

*International Explosives Safety Symposium &  
Exposition*

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# IMESAFR Science Panel

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# Topics

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- ❖ Key Organizations
- ❖ Perspective on ATD/QRA
- ❖ Science Panel
  - ❖ Purpose
  - ❖ Work Examples
  - ❖ Current Work
  - ❖ Field Testing
  - ❖ Future Work

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# Safety and Security

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**IME**

**institute of makers  
of explosives**



6,000,000,000  $\frac{lb}{yr}$

98%

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# Acceptable Risk Criteria

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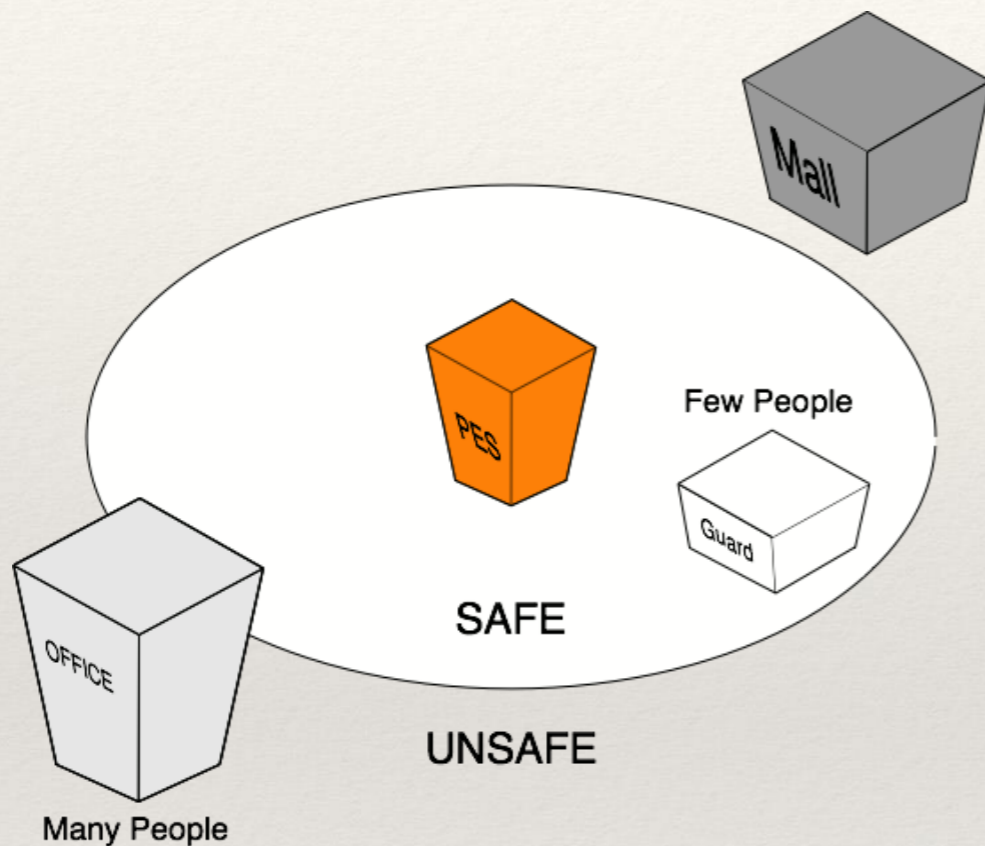
- ❖ Requested an individual acceptable risk criteria of  $1E-6$  from ATF in 2017

