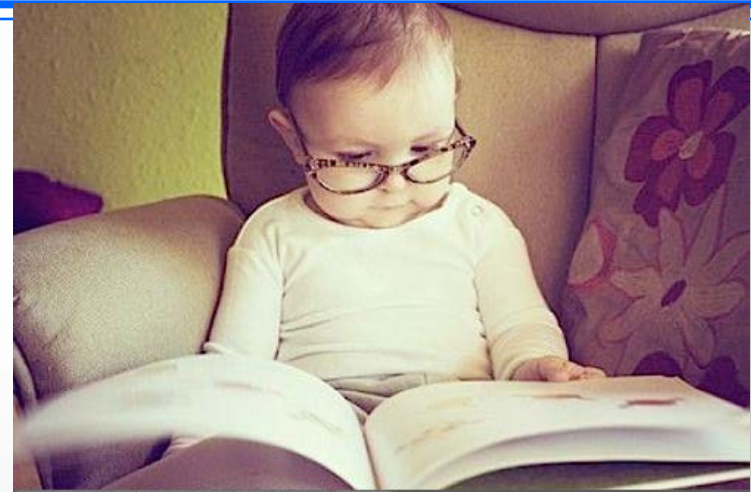


## Cost Allocation 101

*Putting Your Premiums Where Your Costs Are!*



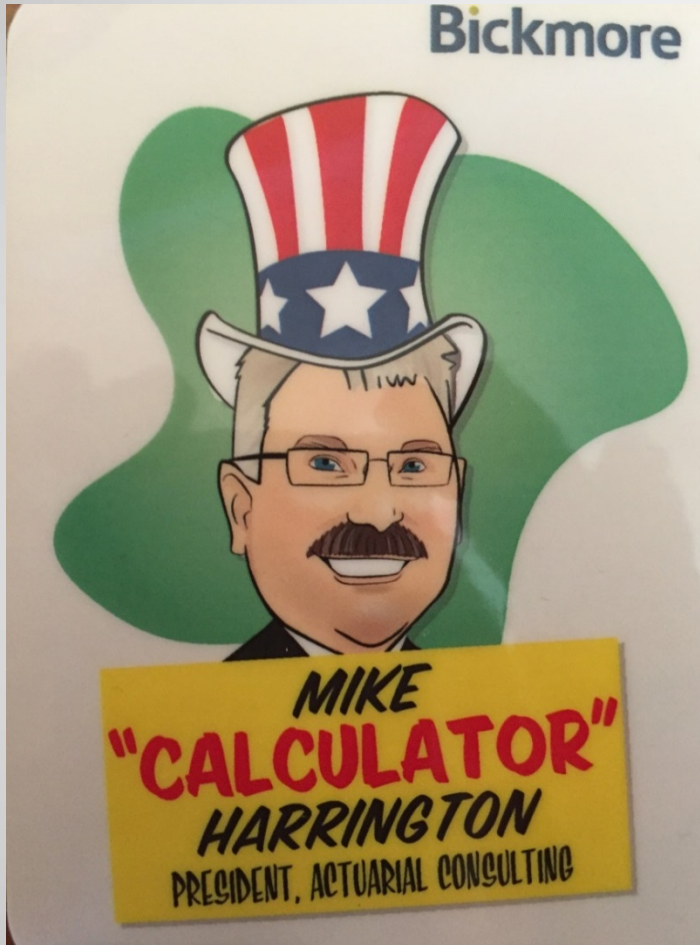
**Mike Harrington, FCAS, MAAA**  
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# A Little About Us...



**MIKE HARRINGTON** FCAS, MAAA  
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YRS EXPERIENCE:  $20 + \pi/2 + \sin 30^\circ + \lim_{n \rightarrow \infty} e^{1/n}$



Mike began his actuarial career in infancy by playing with calculators and protractors instead of toys. Before long he was setting rates and reserves for the first of five insurance companies he worked for prior to joining Bickmore. Mike's brings expertise in both private and public self-insurance valuations, as well as a geeky sense of humor, to his clients.

Bickmore's **PROPERTY & CASUALTY ACTUARIAL SERVICES** practice evaluates and measures financial risks of self-insured programs. The team quantifies claim liabilities, recommends funding levels, cost allocations, and much more!

