

# Risk-informed Decision Framework

## Implementation Issues

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Presented to the CPUC

Safety Model Assessment Proceeding

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Dr. Sam L. Savage is Executive Director, ProbabilityManagement.org,  
Inventor of the SIP, a data structure that connects simulations, and  
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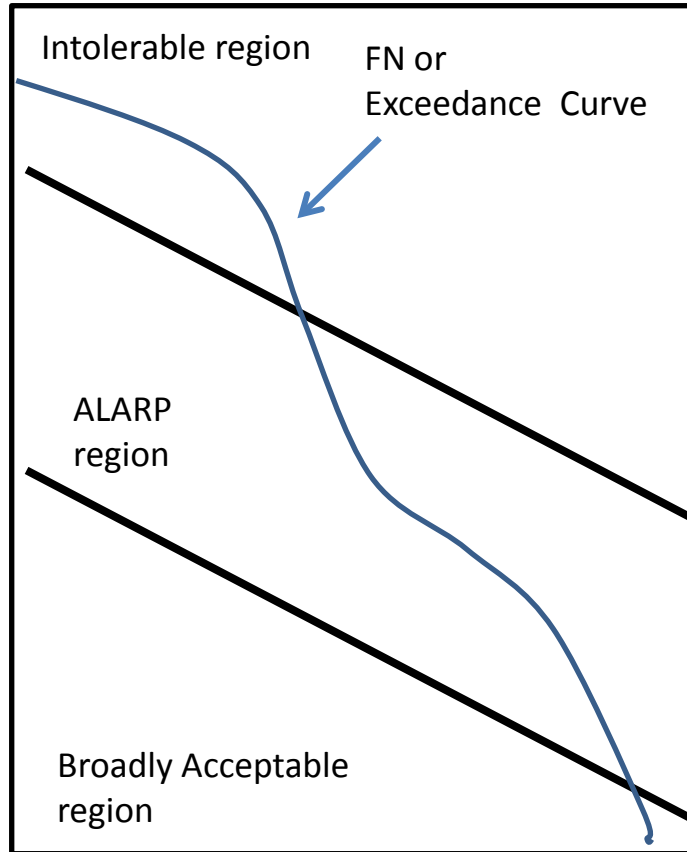
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“Success is a journey, not a destination. The doing is often more important than the outcome”

*Arthur Ashe – Tennis Champion*

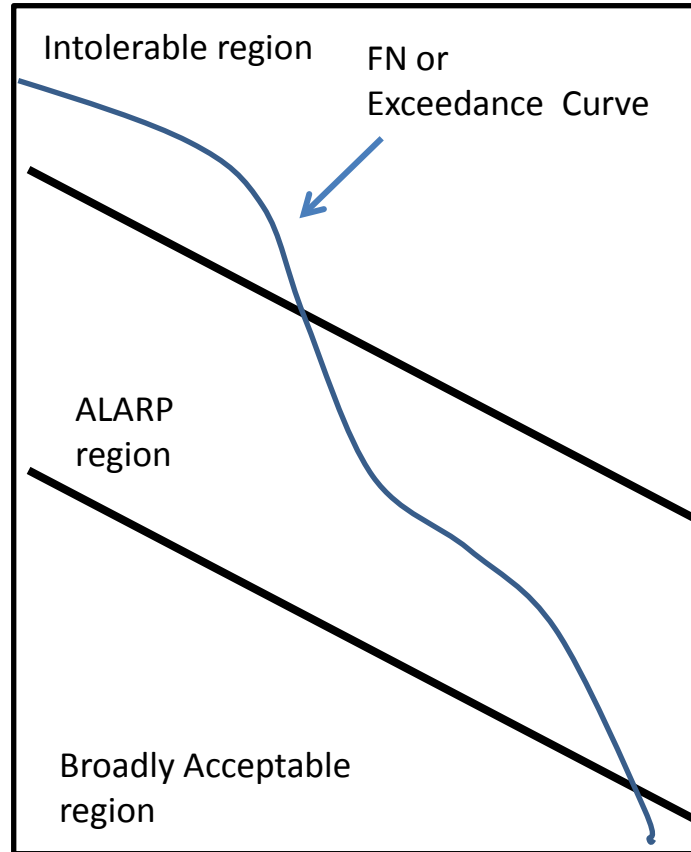
The same can be said of developing a Risk-informed Decision Framework. The doing will increase safety along the way.