# Safety and Security of Explosives in Storage

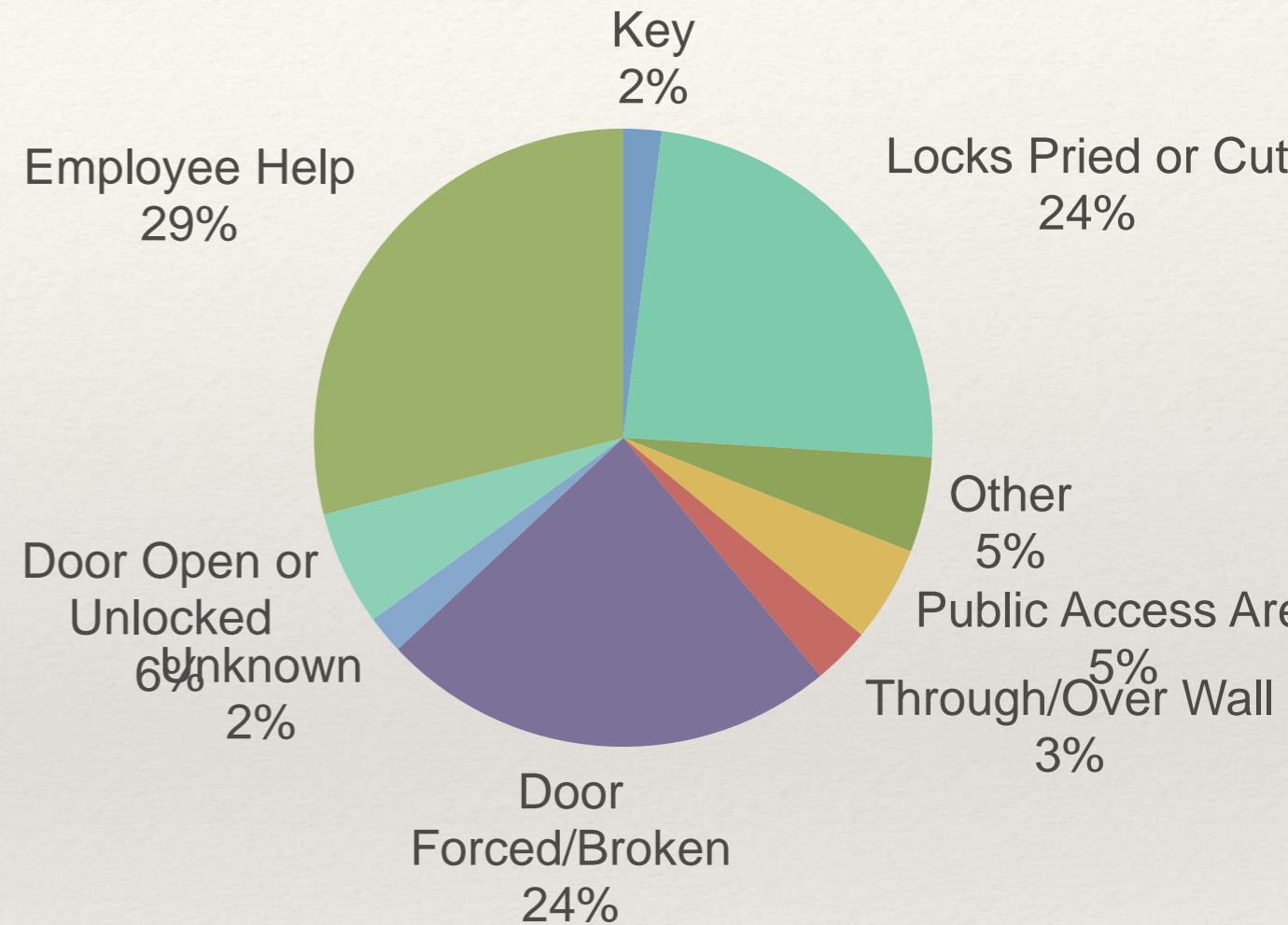


# American Table of Distances

Adopted by U.S. Government in 1923  
 Adopted by ATF in 1971



# Magazine B&E





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# American Table of Distances

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- ❖ System is based on mid 19th and early 20th century explosives and storage.
- ❖ Cannot minimize the risk - ATD is binary (safe/unsafe)
- ❖ There is no regulatory incentive for improvements in explosives or explosive storage



# Quantitative Risk Assessment (QRA)

- ❖ Supported by testing (modern storage & explosives)
- ❖ It spatially quantifies the risk to the public and employees
- ❖ Credit is given to the industry for improving the safety of their explosives and improving explosive storage.



