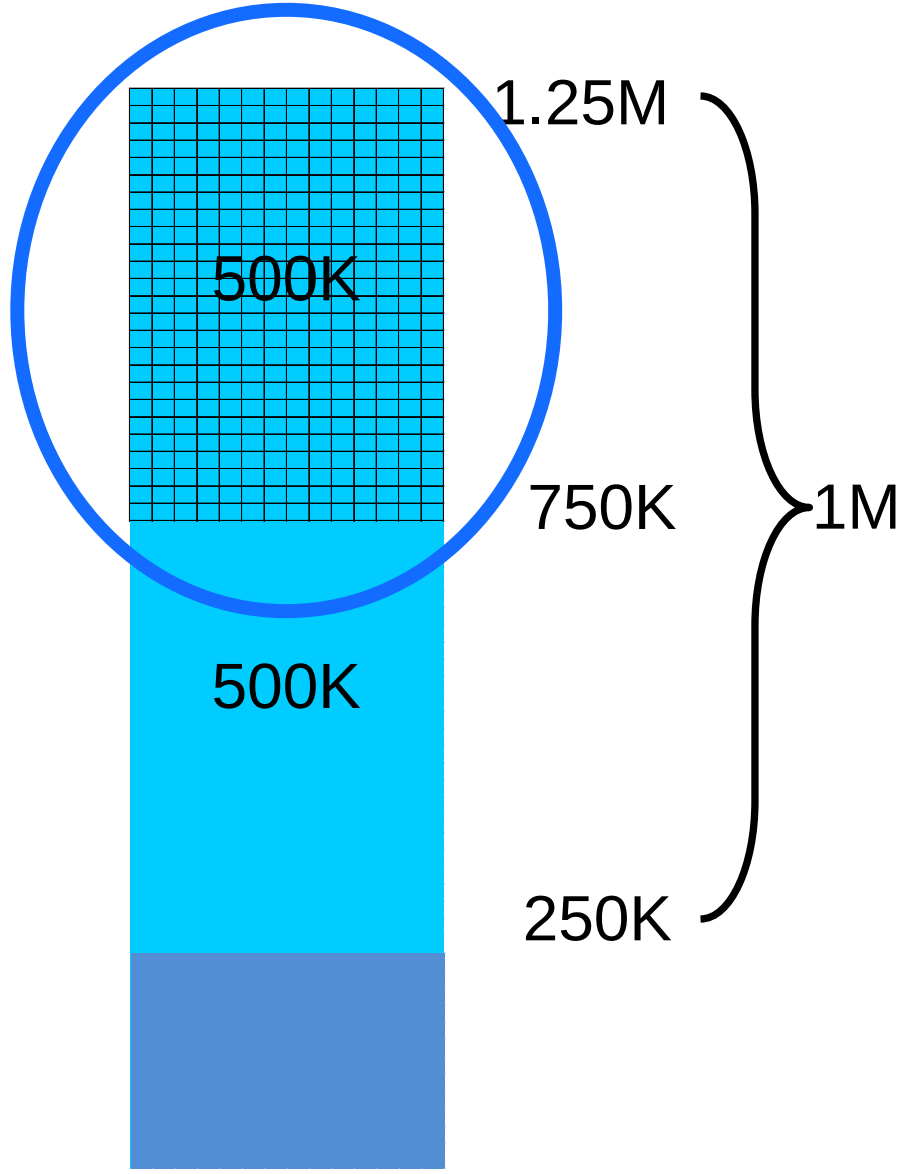
# ILF Calculations

## Example 2

Policy Limit = 1M
SIR = 250K
Policy Prem = 1000

What is the premium for 500K x 500K?

| Limit | ILF |
|---|---|
| 100,000 | 1.0 |
| 250,000 | 1.9 |
| 500,000 | 2.9 |
| 750,000 | 3.6 |
| 1,000,000 | 4.1 |
| 1,250,000 | 4.5 |
| 2,000,000 | 5.4 |



# ILF Calculations

Example 2

Policy Limit = 1M
SIR = 250K
Policy Prem = 1000

What is the premium for 500K x 500K?

| Limit | ILF |
|---|---|
| 100,000 | 1.0 |
| 250,000 | 1.9 |
| 500,000 | 2.9 |
| 750,000 | 3.6 |
| 1,000,000 | 4.1 |
| 1,250,000 | 4.5 |
| 2,000,000 | 5.4 |

Step 1: Calculate $Prem_{Base}$

$Prem_{Base} * (ILF_{1.25M} - ILF_{250K}) = Prem_{policy}$

*Note: Policy premium already a layer premium*

$Prem_{Base} * ( 4.5 - 1.9 ) = 1000$

$Prem_{Base} = 1000 \div ( 4.5 - 1.9 )$

$Prem_{Base} = 385$

Step 2: Calculate $Prem_{layer}$

$Prem_{Base} * (ILF_{1.25M} - ILF_{750K}) = Prem_{layer}$

$385 * ( 4.5 - 3.6 ) = 347$

# IMPORTANT POINT

## Look how much difference the SIR information made!

For a $1M limit and total premium = $1000
The premium for 500K x 500K is:

$292 with no SIR
$347 if SIR is $250K

In this example, if we didn't know about the SIR, the cedant would be undercharged by $55 – the correct price is 20% higher than the no-SIR price. In the real world, the actual difference depends on the nature of the business and the limit / SIR profile. That's why we ask for deductible / SIR information!

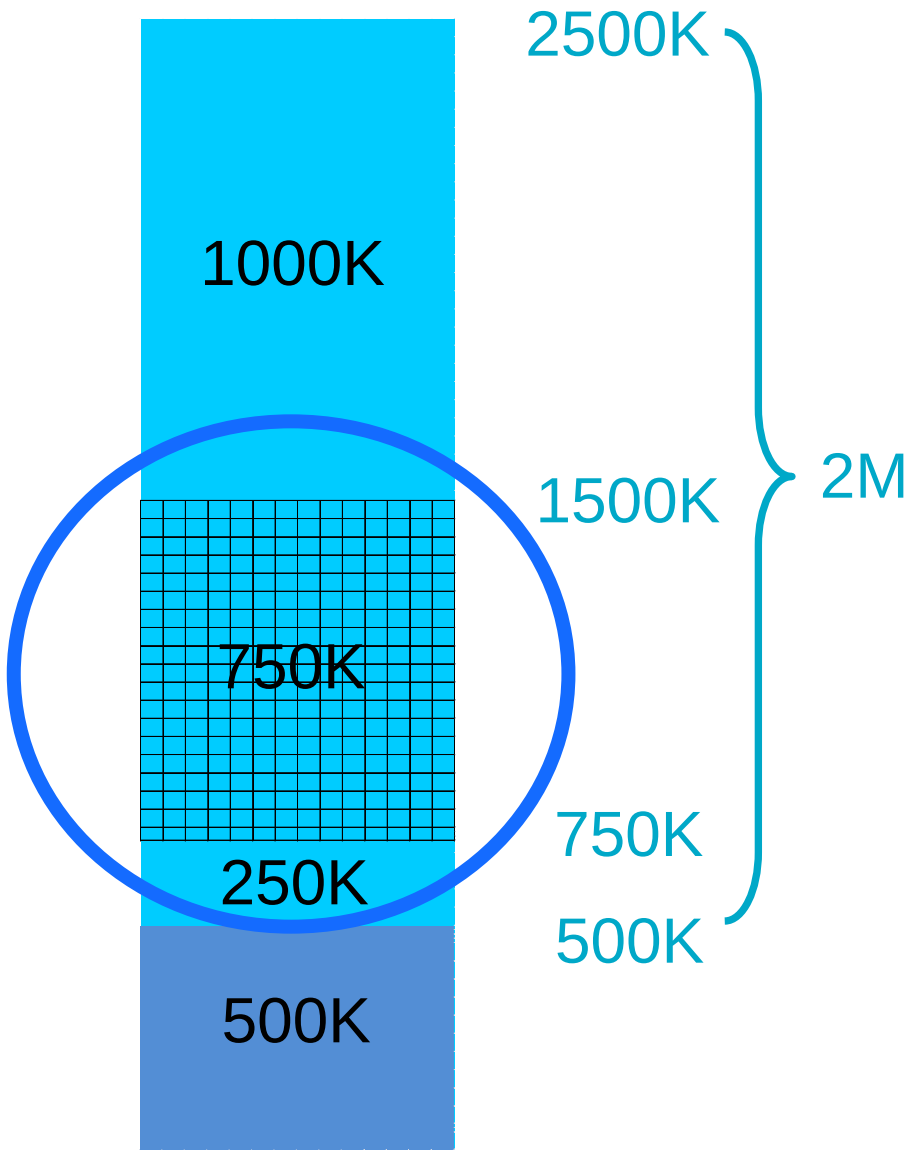
# ILF Calculations

## Example 3

Policy Limit = 2M
SIR = 500K
Policy Prem = $1500

What is the premium for 750K x 250K?

| Limit | ILF |
|---|---|
| 500,000 | 0.7 |
| 750,000 | 0.9 |
| 1,000,000 | 1.0 |
| 1,500,000 | 1.2 |
| 2,000,000 | 1.3 |
| 2,500,000 | 1.4 |
| 3,000,000 | 1.5 |
| 5,000,000 | 1.7 |



# ILF Calculations

## Cessions Example 3

Policy Limit = 2M
SIR = 500K
Policy Prem = $1500

What is the premium for 750K x 250K?

| Limit | ILF |
|---|---|
| 500,000 | 0.7 |
| 750,000 | 0.9 |
| 1,000,000 | 1.0 |
| 1,500,000 | 1.2 |
| 2,000,000 | 1.3 |
| 2,500,000 | 1.4 |
| 3,000,000 | 1.5 |
| 5,000,000 | 1.7 |

Step 1: Calculate $Prem_{Base}$

$Prem_{Base} * (ILF_{2.5M} - ILF_{500K}) = Prem_{policy}$

*Note: Policy premium already a layer premium*

$Prem_{Base} * ( 1.4 - 0.7 ) = 1500$

$Prem_{Base} = 1500 \div (1.4 - 0.7 )$

$Prem_{Base} = 2143$

Step 2: Calculate $Prem_{layer}$

$Prem_{Base} * (ILF_{1.5M} - ILF_{750K}) = Prem_{layer}$

$2143 * ( 1.2 - 0.9 ) = 643$

# General ILF Calculations

$$Prem_{Base} * (ILF_{Top} - ILF_{Bottom}) = Prem_{Layer}$$

- Be careful to get the right “Top” and “Bottom” for your layer
  - Drawing a picture is very useful
- Effect of Deductible or SIR
  - Direct policy premium is already a layer premium
  - But ILF table operates from ground up
  - $ILF_{Bottom}$ for the layer is $ILF_{Ded/SIR+Att\ Pt}$ instead of $ILF_{Att\ Pt}$
- Top of layer to be priced may not equal top of policy limit
  - Consider whether top of the layer is within the policy