**QUIZ**

*WHAT INSTRUMENT DID MIKE PLAY IN HIS HIGH SCHOOL BAND?*

# A Little About Us...




**Bickmore**



**NINA**  
**"THE MATH-MAGICIAN"**  
**GAU**  
DIRECTOR, P&C ACTUARIAL SERVICES

**NINA GAU, FCAS, MAAA**  
(916) 244-1193    [NGau@bickmore.net](mailto:NGau@bickmore.net)  
GAMES: Cards Against Humanity & Quelf



Raised in Moscow with no TV and little parental supervision, Nina trained as a gymnast until growth spurts forced her to swap leotards for math books. She went on to earn a degree in applied mathematics. Nina's actuarial career began when she moved to the US 20 years ago. She's been helping clients analyze and quantify risk ever since.

Bickmore's **PROPERTY & CASUALTY ACTUARIAL SERVICES** practice evaluates and measures financial risks of self-insured programs. Actuaries quantify claim liabilities, recommend funding levels, cost allocations and much more!

**QUIZ**

*WHAT SUBJECT WAS NINA'S WORST NIGHTMARE IN SCHOOL?*

3.007, CAIPA 2015      ANSWER: ENGLISH

# Actuaries

---

A Special Breed of ???

# Happy Valentine's Day! Actuarial Relationships...

---

Getting the relationship started...

- What's your sign?
- What's your cosine?
- Your calculator or mine?



Keeping the fire kindled...

- Since the first time I set eyes on you, my interest in you has compounded daily, at a 4% effective annual rate of return.
- My love for you is endless, like the tail on workers' compensation liabilities.

# So Why Are We Here?

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## Summary of Session

---

- What is cost allocation?
- Key considerations in cost allocation plan design
- The typical parameters of a cost allocation plan
- Responsiveness vs stability in parameter selection
- Percentage allocations vs experience modification factors
- Minimizing swings in annual premiums
- Making changes to an existing plan
- Explaining annual changes



## Session Objectives

---

Allocating costs between departments within a public agency or between members in a risk pool is an important task. In this session, you will...

- Understand the key considerations in designing or updating a cost allocation plan.
- Learn how to allocate costs in such a way that is fair and equitable to all departments/members.
- Use your allocation plan to encourage loss control by departments/members.

## Lingo...

---

- We will be using the terms “**premium allocation**” and “**cost allocation**” interchangeably.
  - Premiums are generally the sum of all the costs to be allocated.
- We will go back and forth using the terms “**departments**” or “**members**”
  - The concepts discussed in this session apply both to individual entities allocating costs down to individual departments and risk pools allocating costs down to individual members.

# Cost Allocation

---

Premiums, %'s,  
X-Mods, and  
Other Fun Stuff



## General Premium Calculation and Allocation

---

First, total premiums are determined.

- Claim costs and rates calculated in annual actuarial study
- Insurance costs provided by broker
- Budget developed for other operating expenses

Next, total premiums are allocated to each department/member

- Costs allocated based upon historical claim experience (e.g. paid losses, claim reserves)
- Costs also shared based upon historical exposure (e.g. payroll).

## Premium Components

---

There are a number of components that must be allocated:

### Workers' Compensation

- Retained claim costs (below self-insured retention)
- Excess insurance premium (claims above the SIR)

### Liability

- Retained claim costs (below self-insured retention)
- Excess insurance premium (claims above the SIR)

### Claims Administration / Third-party Administrator Costs

### Safety Program Costs

### General Administration Costs

## Cost Allocation

---

So how do we do it???



## Considerations

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Selection of the appropriate cost allocation plan involves consideration of a number of trade-offs:

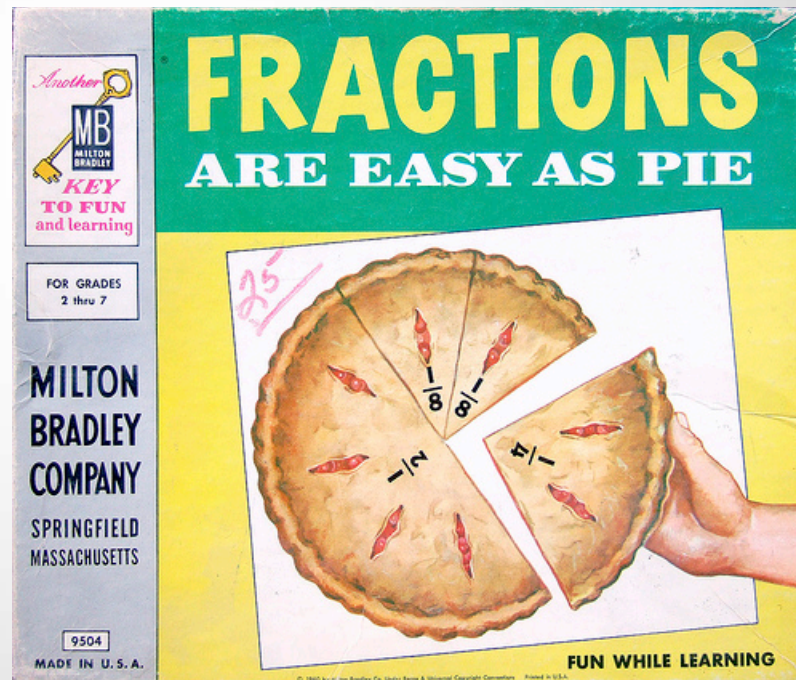
- Sharing vs. Bearing – To what extent does member loss experience impact their premiums? More bearing → More incentive for safety
- Responsiveness vs. Stability – How quickly should premiums respond to bad/good experience? More responsive → More incentive for safety
- Equity vs. Simplicity – How complicated should the plan be? A very detailed calculation may have a better answer, but nobody can explain why.

**Note: There is no single “correct” cost allocation plan!**

# Who Pays What ??

## Percentage Allocation

Simple  
Percentage Cost  
Allocation





## Percentage Allocation Plans

---

The most common method used by public agencies to allocate costs by department is a percentage allocation plan.

Costs are allocated to each department based upon a combination of “experience” and “exposure”.

- A specified weight, say 70%, is given to the loss experience of the department.
  - Some plans use a constant weight for all departments (e.g. Counties)
  - Some specify a maximum weight for the largest department, while others get a lower weight.
- The remaining weight, say 30%, is given to the exposure measure of each department.

## %-Alloc: Plan Parameters

---

### Years of Experience/Exposure

- How many and which ones to use when calculating the loss rate?
- Exclude the most recent year since it's too "green"?
- Fewer and recent years increases responsiveness
- More years increases stability
- Need to match experience and exposure
- Typical is 3-7 years
  - ❖ Counties use 5-7 years

### Loss Capping

- How much of each loss is included?
- Lessens the impact of very large losses in the calculation
- Lower cap emphasizes frequency
- Higher cap makes departments more accountable for large losses
- Typical is \$50K - \$250K

### Weight to Member Experience

- How much weight given to individual department loss experience?
  - Higher weight implies more bearing than sharing
  - Penalizes bad experience with higher premiums
  - Rewards good experience with lower premiums
  - Typical maximum experience weight is 30% - 75%
  - Others have experience weight scaled back
- ❖ Counties use 60% to 80% constant weight for all departments.

## %-Alloc: Sample Parameters

---

- Latest Five Years Of Incurred Losses And Payroll Are Used.
- Incurred Losses Are Limited To \$100,000 Per Occurrence.
- Weighting Is:
  1. 75% Experience and 25% Exposure
  2. 75% Experience Max and Scaled

## Sample Loss History

### Incurring Losses Capped at \$100K

Department	2011-12	2012-13	2013-14	2014-15	2015-16	Total	% of Total
Administration	\$0	\$0	\$0	\$1,327	\$4,421	\$5,748	0.4%
Human Resources	17,538	0	0	35,000	0	52,538	3.9%
Public Works	41,157	195,504	137,545	107,073	134,629	615,907	45.5%
Police	10,193	101,055	166,347	111,437	117,284	506,316	37.4%
Fire	2,735	1,075	10,765	6,229	19,144	39,948	3.0%
Utilities	46,963	24,753	31,086	18,817	11,490	133,109	9.8%
<b>Total</b>	<b>\$118,586</b>	<b>\$322,387</b>	<b>\$345,743</b>	<b>\$279,883</b>	<b>\$286,967</b>	<b>\$1,353,566</b>	<b>100.0%</b>