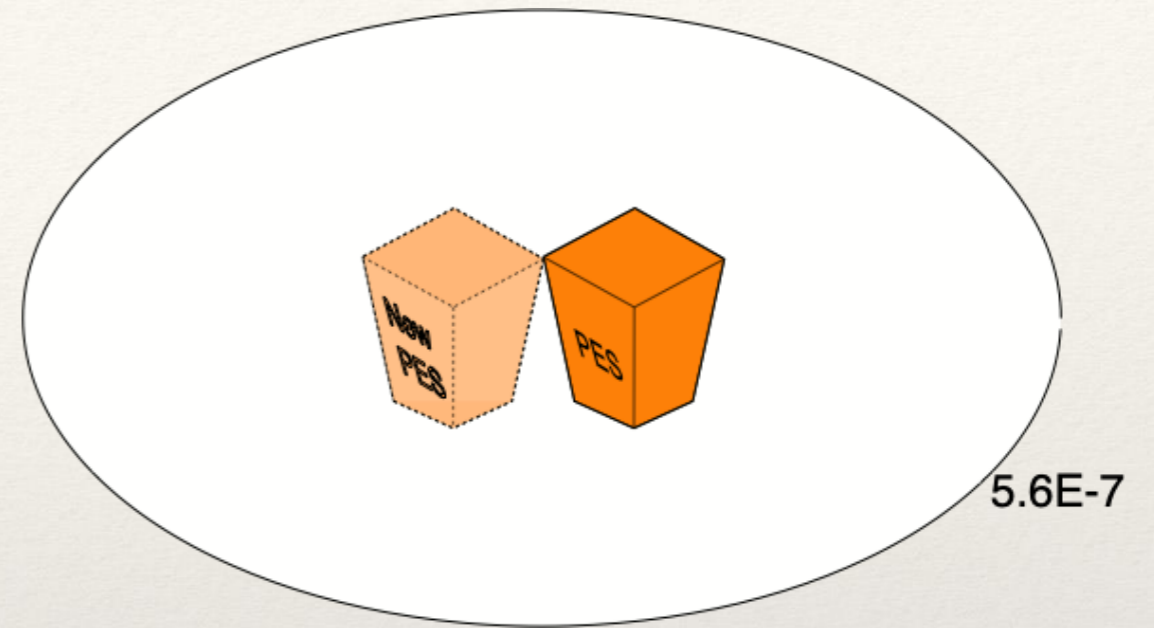
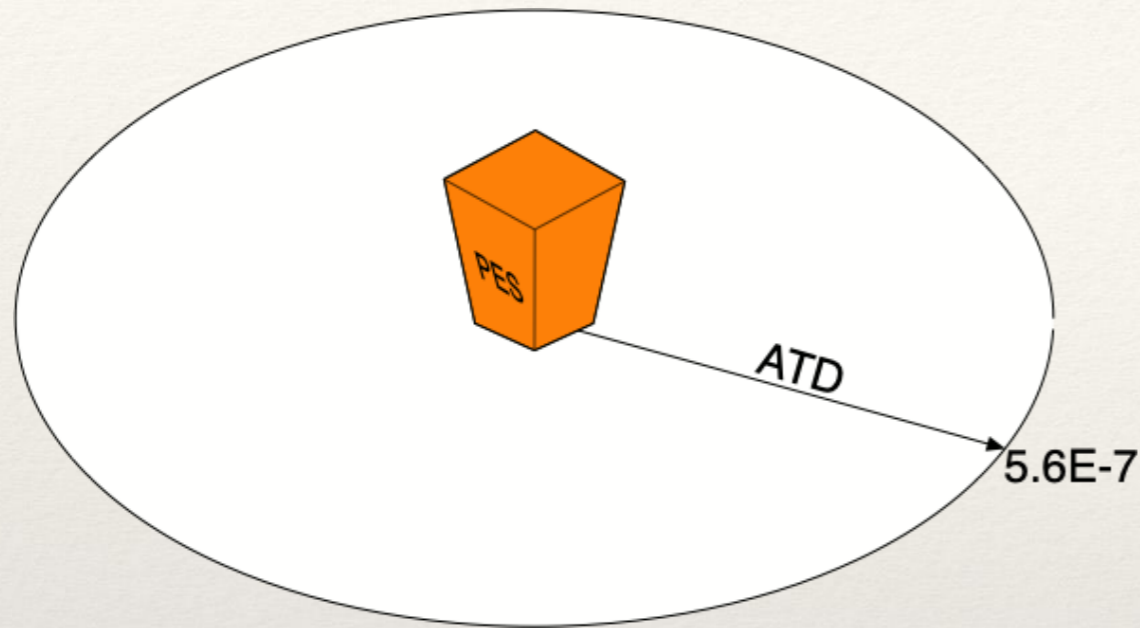
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# ATF and QRA

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- ❖ 2014 ATF has accept QRA applications
- ❖ Handled as a waiver
- ❖ 8-9 waivers approved since 2014
- ❖ Use a Risk Bank Method for criteria
- ❖ IME Requested ATF Accept  $1E-06$  Individual Risk Criteria
- ❖ ATF Requested a Review of Pe Model in IMESAFR





# Risk Bank Method

1. Set risk based on ATD
2. New storage must meet old risk level to use QRA.



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# APT Research

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- ❖ Support contractor for the RBESCT<sup>1</sup> since its inception
- ❖ DDESB<sup>2</sup> chose to implement a technology transfer to help IME begin the IMESAFR project
- ❖ Developed IMESAFR Tool



**US DoD**

**Risk  
Based  
Explosives  
Safety  
Criteria  
Team**

APT has supported the RBESCT since 1997 as SMEs on QRA and explosives effects and consequence modeling, and serves as the software developers of SAFER.