# Liability Exposure Rating

- Data Needed From Company
  - Premium and Pricing History
  - Ground-up Loss or Loss Ratio
  - Limit/Deductible Profiles
- Other Data Used
  - Increased Limit Factors
- Need all data by LOB and maybe State

# Liability Exposure Rating

- Need all data by LOB and maybe State

| PREM/OPS | | | |
|---|---|---|---|
| MultiState | Table 1 | Table 2 | Table 3 |
| Calif | Table 1 | Table 2 | Table 3 |
| FL | Table 1 | Table 2 | Table 3 |
| GA | Table 1 | Table 2 | Table 3 |
| IL | Table 1 | Table 2 | Table 3 |
| IN | Table 1 | Table 2 | Table 3 |
| MA | Table 1 | Table 2 | Table 3 |
| MI | Table 1 | Table 2 | Table 3 |
| NJ | Table 1 | Table 2 | Table 3 |
| NY | Table 1 | Table 2 | Table 3 |
| NC | Table 1 | Table 2 | Table 3 |
| OH | Table 1 | Table 2 | Table 3 |
| PA | Table 1 | Table 2 | Table 3 |
| TX | Table 1 | Table 2 | Table 3 |
| VA | Table 1 | Table 2 | Table 3 |
| WI | Table 1 | Table 2 | Table 3 |
| Group_A | Table 1 | Table 2 | Table 3 |
| Group_B | Table 1 | Table 2 | Table 3 |
| Group_C | Table 1 | Table 2 | Table 3 |
| Group A prime | Table 1 | Table 2 | Table 3 |
| Group B prime | Table 1 | Table 2 | Table 3 |
| Group C prime | Table 1 | Table 2 | Table 3 |

| COMMERCIAL AUTO | | | |
|---|---|---|---|
| STATE GROUP 1 | L & M | STATE GROUP 5 | L & M |
| STATE GROUP 1 | HEAVY | STATE GROUP 5 | HEAVY |
| STATE GROUP 1 | X-HEAVY | STATE GROUP 5 | X-HEAVY |
| STATE GROUP 1 | ZONE RATED | STATE GROUP 5 | ZONE RATED |
| STATE GROUP 1 | ALL OTHER | STATE GROUP 5 | ALL OTHER |
| STATE GROUP 2 | L & M | STATE GROUP 6 | L & M |
| STATE GROUP 2 | HEAVY | STATE GROUP 6 | HEAVY |
| STATE GROUP 2 | X-HEAVY | STATE GROUP 6 | X-HEAVY |
| STATE GROUP 2 | ZONE RATED | STATE GROUP 6 | ZONE RATED |
| STATE GROUP 2 | ALL OTHER | STATE GROUP 6 | ALL OTHER |
| STATE GROUP 3 | L & M | STATE GROUP 7 (CA) | L & M |
| STATE GROUP 3 | HEAVY | STATE GROUP 7 (CA) | HEAVY |
| STATE GROUP 3 | X-HEAVY | STATE GROUP 7 (CA) | X-HEAVY |
| STATE GROUP 3 | ZONE RATED | STATE GROUP 7 (CA) | ZONE RATED |
| STATE GROUP 3 | ALL OTHER | STATE GROUP 7 (CA) | ALL OTHER |
| STATE GROUP 4 | L & M | STATE GROUP 8 (NY) | L & M |
| STATE GROUP 4 | HEAVY | STATE GROUP 8 (NY) | HEAVY |
| STATE GROUP 4 | X-HEAVY | STATE GROUP 8 (NY) | X-HEAVY |
| STATE GROUP 4 | ZONE RATED | STATE GROUP 8 (NY) | ZONE RATED |
| STATE GROUP 4 | ALL OTHER | STATE GROUP 8 (NY) | ALL OTHER |
| | | | |
| | STATE GROUP MULTISTATE | L & M | |
| | STATE GROUP MULTISTATE | HEAVY | |
| | STATE GROUP MULTISTATE | X-HEAVY | |
| | STATE GROUP MULTISTATE | ZONE RATED | |
| | STATE GROUP MULTISTATE | ALL OTHER | |

| PERSONAL AUTO |
|---|
| Tort States |
| CO, DE, KY, MN, ND |
| FL |
| KS, UT |
| MI, NY |
| Multi-State |

| MEDICAL/PROFESSIONAL |
|---|
| HOSPITALS LIABILITY GRP A |
| HOSPITALS LIABILITY GRP B |
| HOSP LIABILITY MULTISTATE |
| PHYSICIANS LIABILITY GRP A |
| PHYSICIANS LIABILITY GRP B |
| PHYSICIANS LIABILITY GRP C |
| PHYS LIABILITY MULTISTATE |
| SURGEONS LIABILITY GRP A |
| SURGEONS LIABILITY GRP B |
| SURGEONS LIABILITY GRP C |
| SURG LIABILITY MULTISTATE |
| DENTISTS LIABILITY |
| NURSING HOMES LIABILITY |
| MISC MEDICAL LIABILITY |

| PRODUCTS | | | |
|---|---|---|---|
| MultiState | Table A | Table B | Table C |

# Calculating Reinsurance Rates

- Loss costs or premiums?
  - Until now we have mostly been talking about premium
- Usual assumption: ILFs are “fair”
  - i.e., same loss ratio at all limit sizes
  - Layer loss cost = (loss ratio) * (layer premium)
- To calculate a technical reinsurance premium, loss costs must be adjusted for the reinsurer’s
  - Expenses (including brokerage)
  - Investment income
  - Combined ratio requirements
  - Risk load / profit margin
- Such factors may differ between insurer and reinsurer

# Liability Exposure Rating
# Using a Limit Profile

**ILF Table**

| Policy Limit | ILF |
|---|---|
| 1,000,000 | 2.000 |
| 2,000,000 | 2.530 |
| 3,000,000 | 2.920 |
| 4,000,000 | 3.190 |
| 5,000,000 | 3.410 |
| 6,000,000 | 3.580 |
| 7,000,000 | 3.720 |
| 8,000,000 | 3.850 |
| 9,000,000 | 3.950 |
| 10,000,000 | 4.030 |

**Limit Profile**

| Policy Limit | Premium |
|---|---|
| 1,000,000 | 5,000,000 |
| 2,000,000 | 10,000,000 |
| 3,000,000 | 4,000,000 |
| 4,000,000 | 7,000,000 |
| 5,000,000 | 25,000,000 |
| 6,000,000 | 6,500,000 |
| 7,000,000 | 3,000,000 |
| 8,000,000 | 1,000,000 |
| 10,000,000 | 10,000,000 |

# Liability Exposure Rating
# Using a Limit Profile

| | |
|---|---|
| Loss Ratio | **60.0%** |
| Brokerage | **10.0%** |
| Rein. Expense | **5.0%** |
| Margin | **5.0%** |

| Policy Limit | Premium | Base Rate | $4M xs $1M | % Premium | $5M xs $5M | % Premium |
|---|---|---|---|---|---|---|
| **1,000,000** | **5,000,000** | 2,500,000 | - | 0.0% | - | 0.0% |
| **2,000,000** | **10,000,000** | 3,952,569 | 2,094,862 | 20.9% | - | 0.0% |
| **3,000,000** | **4,000,000** | 1,369,863 | 1,260,274 | 31.5% | - | 0.0% |
| **4,000,000** | **7,000,000** | 2,194,357 | 2,611,285 | 37.3% | - | 0.0% |
| **5,000,000** | **25,000,000** | 7,331,378 | 10,337,243 | 41.3% | - | 0.0% |
| **6,000,000** | **6,500,000** | 1,815,642 | 2,560,056 | 39.4% | 308,659 | 4.7% |
| **7,000,000** | **3,000,000** | 806,452 | 1,137,097 | 37.9% | 250,000 | 8.3% |
| **8,000,000** | **1,000,000** | 259,740 | 366,234 | 36.6% | 114,286 | 11.4% |
| **10,000,000** | **10,000,000** | 2,481,390 | 3,498,759 | 35.0% | 1,538,462 | 15.4% |
| **Total** | **71,500,000** | | 23,865,810 | **33.4%** | 2,211,406 | **3.1%** |
| **Loss Cost** | **= Premium x Loss Ratio** | | 14,319,486 | **20.0%** | 1,326,844 | **1.9%** |
| **Reins. Premium** | **= Loss Cost / (1 - Expenses)** | | 17,899,358 | **25.0%** | 1,658,555 | **2.3%** |

# Property Exposure Rating

# PROPERTY Exposure Rating

- Commercial Property
- Residential Property
- Ocean Marine
- Inland Marine

# Property Rating - Terminology

## A bit of vocabulary

**TIV: Total Insured Value**

**TSI: Total Sums Insured**

Tied to the value of the building

**PML: Probable Maximum Loss**

**MFL: Maximum Forseeable Loss**

Tied to the value of the loss (this is almost always less than TIV/TSI)

Shades of meaning, or a real difference?

# Property Rating - Pure

**Premium = Rate * Insured Value**

Rate: Amount you charge per $100 of Insured Value

Insured Value: Value of building (more or less)
Sometimes called TIV or PML

# Property Rating –Example

Building Value = $100,000

Rate = $0.20 per $100 TIV

$$\text{Direct Premium} = \frac{\$100{,}000}{100} \times 0.20 = \$\ 200$$

$$\text{Direct Premium} = \frac{\$200{,}000}{100} \times 0.20 = \$\ 400$$

# Property Rating - Problem

Using a single rate for the entire exposure leaves us in a bit of a bind....