## Total Losses vs Capped Losses

Department	2011-12 to 2015-16 Total Incurred Losses		2011-12 to 2015-16 \$100K Limited Incurred Losses	
		% of Total		% of Total
Administration	\$5,748	0.3%	\$5,748	0.4%
Human Resources	52,538	2.9%	52,538	3.9%
Public Works	657,405	36.0%	615,907	45.5%
Police	935,563	51.3%	506,316	37.4%
Fire	39,948	2.2%	39,948	3.0%
Utilities	133,109	7.3%	133,109	9.8%
Total	\$1,824,312	100.0%	\$1,353,566	100.0%

## Sample Payroll History

### Payroll (00's)

Department	2011-12	2012-13	2013-14	2014-15	2015-16	Total	% of Total
Administration	\$32,171	\$32,469	\$33,783	\$34,453	\$36,813	\$169,689	5.2%
Human Resources	10,774	12,426	13,455	14,082	14,761	65,498	2.0%
Public Works	133,853	135,407	142,116	150,769	162,053	724,197	22.0%
Police	139,077	133,512	142,304	145,493	151,453	711,839	21.6%
Fire	133,054	120,125	123,389	113,910	107,197	597,675	18.2%
Utilities	186,860	191,274	199,294	210,766	230,941	1,019,134	31.0%
<b>Total</b>	<b>\$635,789</b>	<b>\$625,213</b>	<b>\$654,340</b>	<b>\$669,473</b>	<b>\$703,217</b>	<b>\$3,288,033</b>	<b>100.0%</b>



## Sample Payroll Allocation

What if we ignored loss experience and just used historical payroll to allocate costs?

Assume \$1,000,000 in costs need to be allocated...

Department	% of Payroll	Allocation
Administration	5.2%	\$51,608
Human Resources	2.0%	19,920
Public Works	22.0%	220,253
Police	21.6%	216,494
Fire	18.2%	181,773
Utilities	31.0%	309,953
Total	100.0%	\$1,000,000



\$1M to Allocate



## Calculating Averages

---

Normally to calculate an “**average**” you add up two things and divide by 2, right?

✓ e.g.  $8+4=12$ ,  $12/2=6$ , Average = 6!

You can also calculate an “**average**” using percentages...

✓ e.g.  $50\% \times 8 + 50\% \times 4 = 4+2=6$ , Average = 6!

...or a “**weighted average**”, giving one number 75% weight and another number 25% weight...

✓ e.g.  $75\% \times 8 + 25\% \times 4 = 6+1=7$ , Weighted Average = 7!

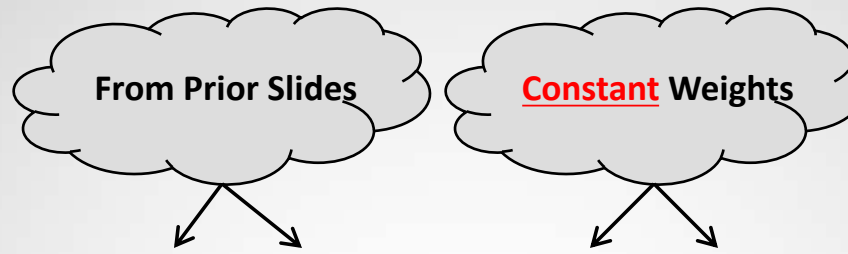
## Math Rules!!

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That was Awesome !!!



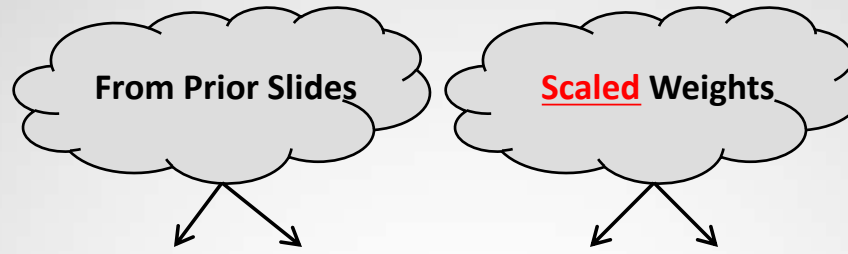
# Sample Allocation – Constant Percent Weights