**SAFER**

First released in 1998



**A-P-T Research, Inc.**

APT is an employee-owned company, headquartered in Huntsville, AL, specializing in providing safety services.

**INSTITUTE OF  
MAKERS OF  
EXPLOSIVES**

APT has supported IME since 2005 as SMEs on QRA and explosives effects and consequence modeling, and serves as the software developers of IMESAFR.

**IMESAFR**

First released in 2007

*Lorem Ipsum Dolor*

# Development of QRA for DDESB and IME

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# IMESAFR Science Panel

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A-P-T RESEARCH, INC.  
AN EMPLOYEE-OWNED COMPANY

**IME**

**institute of makers  
of explosives**



**Natural Resources Canada**

**MISSOURI  
S&T**

University of  
Science & Technology



**Transportation  
Security  
Administration**

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# IMESAFR Science Panel

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- ❖ ISP was founded at the request of and funding from the ATF
- ❖ Mirror the Science Panel role for the DDESB but for commercial explosives
- ❖ The two components of that role are:
  - ❖ Identify potential improvements to IMESAFR
  - ❖ Provide technical evidence to support any proposed changes/additions
    - ❖ This is particularly true when the proposed change will reduce conservatism
- ❖ The ISP has provided significant benefit to/improvement of IMESAFR
  - ❖ Recommendation to add Bin G
  - ❖ Recommendation to add more debris blockage
  - ❖ Review of Probability of Event (in-progress)
  - ❖ Recommendation to maintain current uncertainty model
  - ❖ Will add more subjects, e.g. frangible walls
- ❖ The ISP provides support for testing



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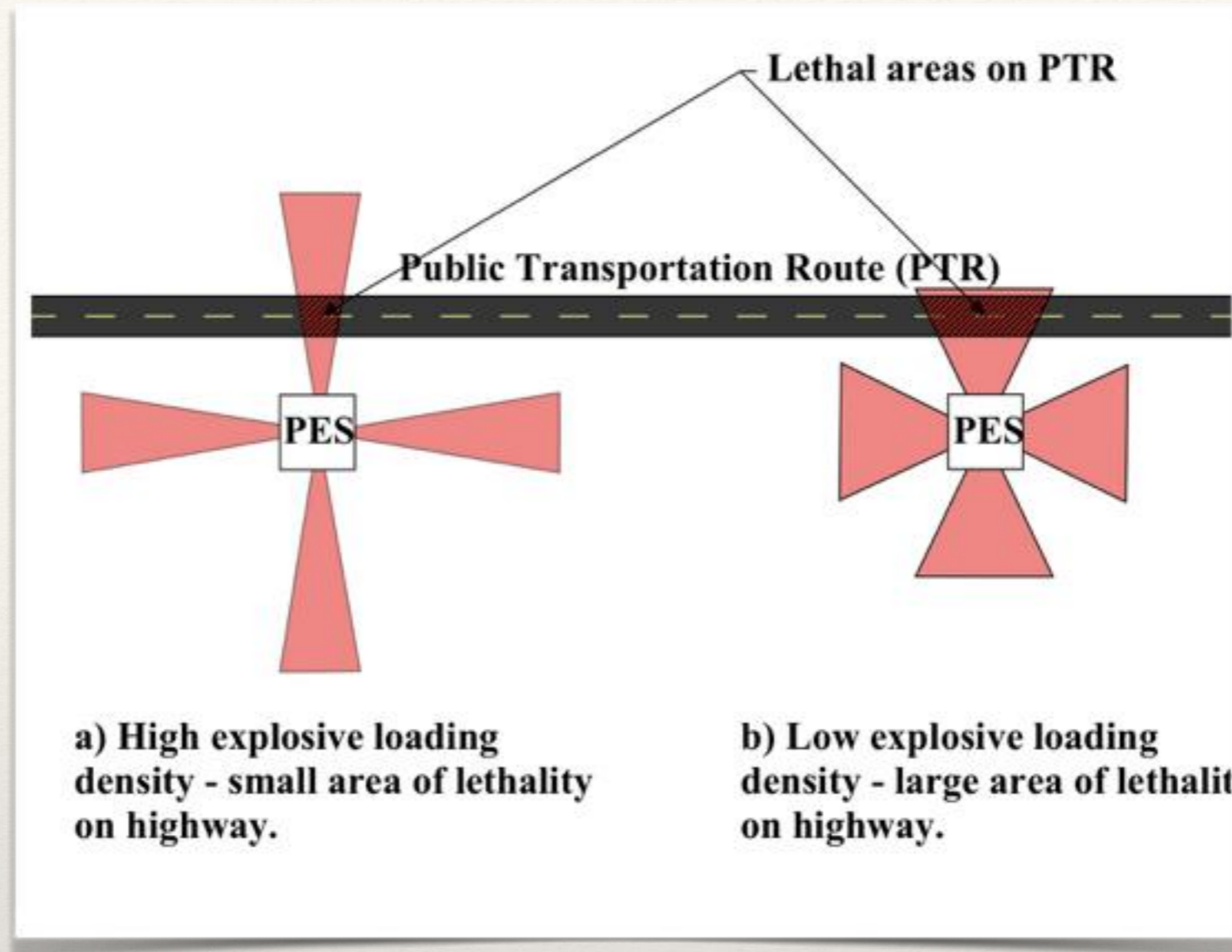
# Conservation of Mass - Debris