Building Value = $1M

Rate = 20 ¢ per $100 in Value

**How much went for 500K x 500K ??????**

**Reinsurer is getting 50% of building**

**Should reinsurer get 50% of the premium?**

# Property Rating - Problem

NOT

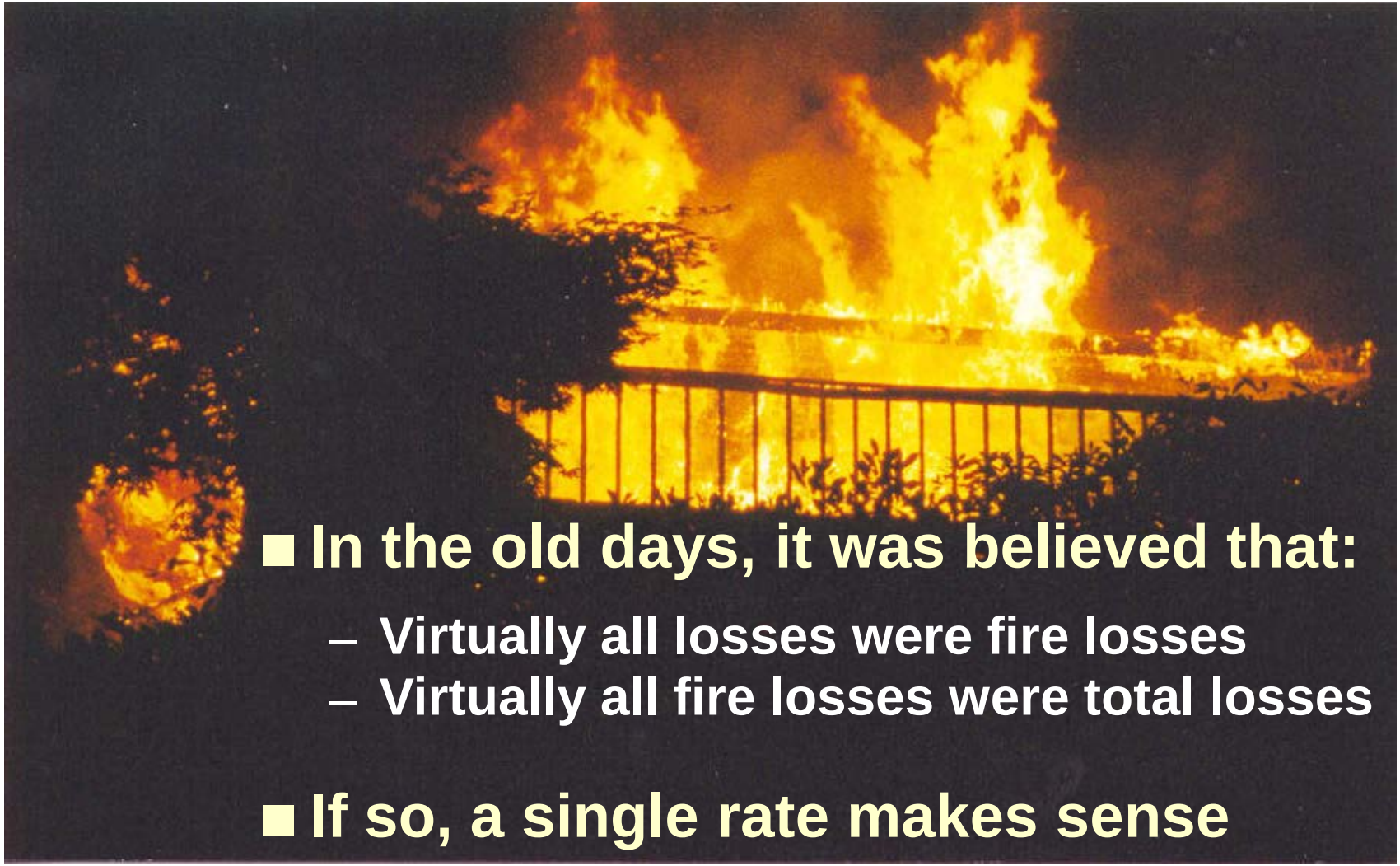
# Property Rating - Problem

So what are we supposed to do ???

Property isn’t rated using ILFs.

Why don’t they???

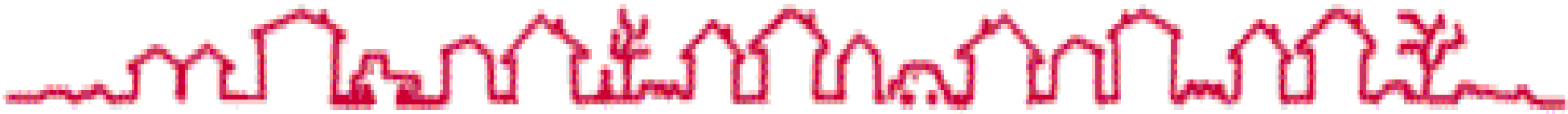
# Property Rating – Bit o' History



- In the old days, it was believed that:
  - Virtually all losses were fire losses
  - Virtually all fire losses were total losses
- If so, a single rate makes sense

# Property Rating – Bit o' History

- These days, it is believed that:
  - <u>For Homeowners</u>
    - There are lots of total fire losses
    - But there are a lot of partial losses too
  - <u>For Commercial Property</u>
    - There are lots of ways to have losses
    - Hardly any losses are total



■ **In response, rating methods are changing**

# Property Rating – Liab vs Prop

- For Liability we think in terms of dollars
  - e.g. a slip & fall costs $2000

- For Property we think in terms of % of TIV
  - e.g. a HO claim is for 10% of the TIV

# Property Rating – First Loss Scales

Traditionally, Property has used something called a ***First-Loss Scale***

*aka* Lloyds Scales

*aka* Salzmann Curves

*aka* Ludwig Curves

First-Loss Scales give the distribution of loss as a percent of insured value (as opposed to the distribution of loss dollars)

This means for property we basically only do allocation of premium based on losses

# Examples and Exercises

# Property Rating – First Loss Scales

| % of TIV | % of Loss |
|---|---|
| 0.0% | 0.0% |
| 10.0% | 25.0% |
| 20.0% | 40.0% |
| 30.0% | 50.0% |
| 40.0% | 60.0% |
| 50.0% | 70.0% |
| 60.0% | 75.0% |
| 70.0% | 80.0% |
| 80.0% | 90.0% |
| 90.0% | 96.0% |
| 100.0% | 100.0% |

Interpretation:

Layer 0-10% should see 25% of the total losses

Layer 0-50% should see 70% of the total losses

# Property Rating – First Loss Scales

| % of TIV | % of Loss |
|---|---|
| 0.0% | 0.0% |
| 10.0% | 25.0% |
| 20.0% | 40.0% |
| 30.0% | 50.0% |
| 40.0% | 60.0% |
| 50.0% | 70.0% |
| 60.0% | 75.0% |
| 70.0% | 80.0% |
| 80.0% | 90.0% |
| 90.0% | 96.0% |
| 100.0% | 100.0% |

TIV = $100,000

25% of losses are less than or equal to 10% of TIV. Therefore, 25% of Premium goes to pay the losses for the first 10,000 of building value.

(since 10% * 100,000 = 10,000)

60% of the premium goes to pay the losses for the first 40,000 of building value

(since 40% * 100,000 = 40,000)

# Property Rating – First Loss Scales

| % of TIV | % of Loss |
|---|---|
| 0.0% | 0.0% |
| 10.0% | 25.0% |
| 20.0% | 40.0% |
| 30.0% | 50.0% |
| 40.0% | 60.0% |
| 50.0% | 70.0% |
| 60.0% | 75.0% |
| 70.0% | 80.0% |
| 80.0% | 90.0% |
| 90.0% | 96.0% |
| 100.0% | 100.0% |

**TIV = $100,000**
**35% (= 60% - 25%) of losses are expected to fall in the layer between $10,000 (10% of TIV) and $40,000 (40% of TIV).**

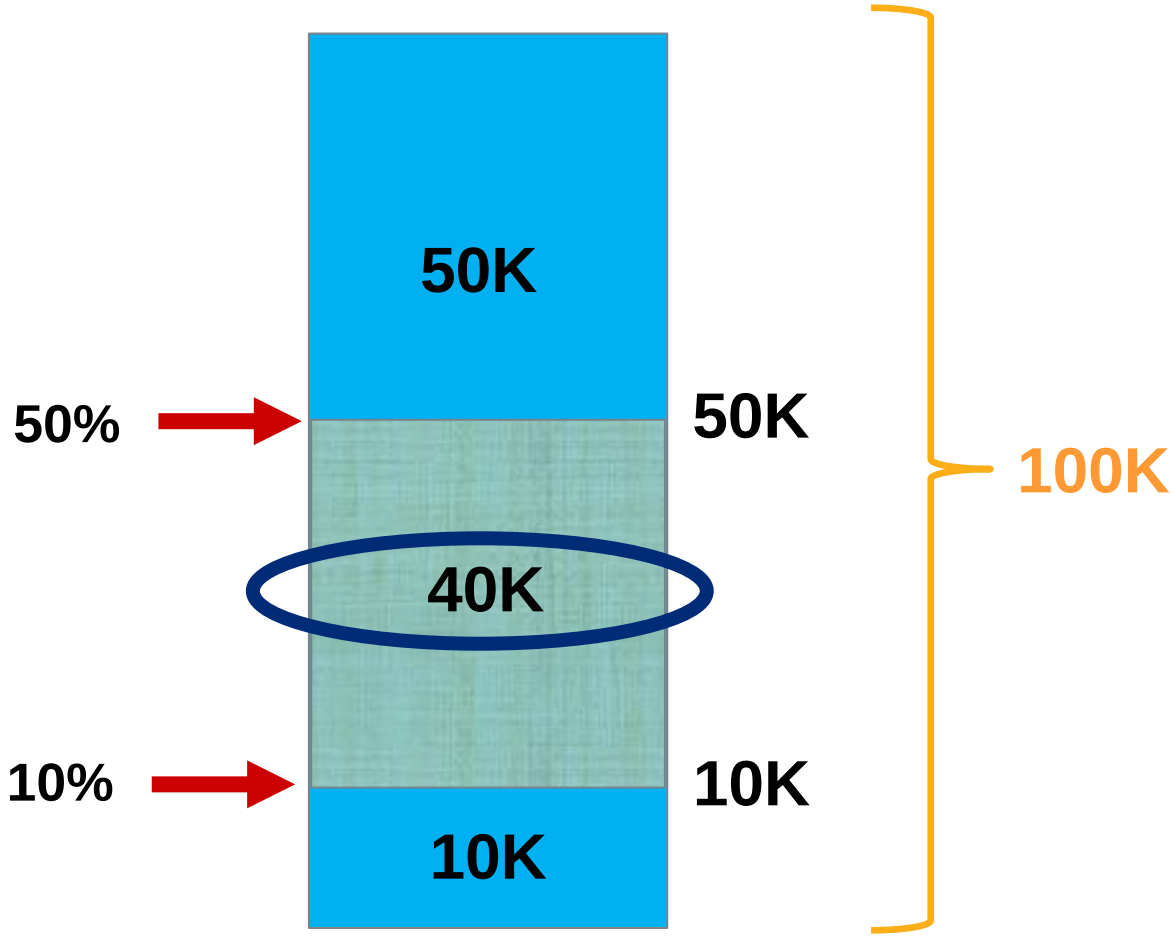
**This also means that if you have a loss, there is a 30% chance more than 50% of the building will be lost.**
**Do you believe the chance of losing half of a $1M building is the same as the chance of losing half of a $100M building?**