# Deconstructing ALARP

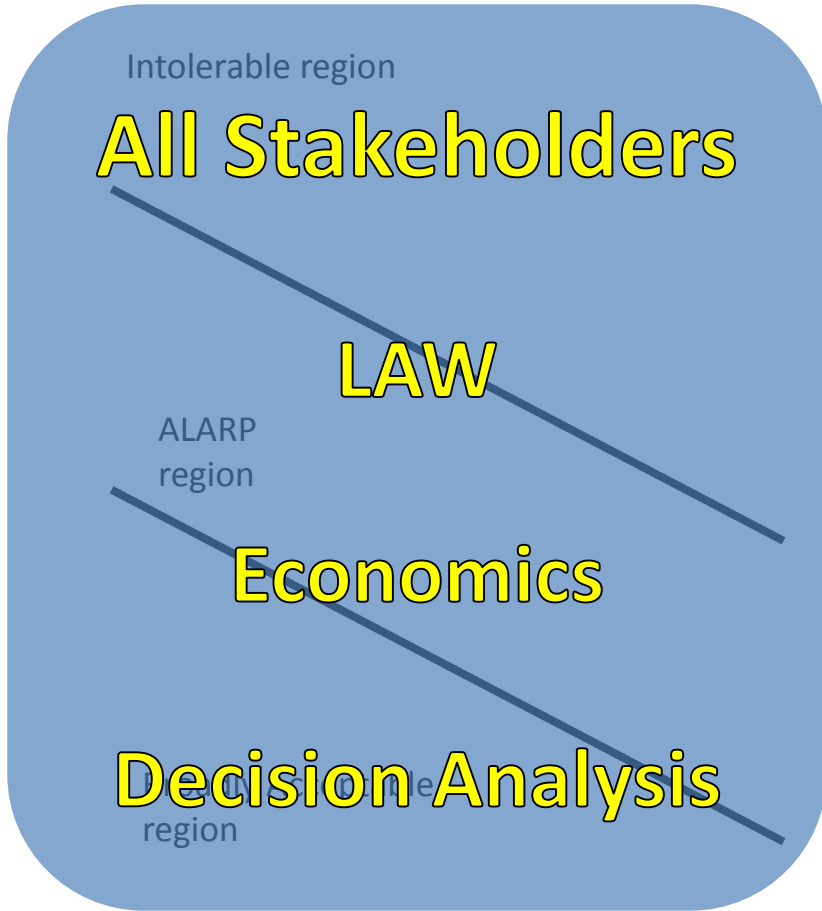


# Decision Framework

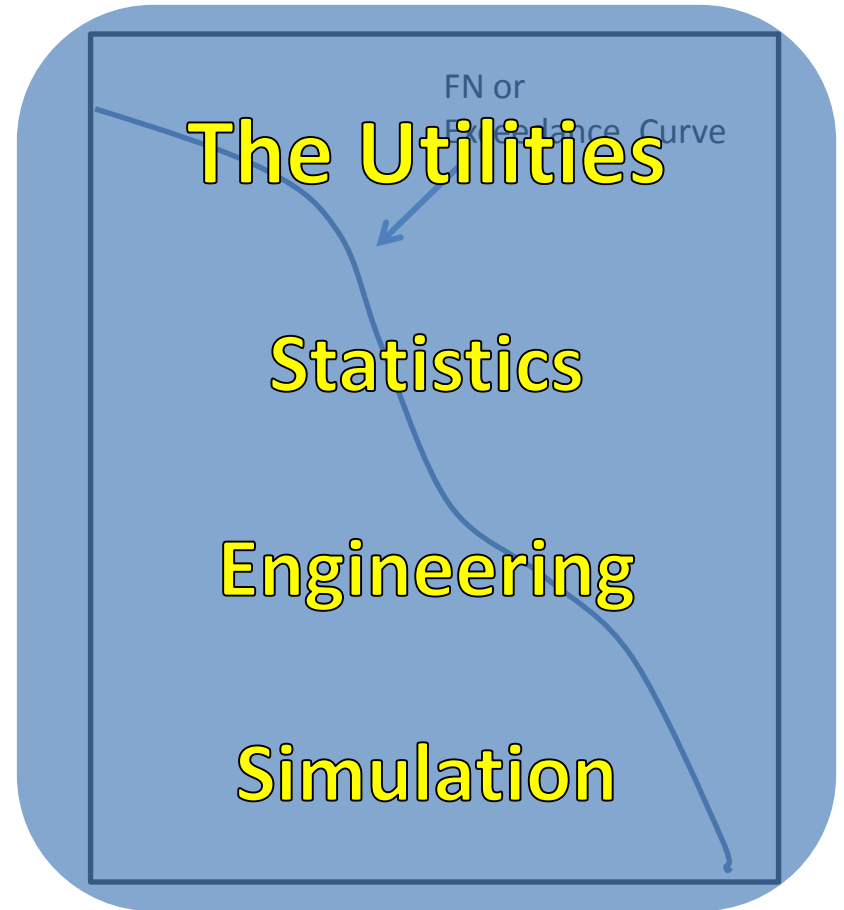
# Aggregated Risk Model



# Decision Framework



# Aggregated Risk Model



# Decision Framework

Intolerable region

- ~~ALARP~~
- ~~Multi-attribute Utility~~
- ~~Pareto Optimal Tradeoffs~~
- ~~Efficient Frontiers~~