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- ❖ Test Programs Have Indicated
  - ❖ Not all Debris is Recoverable
  - ❖ Some Debris Too Small to be Lethal at Any Range
  - ❖ Dependent on Structure Type

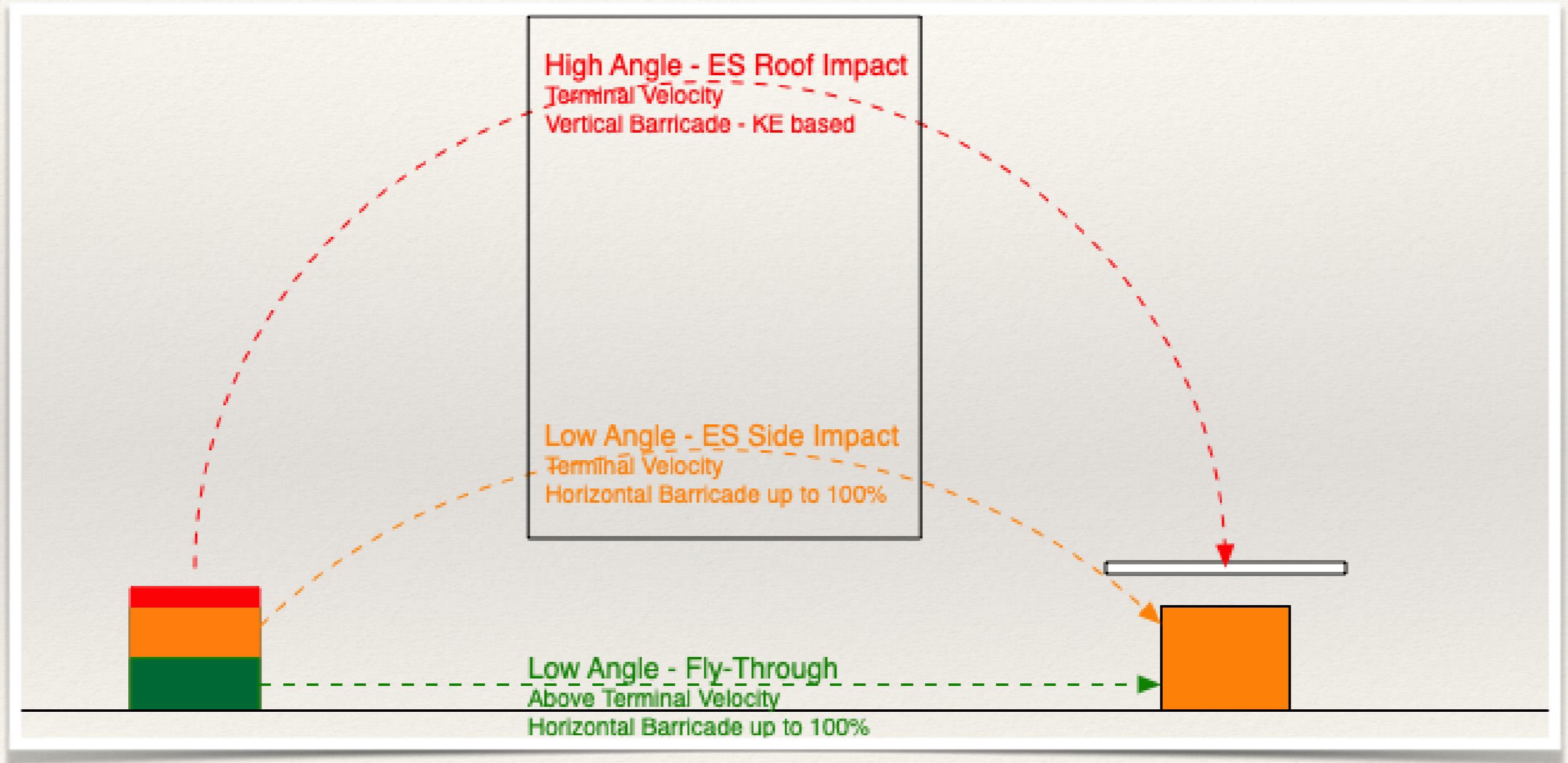
# Mass Distribution

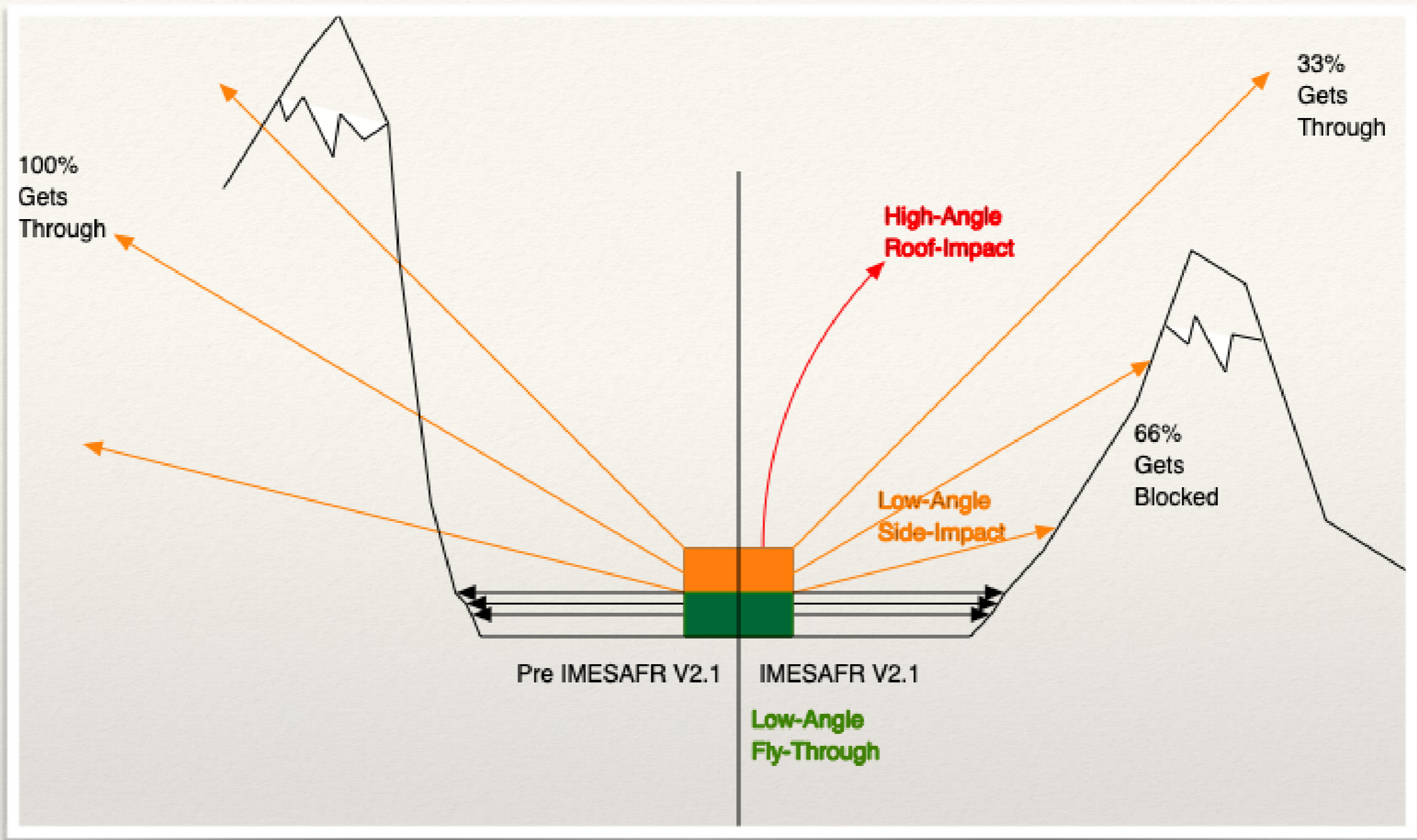
Material Type % Total Mass	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5	Bin 6	Bin 7	Bin 8	Bin 9	Bin 10	Bin G
Standard Concrete	0.00	0.43	2.49	5.63	5.81	5.82	4.52	4.66	4.62	5.24	60.78
Thick Concrete	3.64	3.35	4.63	6.31	7.56	8.1	8.06	7.77	7.51	7.52	35.55
Wall Rebar	0.00	57.6	29.7	10.1	2.00	0.50	0.10	0.00	0.00	0.00	0.00
Composite Roof	45.6	17.0	10.5	8.10	3.70	4.60	3.50	3.20	1.90	0.90	1.00
AGBS	0.00	4.00	4.00	8.00	32.0	8.00	4.00	4.00	4.00	12.0	20.0
HCT Wall	0.75	1.50	2.25	3.00	3.75	4.50	6.00	4.50	3.00	0.75	70.0
HCT Roof	0.00	0.00	1.50	1.50	1.50	4.50	6.00	7.50	4.50	3.00	70.0
ISO	34.0	12.0	10.0	10.0	8.00	9.00	6.50	5.00	2.70	1.40	1.40
Ship and Steel ECM	50.0	12.5	10.0	9.70	6.30	6.20	3.10	1.60	0.50	0.10	0.00
PEMB	30.6	11.8	10.5	10.3	8.50	9.90	6.80	5.60	3.10	1.50	1.40