# First Loss Scales – Example

**What premium is needed for a layer of 40K x 10K?**

| % of TIV | % of Loss |
|---|---|
| 0.0% | 0.0% |
| 10.0% | 25.0% |
| 20.0% | 40.0% |
| 30.0% | 50.0% |
| 40.0% | 60.0% |
| 50.0% | 70.0% |
| 60.0% | 75.0% |
| 70.0% | 80.0% |
| 80.0% | 90.0% |
| 90.0% | 96.0% |
| 100.0% | 100.0% |

TIV = 100K
Prem = 1,000
Loss Ratio = 60%
Reins. Expenses = 20%




**Step 1: We need to know what the retention and the top of the layer are as a % of TIV**

# First Loss Scales – Example

**What premium is needed for a 40K x 10K treaty?**

| % of TIV | % of Loss |
|---|---|
| 0.0% | 0.0% |
| 10.0% | 25.0% |
| 20.0% | 40.0% |
| 30.0% | 50.0% |
| 40.0% | 60.0% |
| 50.0% | 70.0% |
| 60.0% | 75.0% |
| 70.0% | 80.0% |
| 80.0% | 90.0% |
| 90.0% | 96.0% |
| 100.0% | 100.0% |

Prem = 1,000
Loss Ratio = 60%
Reins. Expenses = 20%

**Step 2: Calculate Expected Loss**

1000 * 60% = 600

**Step 3: Look up Ratios on Table**

10% → 25% of loss
50% → 70% of loss

**Step 4: Multiply E(Loss) by Ratio Difference**

$E(Loss)_{40x10}$ = (70% - 25% ) * 600 = 270

**Step 5: Gross Up for Reins. Expenses**

Reins. $Prem_{40x10}$ = 270/(1 - 0.2) = 338

So insuring 40% of limit for 33.8% of premium

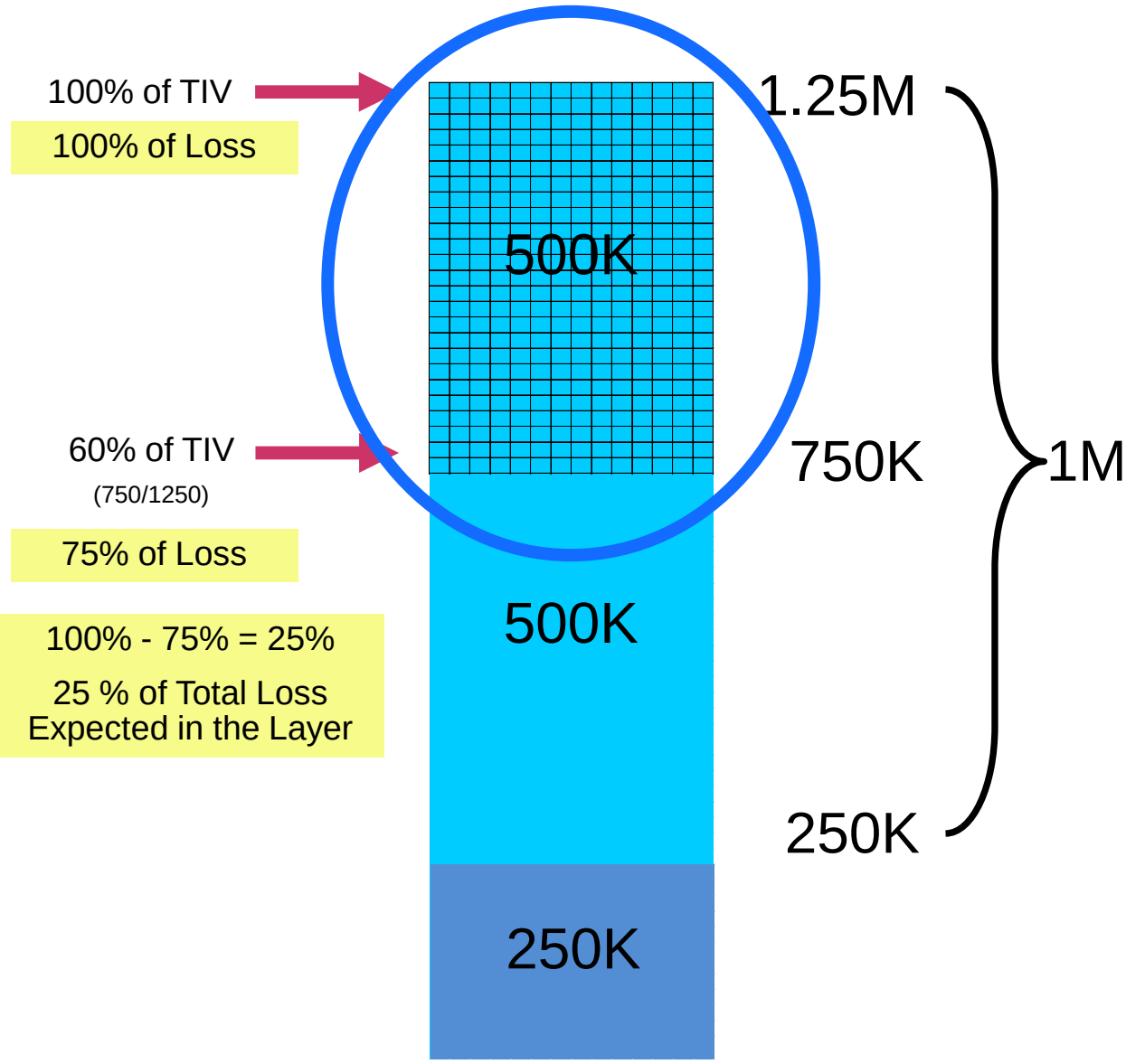
# First Loss Scales – Example 2

## Policy with SIR

What premium is needed for a 500K x 500K treaty?

| % of TIV | % of Loss |
|---|---|
| 0.0% | 0.0% |
| 10.0% | 25.0% |
| 20.0% | 40.0% |
| 30.0% | 50.0% |
| 40.0% | 60.0% |
| 50.0% | 70.0% |
| 60.0% | 75.0% |
| 70.0% | 80.0% |
| 80.0% | 90.0% |
| 90.0% | 96.0% |
| 100.0% | 100.0% |

Policy Limit = 1M
SIR = 250K
TIV = 1.25M
Prem = 10,000
Loss Ratio = 55%
Reins. Expenses = 20%



# First Loss Scales – Example 2

## Policy with SIR

BUT WHAT IS THE TOTAL LOSS?

# First Loss Scales – Example 2

## Policy with SIR

Policy Limit = 1M
SIR = 250K
TIV = 1.25M
Prem = 10,000
Loss Ratio = 55%
Reins. Expenses = 20%

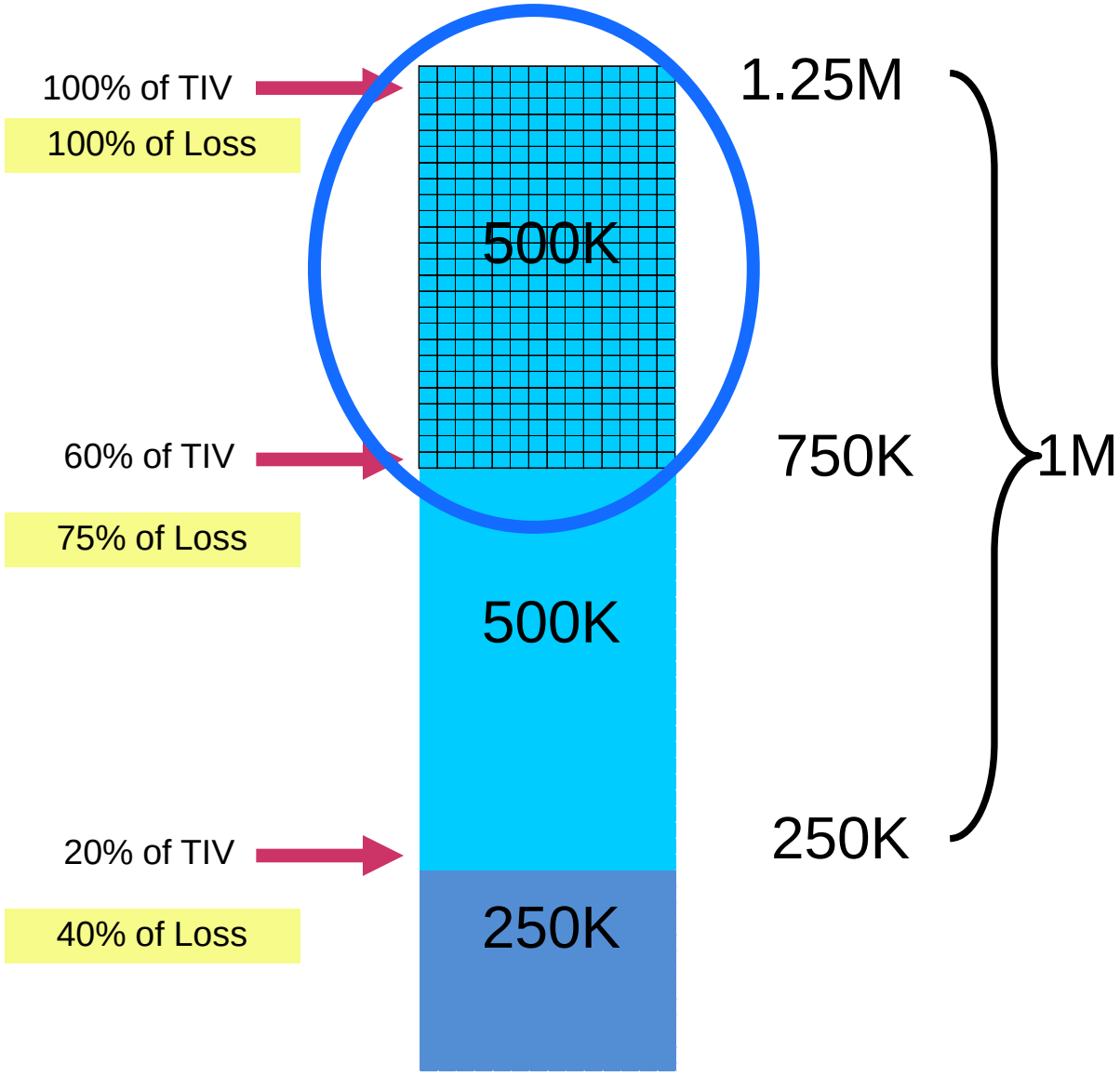
E(Loss) = Premium * Loss Ratio
= 10,000 * 0.55 = 5,500

BUT THIS IS ONLY FOR LOSSES ABOVE 250,000!