Broadly Acceptable region

# Aggregated Risk Model

Probably Impossible...  
Statistics

... Until a couple of years ago  
Simulation

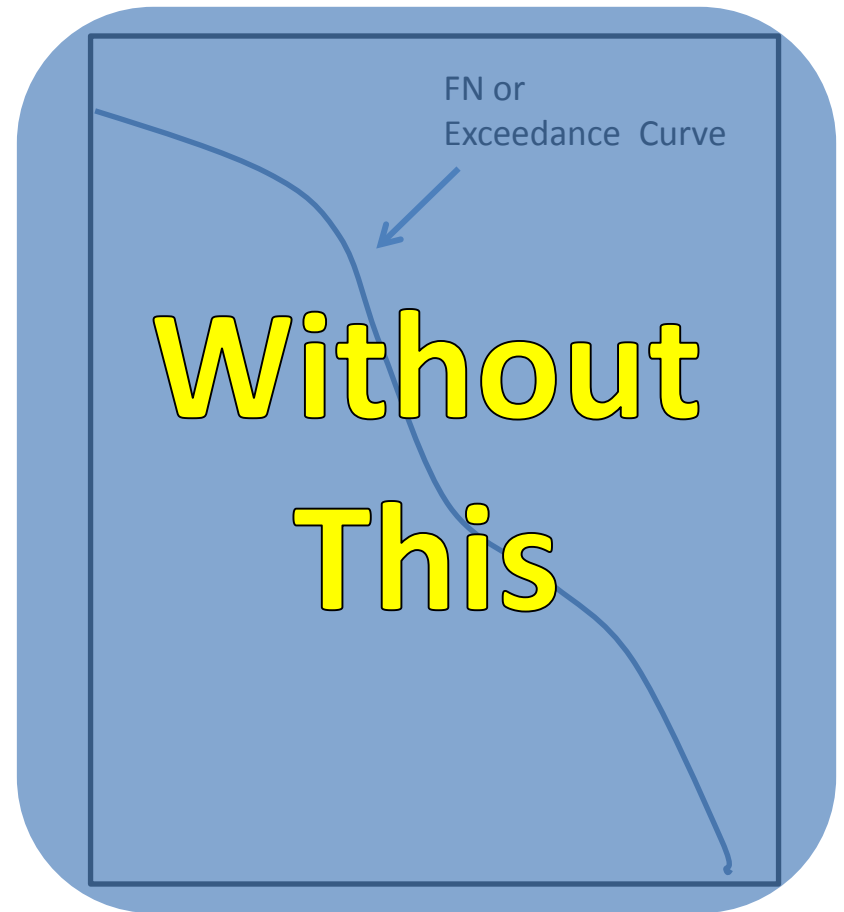
FN or  
The Utilities Curve

Engineering

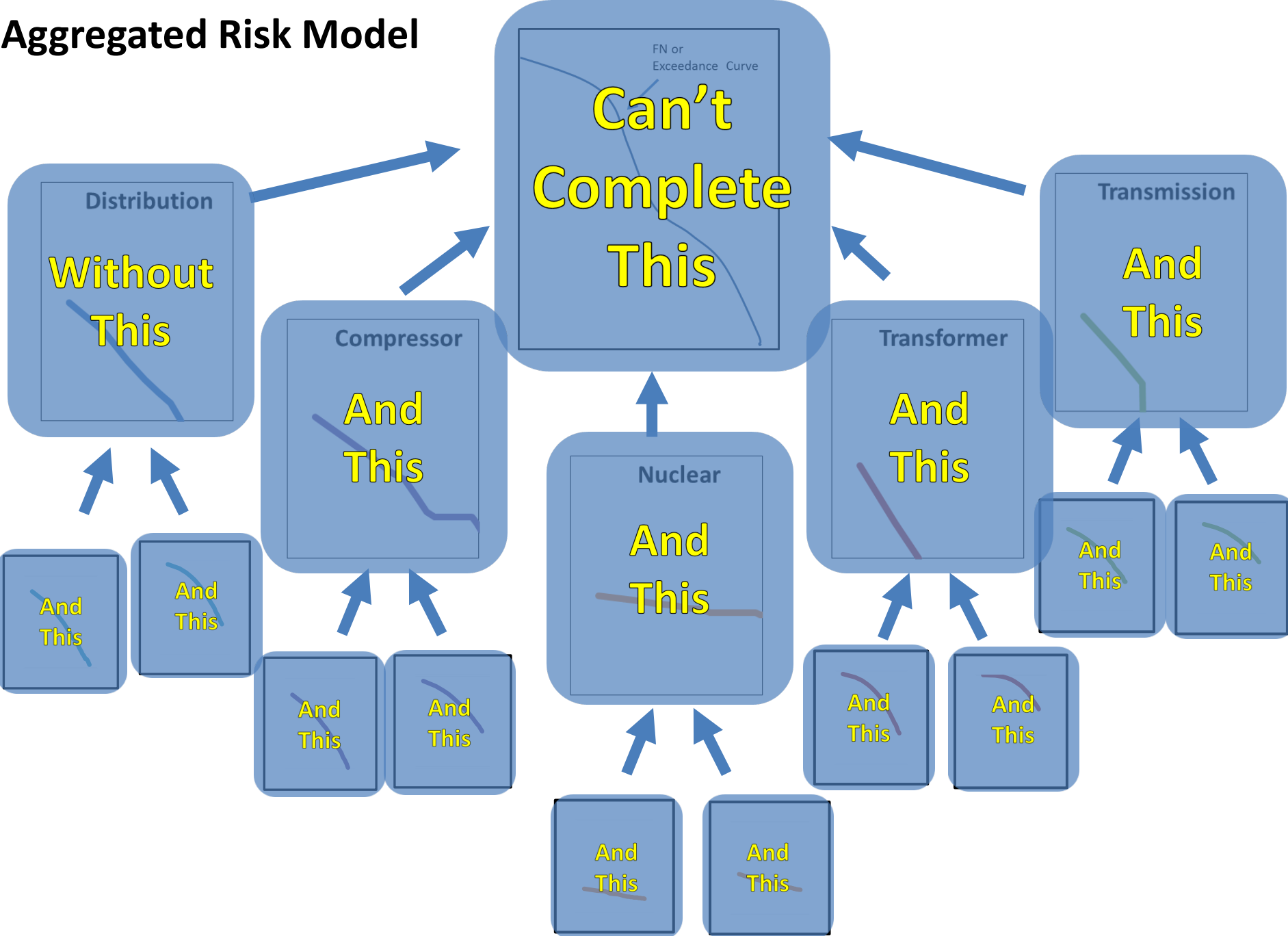
# Decision Framework



# Aggregated Risk Model



# Aggregated Risk Model





New open data type (the SIP) CONNECTS risk models so they may be

- Aggregated across the enterprise
- Audited
- Shared across platforms, no new software required

*Freely available standard promulgated by a  
501(c)(3) nonprofit*

# Example: Aggregating PHMSA Pipeline Leak Data

# PHMSA

Pipeline and Hazardous Materials Safety Administration

U.S. Department of Transportation

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Enter Search Term(s):



**PHMSA Announces over \$54 Million in Pipeline Safety Grants to Support State Pipeline Safety Programs**

1 2 3 4 5

## News & Updates

- ▶ [PHMSA Issues Second Amendment to Plains Pipeline Corrective Action Order](#)
- ▶ [DOT Announces Response to Appeals of High-Hazard Flammable Trains Rule](#)
- ▶ [DOT Issues New Flight Safety Rule for E-Cigarettes](#)
- ▶ [Hazardous Materials: Carriage of Battery-Powered Electronic Smoking Devices in Passenger Baggage](#)
- ▶ [PHMSA Completes Investigation of ExxonMobil Pegasus Failure; Issues \\$2.6M Fine](#)
- ▶ [PHMSA Proposes New Safety Regulations](#)

## PHMSA Updates

## PHMSA Resources

Regulations

# Example: Aggregating PHMSA Pipeline Leak Data

<https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?PortalPages>

Year ▲ ▼	HCA Miles	Leaks per 1,000 HCA Miles	Non-HCA Miles	Leaks per 1,000 non-HCA Miles
2014	19,822.89	9.58	279,075.33	3.95