# PTR Logic

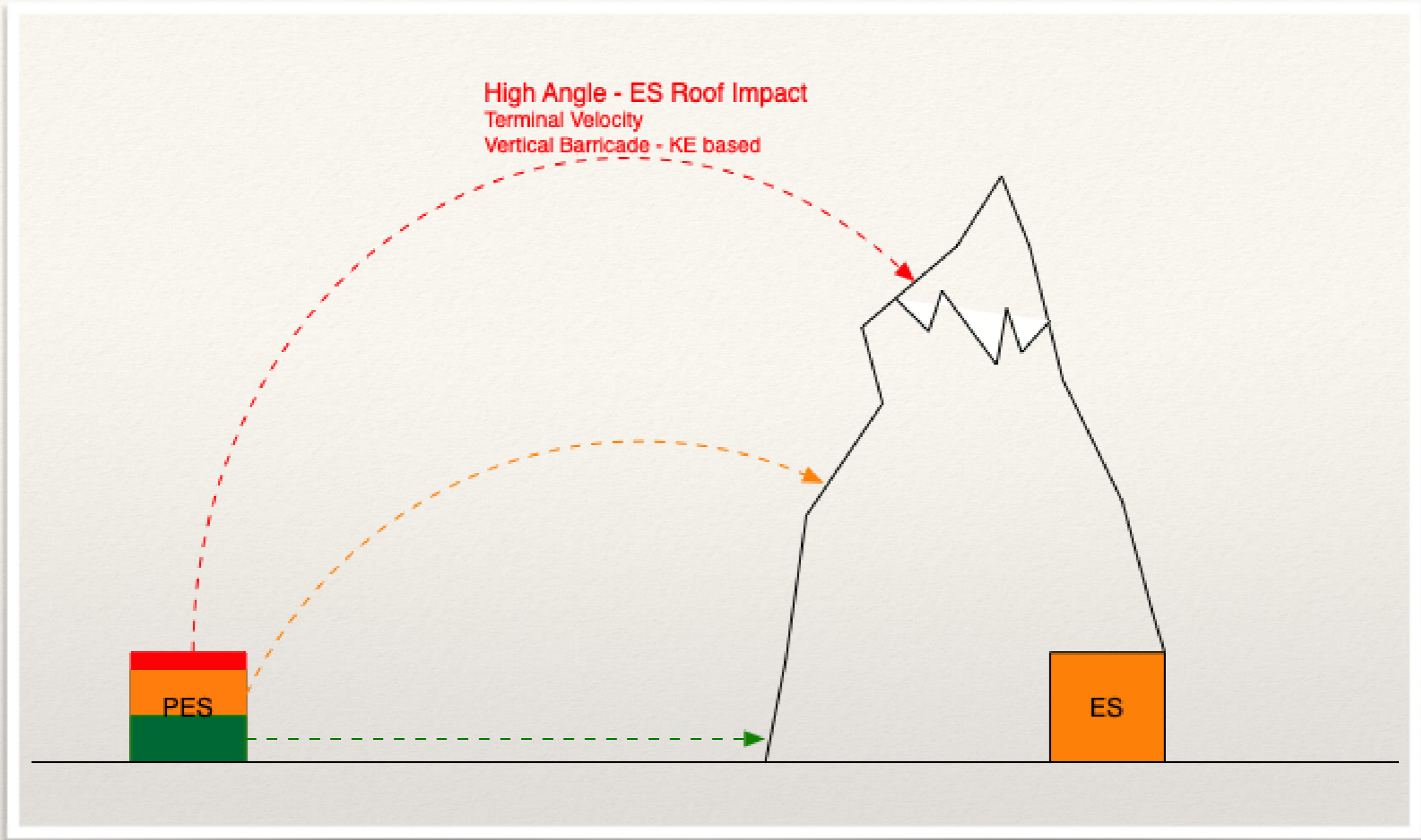