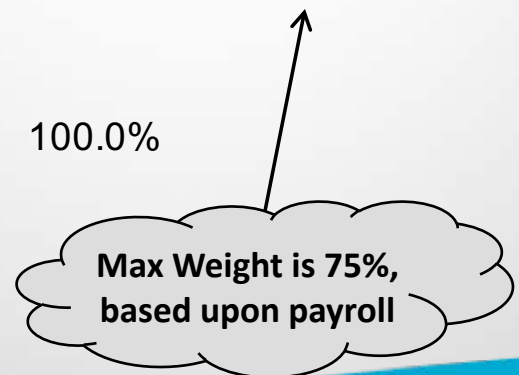
Department	% of Losses	% of Payroll	Loss Weight	Payroll Weight	% of Total	Allocation
Administration	0.4%	5.2%	75.0%	25.0%	1.6%	16,087
Human Resources	3.9%	2.0%	75.0%	25.0%	3.4%	34,091
Public Works	45.5%	22.0%	75.0%	25.0%	39.6%	396,332
Police	37.4%	21.6%	75.0%	25.0%	33.5%	334,669
Fire	3.0%	18.2%	75.0%	25.0%	6.8%	67,578
Utilities	9.8%	31.0%	75.0%	25.0%	15.1%	151,243
<b>Total</b>	<b>100.0%</b>	<b>100.0%</b>			<b>100.0%</b>	<b>\$1,000,000</b>



# Sample Allocation – Scaled Percent Weights



Department	% of Losses	% of Payroll	Loss Weight	Payroll Weight	% of Total	Allocation
Administration	0.4%	5.2%	33.3%	66.7%	3.6%	35,904
Human Resources	3.9%	2.0%	16.2%	83.8%	2.3%	23,021
Public Works	45.5%	22.0%	68.1%	31.9%	38.1%	380,838
Police	37.4%	21.6%	67.7%	32.3%	32.4%	323,818
Fire	3.0%	18.2%	63.8%	36.2%	8.5%	84,866
Utilities	9.8%	31.0%	75.0%	25.0%	15.2%	151,552
<b>Total</b>	<b>100.0%</b>	<b>100.0%</b>			<b>100.0%</b>	<b>\$1,000,000</b>



## Impact of Losses – Constant Weight vs Scaled Weight

Department	Payroll Only Allocation	Constant Weight Allocation	Change	Percent Change	Scaled Weight Allocation	Change	Percent Change
Administration	\$51,608	\$16,087	(\$35,521)	-69%	\$35,904	(\$15,704)	-30%
Human Resource	19,920	34,091	14,171	71%	23,021	3,101	16%
Public Works	220,253	396,332	176,080	80%	380,838	160,586	73%
Police	216,494	334,669	118,175	55%	323,818	107,324	50%
Fire	181,773	67,578	(114,195)	-63%	84,866	(96,907)	-53%
Utilities	309,953	151,243	(158,710)	-51%	151,552	(158,400)	-51%
Total	\$1,000,000	\$1,000,000	\$0	0%	\$1,000,000	\$0	0%

**Scaled Weight Impact is less than Constant Weight Impact**

You Did It !!

---

Now wasn't that cool...





# Who Pays What ??

## Experience Modification Factors

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Cost  
Allocation  
“X-Mods”



## Experience Modification Factors

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To use member loss experience in the premium allocation plan, an experience modification factor (x-mod) is calculated for each member.

The x-mod represents the relationship between the “experience” of the member and the “experience” of the pool.

- A factor greater than 1.00 indicates that the member’s expected loss rate is worse than the pool average.
- Conversely, a factor less than 1.00 indicates that the member’s expected loss rate is better than the pool.
- Loss rate = historical losses / historical exposure

### Years of Experience/Exposure

- How many and which ones to use when calculating the loss rate?
- Exclude the most recent year since it's too "green"
- Fewer and recent years increases responsiveness
- More years increases stability
- Need to match experience and exposure
- Typical is 3-5 years

### Loss Capping

- How much of each loss is included?
- Lessens the impact of very large losses in the calculation
- Lower cap emphasizes frequency
- Higher cap make members more accountable for large losses
- Typical is \$50K - \$250K

### Weight to Member Experience

- How much weight given to individual member losses?
  - Higher weight implies more bearing than sharing
  - Penalizes bad experience with higher premiums
  - Rewards good experience with lower premiums
  - Typical maximum is 30% - 75%
- What do we give the remaining weight to?
  - Pool Average (i.e. “You’re similar to the pool.”)
  - Prior x-mod (i.e. “You’re similar to how you used to be.”)