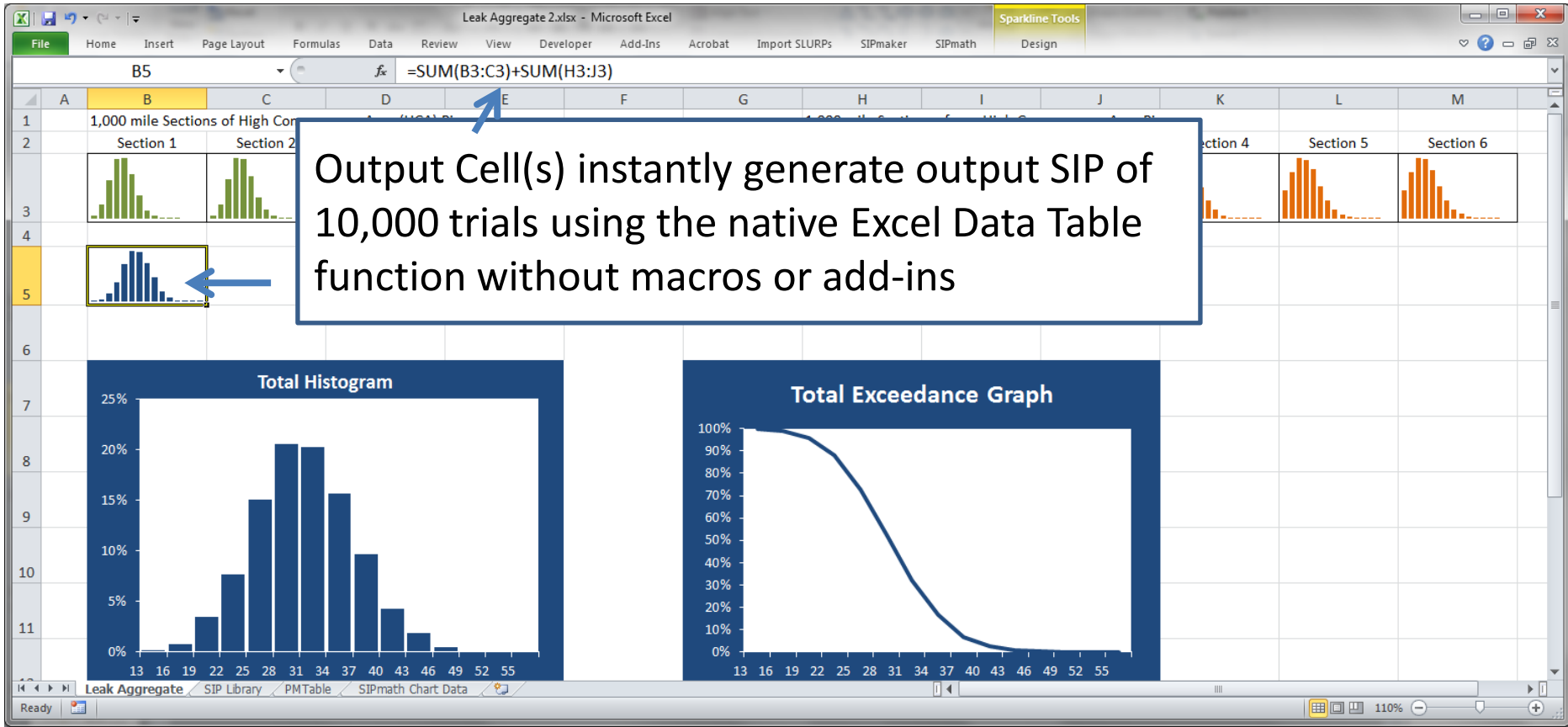
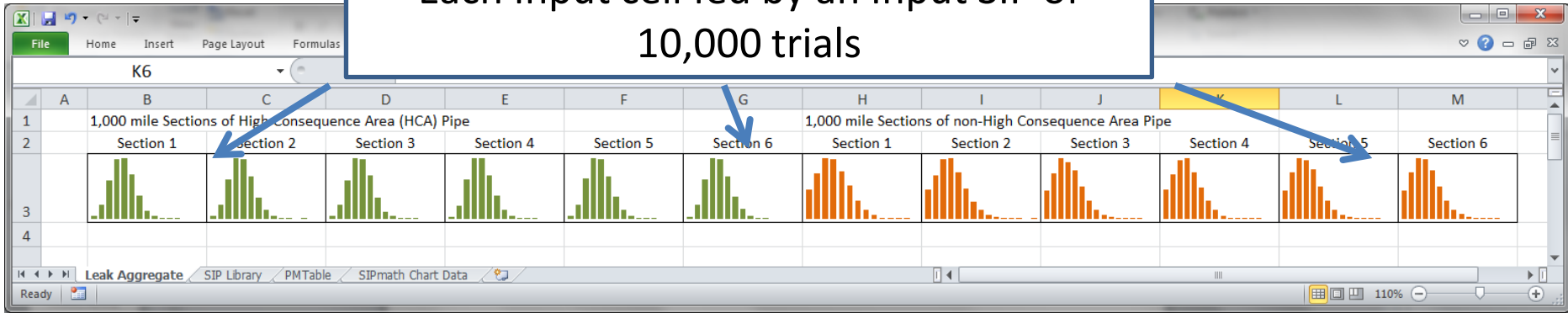
**SIP** (array of thousands of potential outcomes)  
With an Average of 9.58