If 40% of losses are below 250,000, then

5,500 = Total Loss * (1-40%)

5,500/(1-40%) = 9,167



# First Loss Scales – Example 2

## Policy with SIR

What premium is needed for a 500K x 500K treaty?

| % of TIV | % of Loss |
|---|---|
| 0.0% | 0.0% |
| 10.0% | 25.0% |
| 20.0% | 40.0% |
| 30.0% | 50.0% |
| 40.0% | 60.0% |
| 50.0% | 70.0% |
| 60.0% | 75.0% |
| 70.0% | 80.0% |
| 80.0% | 90.0% |
| 90.0% | 96.0% |
| 100.0% | 100.0% |

Policy Limit = 1M
SIR = 250K
TIV = 1.25M
Prem = 10,000
Loss Ratio = 55%
Reins. Expenses = 20%

**Calculate Expected Loss in the Layer**

9,167 * 25% = 2,292

**Gross-up for Reinsurer Expenses**

2292 / (1 – 0.2) = 2,865

So insuring 40% of limit for 28.7% of premium

# First Loss Scales – Example 3

## Multiple Locations

What premium is needed for a 500K x 200K treaty?

200K to 700K

| % of TIV | % of Loss |
|---|---|
| 0.0% | 0.0% |
| 10.0% | 25.0% |
| 20.0% | 40.0% |
| 30.0% | 50.0% |
| 40.0% | 60.0% |
| 50.0% | 70.0% |
| 60.0% | 75.0% |
| 70.0% | 80.0% |
| 80.0% | 90.0% |
| 90.0% | 96.0% |
| 100.0% | 100.0% |

Loss Ratio = 60%

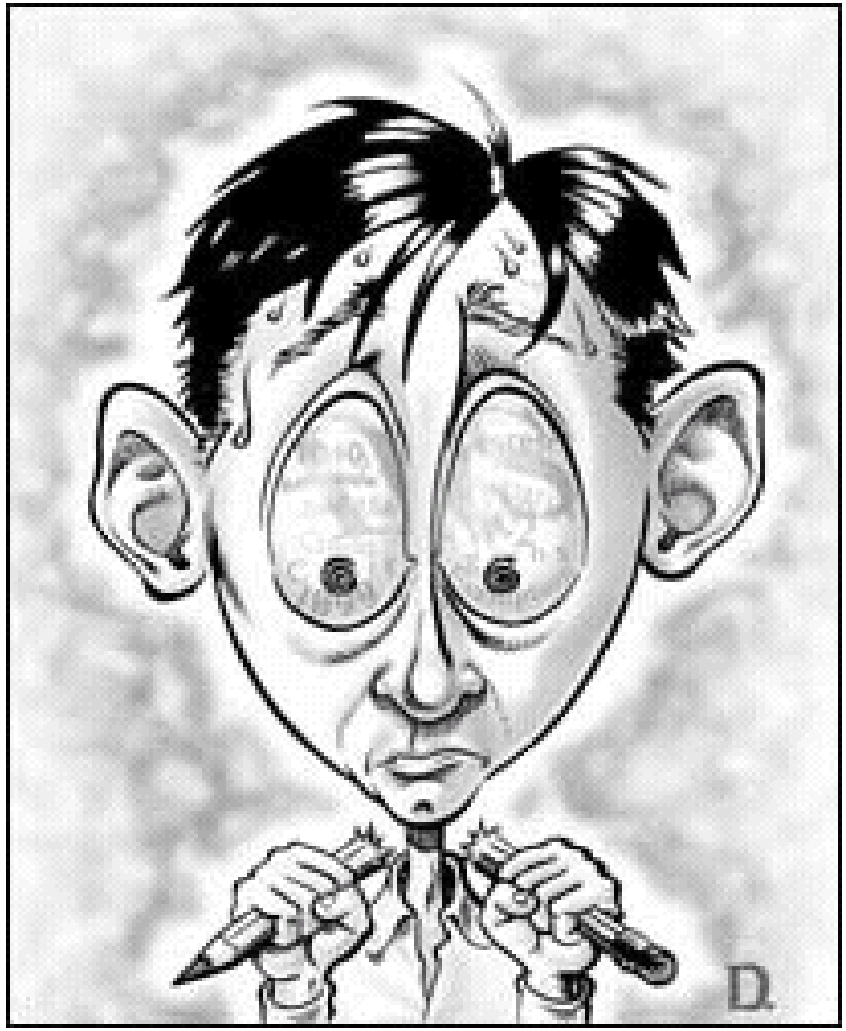
Reins. Expenses = 20%

| BLDG | Prem | TIV | Exp Loss | Lower TIV | Upper TIV |
|---|---|---|---|---|---|
| A | 100 | **100K** | 60 | | |
| B | 200 | **400K** | 120 | 200K | 400K |
| C | 300 | **500K** | 180 | 200K | 500K |
| D | 400 | **1,000K** | 240 | 200K | 700K |
| Tot | 1,000 | | 600 | | |

| Lower % | Upper % | % $Loss_{Lower}$ | % $Loss_{Upper}$ | Difference | E(Layer Loss) |
|---|---|---|---|---|---|
| 50% | 100% | 70% | 100% | 30% | 36 |
| 40% | 100% | 60% | 100% | 40% | 72 |
| 20% | 70% | 40% | 80% | 40% | 96 |
| | | | | | 204 |

E(Layer Loss) / (1-Reins. Exp) = 255

% of Premium 25.5%



# First Loss Scales – Example 4

| % of TIV | % of Loss |
|---|---|
| 0.0% | 0.0% |
| 10.0% | 25.0% |
| 20.0% | 40.0% |
| 30.0% | 50.0% |
| 40.0% | 60.0% |
| 50.0% | 70.0% |
| 60.0% | 75.0% |
| 70.0% | 80.0% |
| 80.0% | 90.0% |
| 90.0% | 96.0% |
| 100.0% | 100.0% |

What premium is needed for a 300K x 200K treaty?

| Layer | # Risks | Lower | Upper |
|---|---|---|---|
| A | 100 | 0 | 100K |
| B | 50 | 100K | 200K |
| C | 20 | 200K | 300K |
| D | 10 | 300K | 500K |
| Tot | 180 | | |

I wish this were a trick question, but this is the kind of data we often get

# First Loss Scales – Problem 3

| % of TIV | % of Loss |
|---|---|
| 0.0% | 0.0% |
| 10.0% | 25.0% |
| 20.0% | 40.0% |
| 30.0% | 50.0% |
| 40.0% | 60.0% |
| 50.0% | 70.0% |
| 60.0% | 75.0% |
| 70.0% | 80.0% |
| 80.0% | 90.0% |
| 90.0% | 96.0% |
| 100.0% | 100.0% |

What's wrong?

Need premium value!

If we have total premium – not fatal

Without premium – fatal

| Layer | # Risks | Lower | Upper |
|---|---|---|---|
| A | 100 | 0 | 100K |
| B | 50 | 100K | 200K |
| C | 20 | 200K | 300K |
| D | 10 | 300K | 500K |
| Tot | 180 | | |

# Wrinkles to Using First Loss Scales

- Need the Correct Information
  - Premium, not number of risks
  - TIV or PML
- **Wind vs Fire vs CAT Loss Ratios???**
  - Sometimes on a combined basis, sometimes calculate separately
  - Best to have Cat vs Non-Cat

# Wrinkles to Using First Loss Scales

- Appropriate First Loss Scale
  - Over 50 First Loss scales
  - Some are more popular with reinsurers
  - Different scales are used differently

# Wrinkles to Using First Loss Scales

- TIV vs PML vs Other
  - Salzmann Curves - Bldg losses for Bldg TIV
  - Ludwig Curves - All losses but Bldg TIV
  - Some curves apply to PMLs
  - No consistent definition of PML
  - What about blanket limits?

# PSOLD Curves

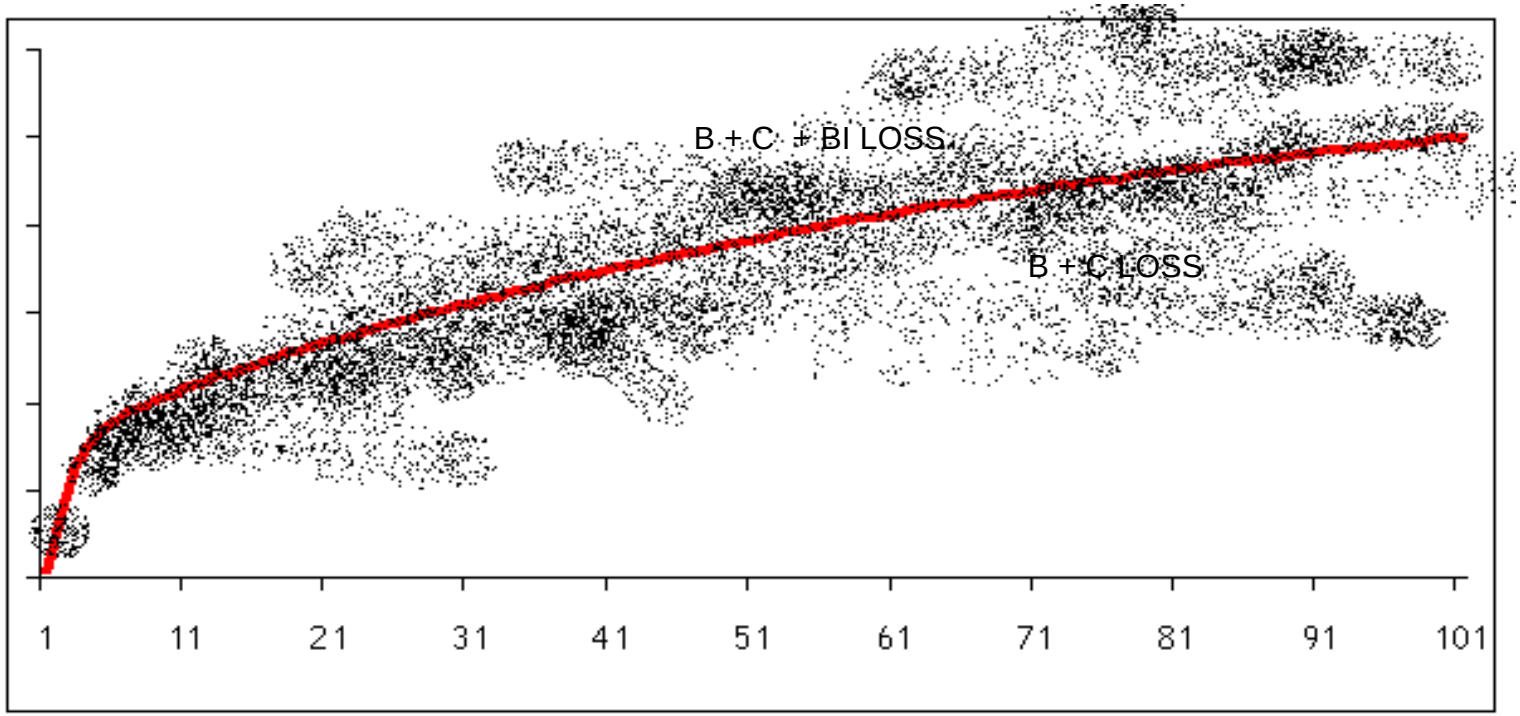
- 1998 – PSOLD Curves Released
- Created to fix assumption of constant loss-to-value ratios across all value ranges
- Calculates average severity of loss given policy limit rather than % of value
- Separate curves for each of:
  - 60 value ranges
  - 38 commercial occupancy classes
  - Building Only
  - Contents Only