# X-Mod Calculation

$$\int_0^x \phi_U(vt) dv = \frac{1}{it} \left[ \left(1 - \frac{ixt}{r}\right)^{-r} - 1 \right]$$

$$V = \sum_{\text{bonds}} \epsilon_r \left[ \left(1 - \left(\frac{xt}{r}\right)^2\right)^{-r/2} - 1 \right] + \sum_{\text{angles}} \epsilon_\theta (\theta - \theta_0)^2 + \sum_{\text{impropers / planar}} \epsilon_\chi (\chi - \chi_0)^2$$

$$+ \sum_{\text{backbone}} \epsilon_{BB} F_D(\phi) + \sum_{\text{sidechain}} \epsilon_{SC} F_D(\phi)$$

$$+ \sum_{\text{contacts}} \epsilon_C \left[ \left(\frac{\sigma_{ij}}{r}\right)^{12} - 2 \left(\frac{\sigma_{ij}}{r}\right)^6 \right] + \sum_{\text{non-contacts}} \epsilon_{NC} \left(\frac{\sigma_{ij}}{r}\right)^{12}$$

$$\left[ \frac{-\hbar^2}{2m} \nabla^2 + V \right] \Psi = i\hbar \frac{\partial}{\partial t} \Psi$$

## X-Mod Calculation

---

Take a deep breath...



...It's not really that complicated.

## X-Mod Calculation

---

**It's simple...**

$$\begin{aligned} & \text{X-Mod} \\ & = \\ & \frac{\text{Member Losses}}{\text{Member Exposure}} \times \text{Experience Weight} \\ & + \\ & \frac{\text{Pool Losses}}{\text{Pool Exposure}} \times (1.00 - \text{Experience Weight}) \end{aligned}$$

**...and fun !**



## Sample Parameters

---

- Latest Five Years Of Incurred Losses And Payroll Are Used.
- Incurred Losses Are Limited To \$100,000 Per Occurrence.
- Weighting Is Maximum 75% Experience and Remainder to Exposure

## Sample Loss History

Department	Incurred Losses Capped at \$100K					Total
	2011-12	2012-13	2013-14	2014-15	2015-16	
Administration	\$0	\$0	\$0	\$1,327	\$4,421	\$5,748
Human Resources	17,538	0	0	35,000	0	52,538
Public Works	41,157	195,504	137,545	107,073	134,629	615,907
Police	10,193	101,055	166,347	111,437	117,284	506,316
Fire	2,735	1,075	10,765	6,229	19,144	39,948
Utilities	46,963	24,753	31,086	18,817	11,490	133,109
<b>Total</b>	<b>\$118,586</b>	<b>\$322,387</b>	<b>\$345,743</b>	<b>\$279,883</b>	<b>\$286,967</b>	<b>\$1,353,566</b>

## Sample Payroll History

Department	Payroll (00's)					Total
	2011-12	2012-13	2013-14	2014-15	2015-16	
Administration	\$32,171	\$32,469	\$33,783	\$34,453	\$36,813	\$169,689
Human Resources	10,774	12,426	13,455	14,082	14,761	65,498
Public Works	133,853	135,407	142,116	150,769	162,053	724,197
Police	139,077	133,512	142,304	145,493	151,453	711,839
Fire	133,054	120,125	123,389	113,910	107,197	597,675
Utilities	186,860	191,274	199,294	210,766	230,941	1,019,134
Total	\$635,789	\$625,213	\$654,340	\$669,473	\$703,217	\$3,288,033

## Sample X-Mod Calculation – Loss Ratios

Department	2011-12 to 2015-16 Payroll (00's)	2011-12 to 2015-16 Incurred Limited to \$100K	2011-12 to 2015-16 Inc \$100K Loss Ratio
Administration	\$169,689	\$5,748	0.034
Human Resources	65,498	52,538	0.802
Public Works	724,197	615,907	0.850
Police	711,839	506,316	0.711
Fire	597,675	39,948	0.067
Utilities	1,019,134	133,109	0.131
Total	\$3,288,033	\$1,353,566	0.412

## Sample X-Mod Calculation – Raw X-Mod

Department	2011-12 to 2015-16 Inc \$100K Loss Ratio	Relative Loss Ratio	Loss Weight	Remaining Weight	2017-18 Experience Modification Factor
Administration	0.034	0.082 ←	33.3%	66.7%	0.694
Human Resources	0.802	1.949 ←	16.2%	83.8%	1.153
Public Works	0.850	2.066 ←	68.1%	31.9%	1.726
Police	0.711	1.728 ←	67.7%	32.3%	1.493
Fire	0.067	0.162 ←	63.8%	36.2%	0.466
Utilities	0.131	0.317 ←	75.0%	25.0%	0.488
Total	0.412	1.000 ←			1.000

## Sample X-Mod Calculation – The Base Rate

---

Let's assume we have \$1 Million in costs to allocate.