SIP of HCA

Trial	Leaks/1,000 mi./yr.
1	13
2	6
3	11
:	:
3,861	24
:	:
9,998	13
9,999	9
10,000	7

<== Max, one in 10,000 year event

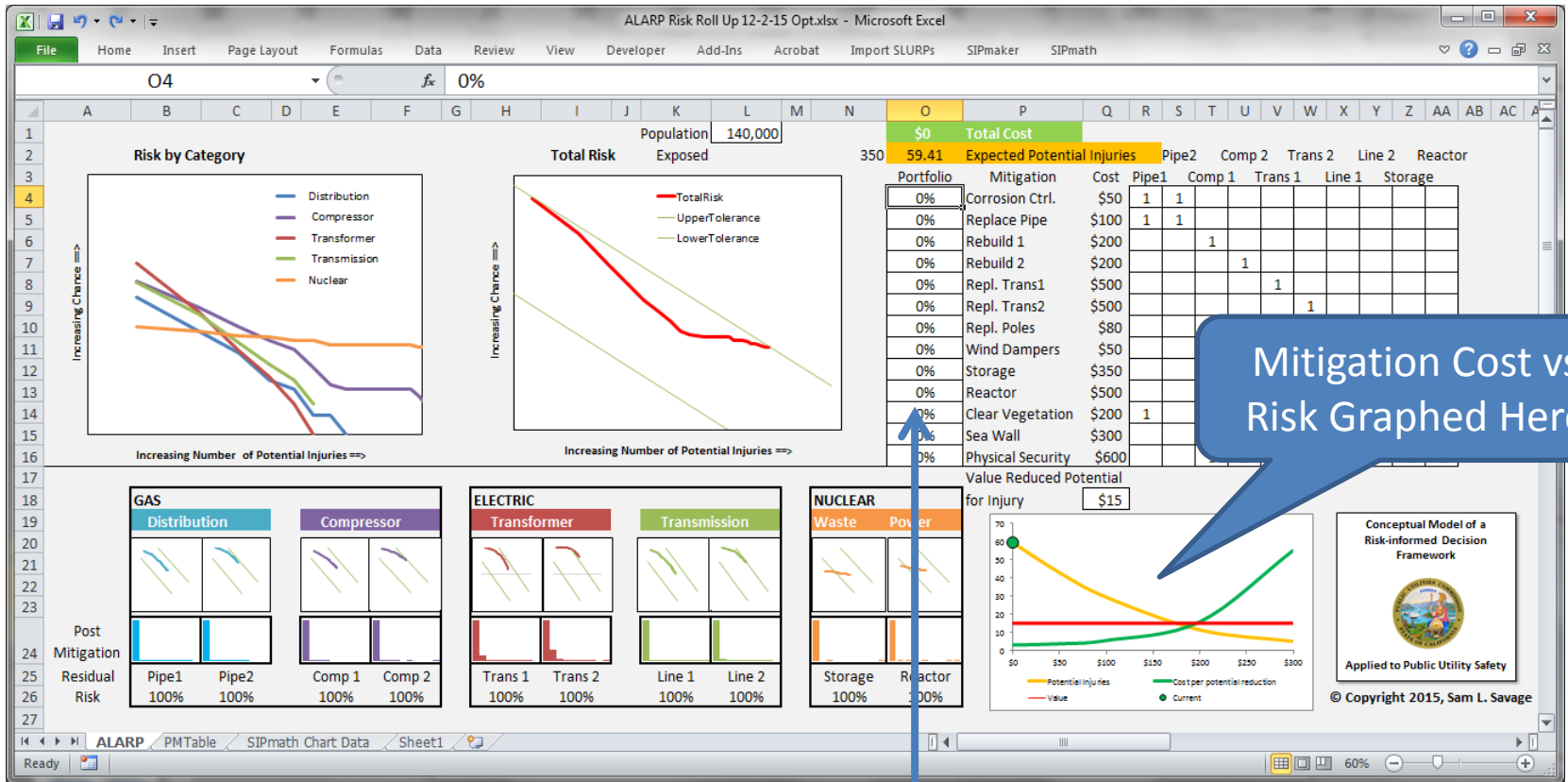
Each Input cell fed by an Input SIP of 10,000 trials