  } (ISO stopped producing these in 2004)
  - Buildings + Contents
  - B + C + BI

  - Homeowners

# PSOLD Curves

- Buildings and Contents – not an issue
- B + C + BI - Watch your Limit Profiles!



# PSOLD Curves

- **DO NOT INCLUDE BI IN LIMITS PROFILES WHEN RATING WITH PSOLD (Most US Markets)**
  - **Overstates Severity of Loss**
- **First-Loss Scales rely on Total Limits Profile (incl. BI)**
- **If profiles are to be sent to London or Foreign markets as well as Domestic, include 2 profiles – one with BI, and one without**

# PSOLD Curves – Example Calculations

| Loss Amount | Cumulative Probability | Limited Average Severity |
|---|---|---|
| 1,000 | 0.300911 | 833 |
| 5,000 | 0.69665 | 2,635 |
| 10,000 | 0.827319 | 3,765 |
| 50,000 | 0.957497 | 6,887 |
| 100,000 | 0.978202 | 8,388 |
| 500,000 | 0.996166 | 11,734 |
| 1,000,000 | 0.998266 | 13,007 |
| 1,500,000 | 0.998964 | 13,675 |
| 2,000,000 | 0.999301 | 14,101 |
| 3,000,000 | 0.999617 | 14,618 |
| 4,000,000 | 0.999753 | 14,925 |
| 5,000,000 | 0.999822 | 15,134 |
| 10,000,000 | 0.999932 | 15,676 |
| 50,000,000 | 0.999998 | 16,288 |
| 100,000,000 | 1 | 16,322 |
| 200,000,000 | 1 | 16,329 |
| 250,000,000 | 1 | 16,329 |

Subject Premium = $75M

Loss Ratio = 60%

Reinsurer Expenses = 15%

What premium is needed for a $3M xs $2M treaty?

Expected Loss = $75M x 0.60 = $45M

Portion of loss in layer = (15,134 – 14,101) / 16,329

= 0.06326

($45M x 0.06326) / (1 – 0.15) = $3,349,148

# Property Exposure Rating
## Required Data

- **Per-Location**
  - Bldg vs Cnt vs BI Limit
  - Deductible/SIR
  - Premium
  - TIV
  - Participation
  - Occupancy
  - Account ID
  - Location ID
  - Policy ID

**For Premium Allocation to Location, we need premium by account along with all this other stuff…**

**By-Band**

Limit Range (excl. BI)
Average SIR
Premium Min & Max TIV (or average)
Average Participation
Occupancy Distribution

**Other Data Used**

Company Specific First-Loss Scales
Perils Covered
Protection, Construction (HO)

# Decomposition of Expected Loss into Frequency and Severity

# Decomposition into Frequency and Severity

**Normally, we think of layers for purposes of reinsurance:**
**$1M xs $1M**
**$3M xs $2M**

**Remember that frequency X severity = loss cost.**

**Each layer loss can be split into frequency and severity.**

**What happens as layer limits get smaller and smaller?**
**What happens to frequency?**
**What happens to severity?**

# Decomposition into Frequency and Severity

**Start with a layer of $1M xs $1M. you might get some values that look like this:**

| | E(Losses) | E(Sev) | E(Count) |
|---|---|---|---|
| **1M xs 1M** | 3,214,710 | 492,531.1 | 6.5 |
| **500K xs 1M** | 2,204,330 | 337,729.0 | 6.5 |
| **250K xs 1M** | 1,323,931 | 202,841.7 | 6.5 |
| **125K xs 1M** | 730,869 | 111,977.6 | 6.5 |
| **50K xs 1M** | 311,740 | 47,762.2 | 6.5 |
| **25K xs 1M** | 159,427 | 24,426.1 | 6.5 |
| **1 xs 1M** | 6.5 | 1.0 | 6.5 |

- **When your layer gets so thin that your severity is equal to the layer width, your expected loss *IS* your frequency.**

# Decomposition into Frequency and Severity

- **When your layer gets so thin that your severity is equal to the layer width, your expected loss *IS* your frequency.**
- **Why?**
- **Frequency x severity = expected loss**
- **That means that**

  **Frequency = expected loss / severity**

  **Frequency = expected loss / 1 = expected loss**

  **Frequency = expected loss**

- **So let's go backwards and pretend we didn't know the severity associated with each layer. Dividing expected loss by frequency for each layer allows you to find the severity of loss for any given layer.**

# Calculation of CDF

# CDF Calculation

**We can also use the frequency values to calculate the CDF of the loss distribution.**

| Loss Amount | (Implied Layer) | Freq | CDF =1-% of Freq. at Trunc. |
|---|---|---|---|
| 500,000 | ($1 xs $500,000) | 25.0291 | - |
| 849,323 | ($1 xs $849,323) | 8.9285 | 0.64327 |
| 1,442,700 | ($1 xs $1,442,700) | 3.1350 | 0.87475 |
| 2,450,637 | ($1 xs $2,450,637) | 0.7584 | 0.96970 |
| 4,162,766 | ($1 xs $4,162,766) | 0.1210 | 0.99517 |
| 7,071,068 | ($1 xs $7,071,068) | 0.0358 | 0.99857 |
| 12,011,244 | ($1 xs $12,011,244) | 0.0117 | 0.99953 |
| 20,402,858 | ($1 xs $20,402,858) | 0.0038 | 0.99985 |
| 34,657,242 | ($1 xs $34,657,242) | 0.0013 | 0.99995 |
| 58,870,402 | ($1 xs $58,870,402) | 0.0003 | 0.99999 |
| 100,000,000 | ($1 xs $100,000,000) | 0.0000 | 1.00000 |

# Premium Allocation

# Policy Level Data

- What do you do when you only have policy level premium?
- We need LOCATION LEVEL data.

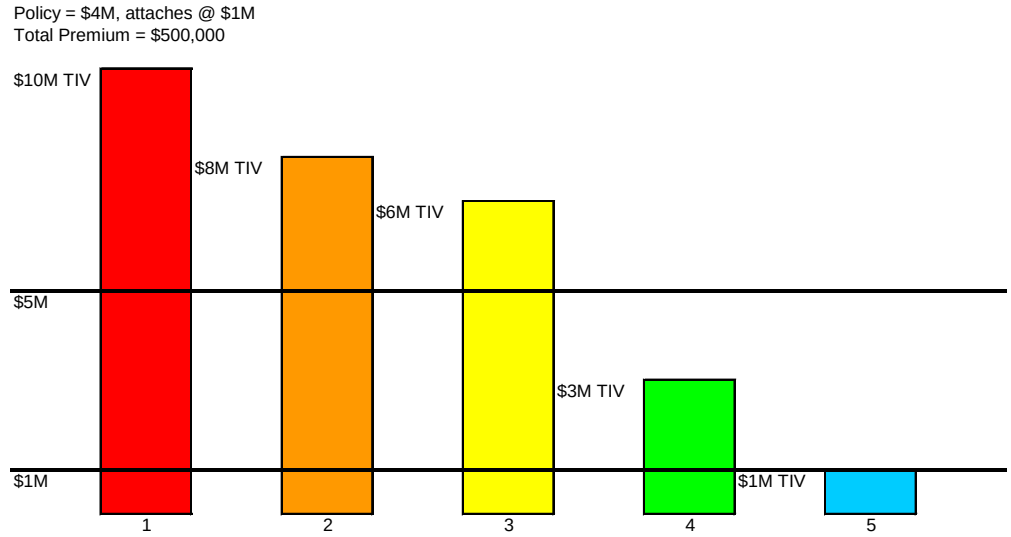
- What assumptions are we making when we use POLICY LEVEL profile data?
    - Every location TIV is equal to policy limit
    - Every location identical in risk and premium charged
- Does every location have the same value and represent the same amount of risk?

# Why the Need to Allocate Premium

- Exposure Rating Model Inputs:
  - Limit
  - Deductible/Attachment
  - Occupancy
  - Coverage
  - PREMIUM!!