If we just charged the same rate to each department, we could just divide the \$1,000,000 by the estimated 2017-18 payroll of \$80,000,000 to figure out the average rate.

$$\text{Base Rate} = \frac{\$1,000,000}{\$80,000,000/\$100} = \$1.25 \text{ per } \$100 \text{ of payroll}$$

# Sample X-Mod Calculation – Without Mod Factor

Department	2017-18 Payroll (00's)	Base Rate	Allocated Premium
Administration	\$41,686	\$1.25	\$52,107
Human Resources	15,977	1.25	19,972
Public Works	182,645	1.25	228,306
Police	170,645	1.25	213,306
Fire	129,392	1.25	161,740
Utilities	259,655	1.25	324,569
<b>Total</b>	<b>\$800,000</b>	<b>\$1.25</b>	<b>\$1,000,000</b>

## Sample X-Mod Calculation – With Mod Factor

Department	2017-18 Payroll (00's)	Base Rate	Exper Mod Factor	Off Balance Factor	Allocated Premium
Administration	\$41,686	\$1.25	0.694	0.995	\$35,987
Human Resources	15,977	1.25	1.153	0.995	22,912
Public Works	182,645	1.25	1.726	0.995	391,881
Police	170,645	1.25	1.493	0.995	316,719
Fire	129,392	1.25	0.466	0.995	74,961
Utilities	259,655	1.25	0.488	0.995	157,540
<b>Total</b>	<b>\$800,000</b>	<b>\$1.25</b>			<b>\$1,000,000</b>

**This is needed so we collect exactly \$1M**



## Sample X-Mod Calculation – Impact of X-Mod

Department	No X-Mod Allocated Premium	X-Mod Allocated Premium	Change	Percent Change
Administration	\$52,107	\$35,987	-\$16,120	-30.9%
Human Resources	19,972	22,912	2,941	14.7%
Public Works	228,306	391,881	163,575	71.6%
Police	213,306	316,719	103,413	48.5%
Fire	161,740	74,961	-86,779	-53.7%
Utilities	324,569	157,540	-167,029	-51.5%
Total	\$1,000,000	\$1,000,000	\$0	0.0%

You Did It Again !!

---

Now wasn't that cool...



## Minimizing Annual Swings

---

Within an existing plan, to minimize annual swings you can:

- Increase the number of years of loss experience
- Decrease the loss cap
- Decrease the weight given to loss experience

Other potential modifications to the x-mod plan include:

1. Set Max and Min X-Mod
2. Cap Annual Change in X-Mod (Min/Max)
3. Cap Annual Change in Premium (Min/Max)

**Note that capping implies subsidization!**

**i.e. Those with good experience pay more than they should, while those with bad experience pay less.**

## Other Cost Allocation Options

---

Other potential modifications to the x-mod plan include:

1. Paid versus Incurred Losses
2. Apply X-Mods only to Loss Portion of Premium
3. Differ Allocation Base by Premium Component
4. Fixed versus Variable Expenses
5. Adjust WC Exposure with WCIRB Class Rates
6. Minimum Premiums

## The Big Question...

---

### Does current cost allocation methodology make sense??

Reminder...

**There is no single “correct” cost allocation plan!**

Current Methodology...

- Has reasonable specified parameters
- Rewards good claim experience with lower premiums
- Uses loss caps and maximum weights for stability
- Has been in place for a number of years with Board acceptance

**But maybe some changes could be made to improve it...**

## Changing An Existing Plan

---

- May want to make changes to the plan if it appears that costs aren't being allocated fairly
  - Annual fluctuations too high, so may want to increase number of years
  - Certain departments or members having large loss issues, so loss cap might be too low
  - If everyone's rate is very close to the base rate, you may want to increase the loss weight.
- **When you make a change, half of the departments or members will be happy, the other half will call you to complain!**

# Time to Wake Up...Questions?



Ask an Actuary !

Call 1-800-[(10x)<sup>2</sup>-2x+34]

$\sqrt{-1}$  ❤️  
**MATH**