# Proof of Concept Model

Demonstrates Risk-informed Decision Framework based on greatly simplified assumptions and hypothetical data.

# 10,000 trials are rolled up to enterprise wide FN (Exceedance) Curve

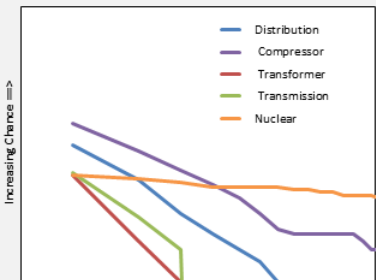


Mitigations may be experimented with (or optimized) in Column O

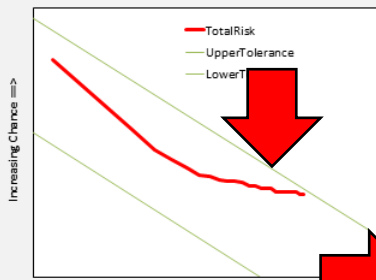


O15 25%

Risk by Category



Total Risk



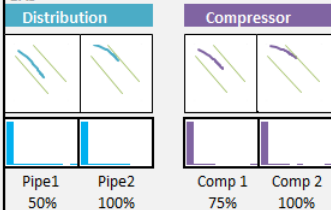
Population 140,000

\$175 Total Cost

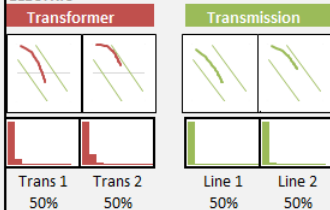
350 Expected Potential Injuries

Portfolio	Mitigation	Cost	Pipe1	Comp 1	Trans 1	Line 1	Storage	Pipe2	Comp 2	Trans 2	Line 2	Reactor
0%	Corrosion Ctrl.	\$50	1	1								
0%	Replace Pipe	\$100	1	1								
0%	Rebuild 1	\$200			1							
0%	Rebuild 2	\$200				1						
0%	Repl. Trans1	\$500							1			
0%	Repl. Trans2	\$500								1		
0%	Repl. Poles	\$80									1	1
0%	Wind Dampers	\$50									1	1
0%	Storage	\$350										1
0%	Reactor	\$500										1
50%	Clear Vegetation	\$200	1						1	1	1	1
25%	Sea Wall	\$300			1							1
0%	Physical Security	\$600			1	1	1	1	1	1		1

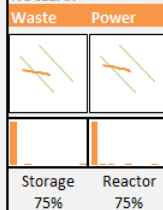
GAS



ELECTRIC

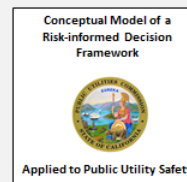
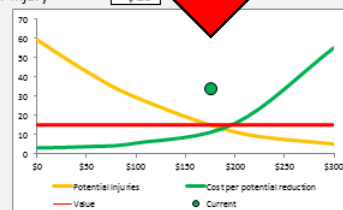


NUCLEAR



Value Reduced Potential for Injury

\$15



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# The Open **SIPmath Standard** allows risk models to talk to each other

Promulgated by ProbabilityManagement.org, a  
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L O R I N G  W A R D

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- Foundation for Creativity in Dispute Resolution

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