# Allocation of Premium to Individual Location

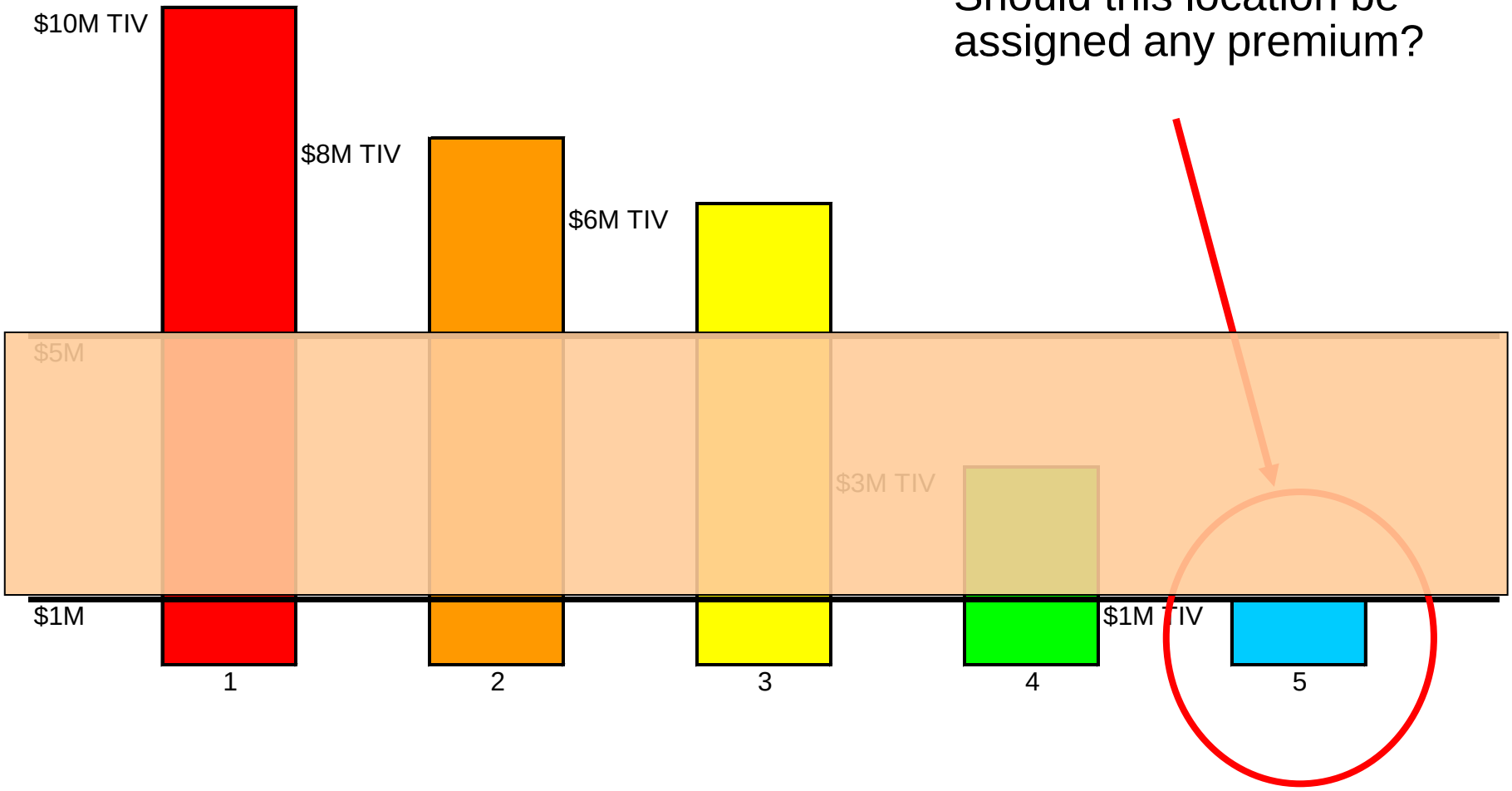
- When policies cover multiple locations, it is necessary to allocate the premium to each individual location before exposure rating techniques can be properly applied.
- Traditional Methods
  - By TIV
  - All Premium Slotted to Highest Limit
  - By Exposed TIV
- Does this always make sense?
  - Why?
  - Why Not?
- Can we do better?
  - How?



# Allocation of Premium to Individual Location

## BY TIV???

Policy = $4M, attaches @ $1M
Total Premium = $500,000

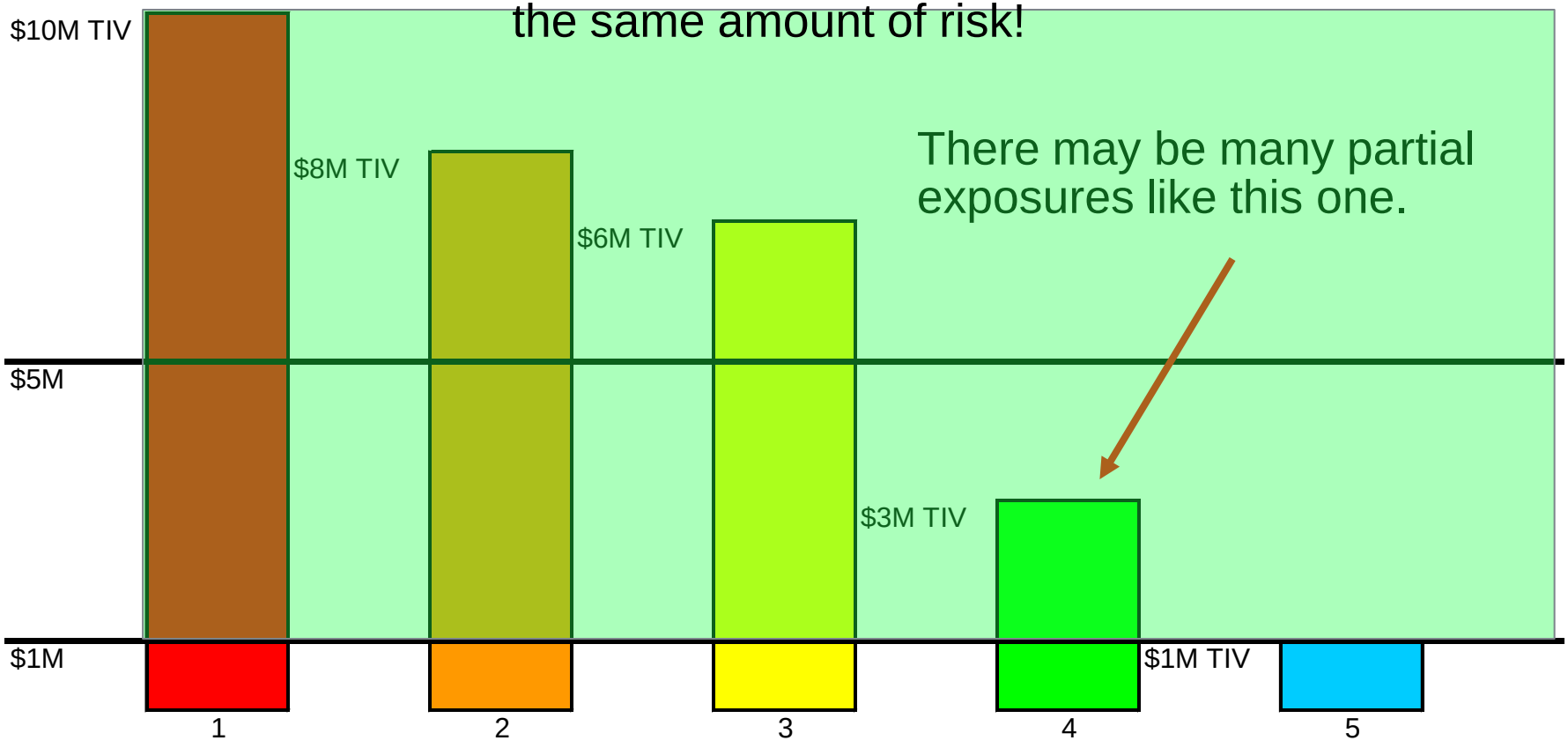


# Allocation of Premium to Individual Location

## ALL PREMIUM SLOTTED TO HIGHEST LIMIT???

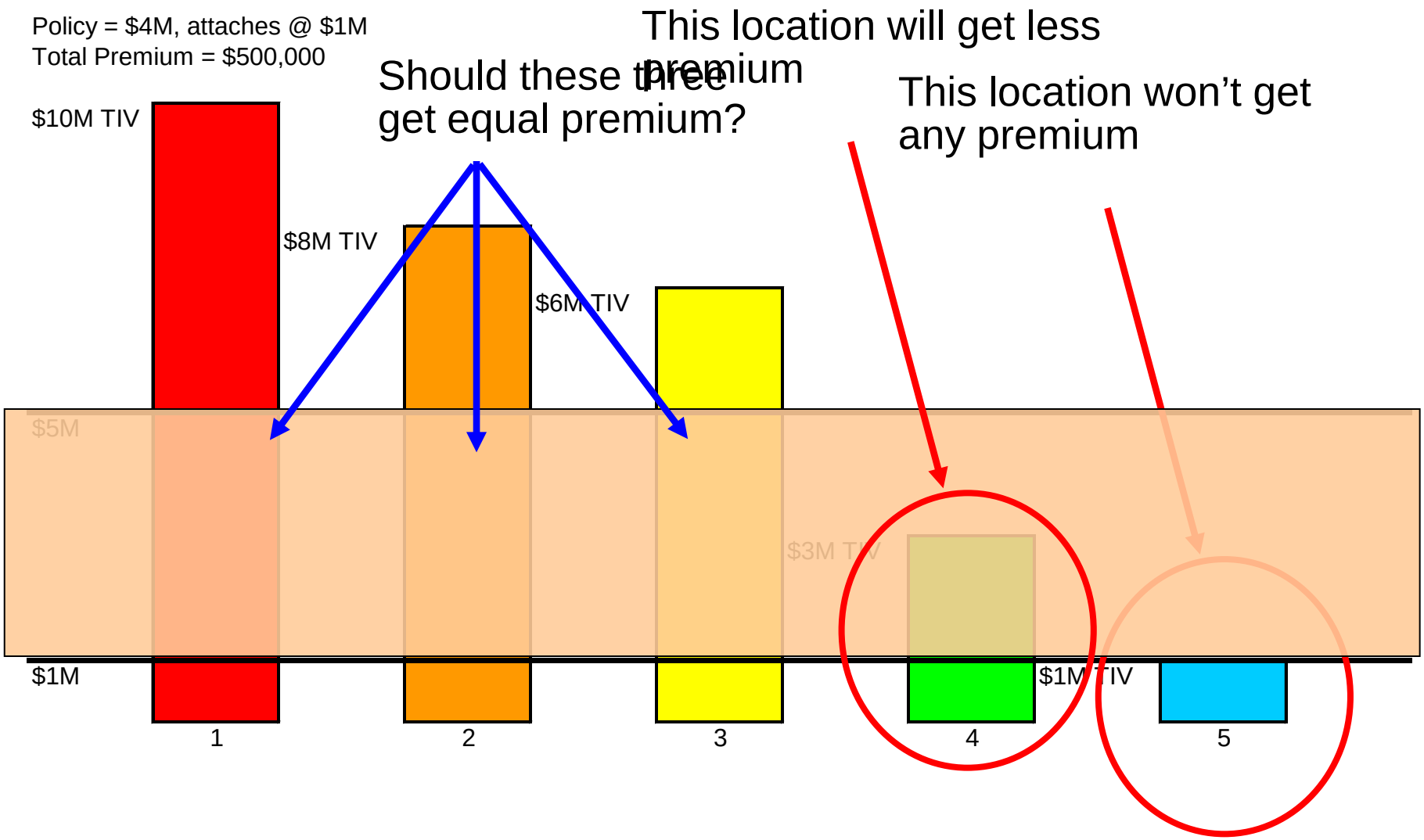
Policy = $4M, attaches @ $1M
Total Premium = $500,000

Would assume all locations expose the policy to the same amount of risk!



# Allocation of Premium to Individual Location

## BY Exposed TIV???

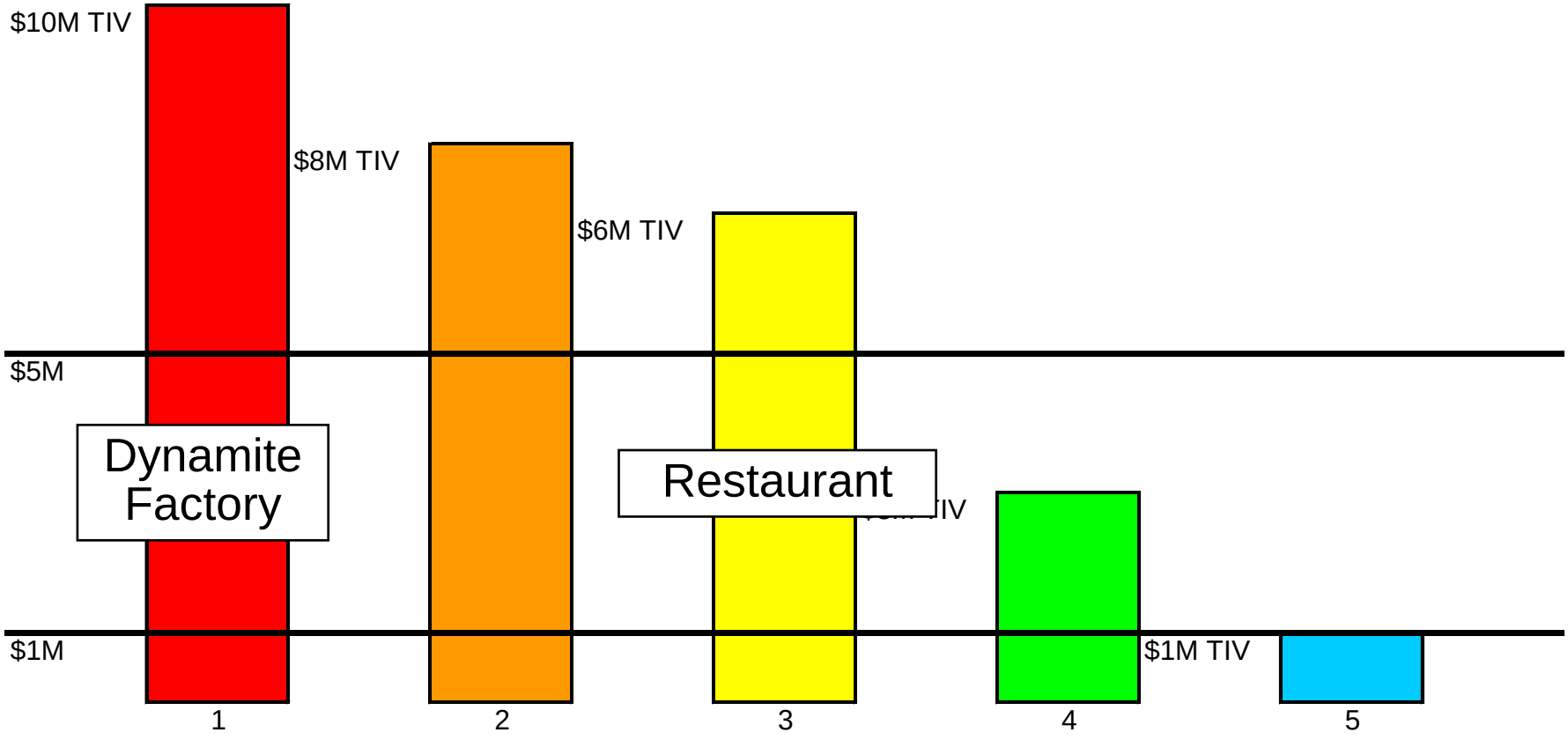


# Allocation of Premium to Individual Location

## BY Exposed TIV???

Policy = $4M, attaches @ $1M
Total Premium = $500,000

Do they subject the policy to equal risk?

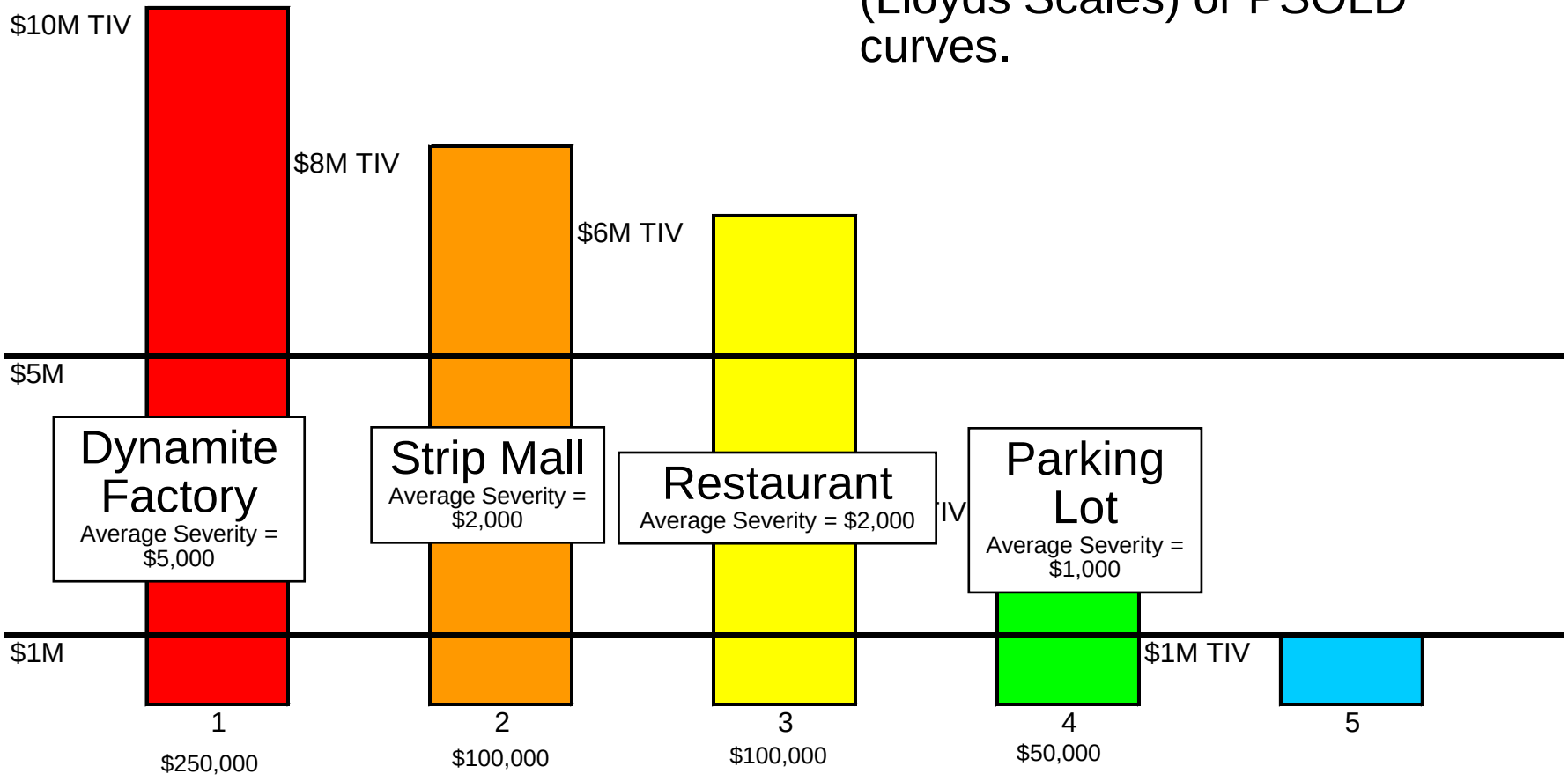


# Allocate Based on Potential for Loss

## SOLUTION

Policy = $4M, attaches @ $1M
Total Premium = $500,000

Average Severity of loss can be based on First Loss Scales (Lloyds Scales) or PSOLD curves.



# Workers Compensation

# Work Comp

GOOD NEWS !!!

We’re only going to do a quick overview

# Work Comp – Pure Rating

- Highly Controlled

- Essentially Rate * Exposure with a lot of mandated tweaks after that
  - Expense Flattening
  - Experience Credits
  - Lots of Junk, Loads of Terminology

# Work Comp – Pure Rating

- Rates vary by
  - State
  - Hazard Class
  - SIC Code
  - Size of Company (through expense load)

# Work Comp – Exposure Rating

- Reinsurance may be priced
  - Exactly the same way as primary pricing
  - Using Excess Loss Factors

- Why ELF's?
  - No ILFs because WC doesn't have limits
  - No First-Loss Scales (What *is* Insured Value?)

# Work Comp – Excess Loss Factors

- Excess Loss Factor
  - % of loss above a given retention
  - Basically (1 – First Loss Scale %)

# WC Exposure Rating

- Data Needed From Company
  - Premium and Pricing History
  - Ground-up Losses
    - Indemnity vs Medical
  - Profiles by Hazard Class and State

- Other Data Used
  - Excess Loss Factors

# A FEW LAST COMPLICATIONS

# General Wrinkles

- Premium Adequacy
  - In purest sense, assumes premium adequate
  - Can correct for that **IF** we have sufficient information about company to come up with independent ground-up ultimate loss ratio
- Allocated Loss Adjustment Expense (ALAE)
  - To what extent included?
  - To what extent *should* include?

# General Wrinkles

- Risk Loads
  - 2 Issues
    - Are there already risk loads in ILFs/FLS/ELFs?
    - What risk load do we want for reinsurance pricing?
  - Risk Loads in Curves
    - Leave in if allocating premium (cessions)
    - Take out if estimating losses or rein prem
  - Risk Load for Reinsurance
    - Need to add one if pricing
    - Lots of methods

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