# Debris Barricades





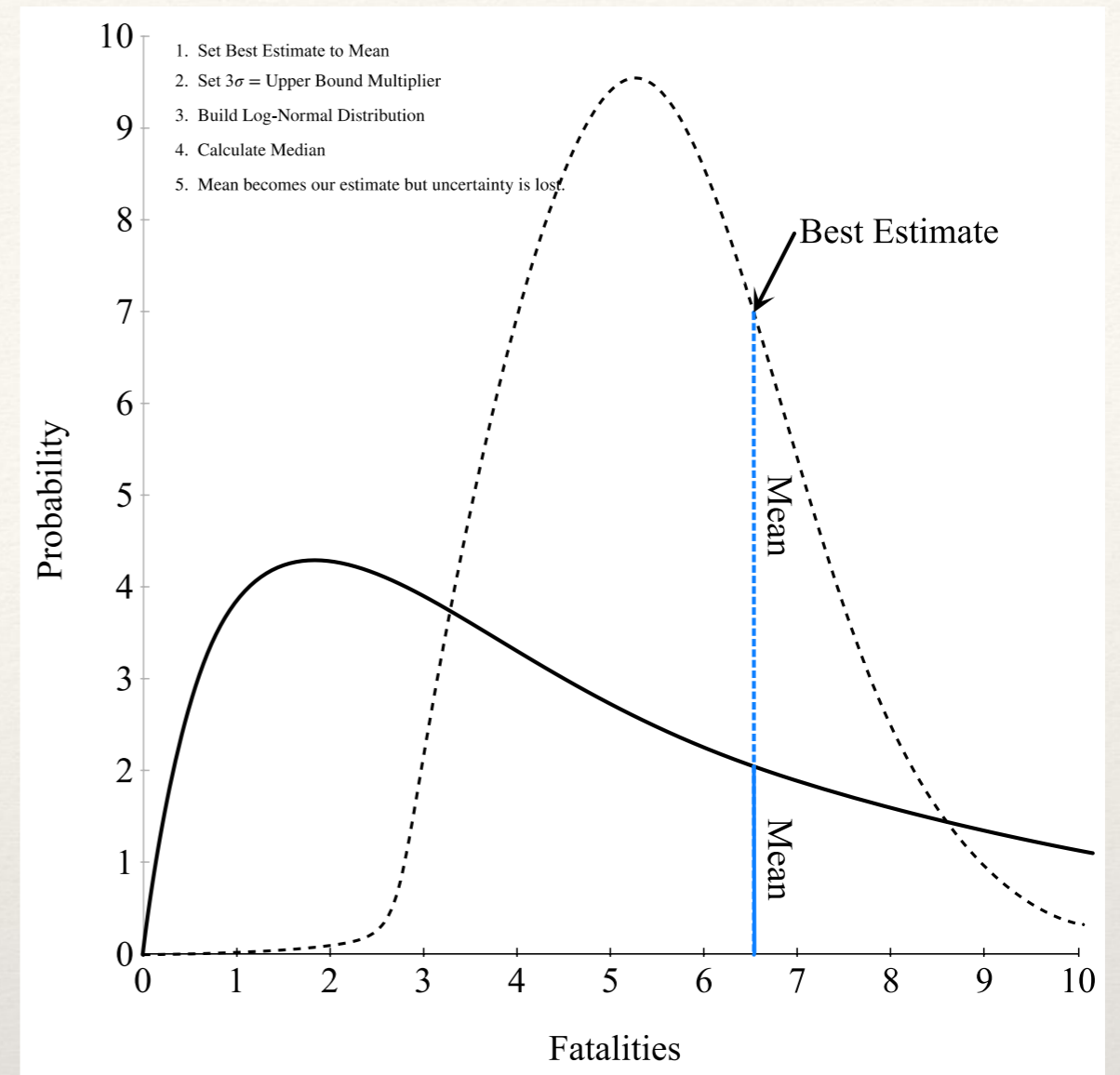
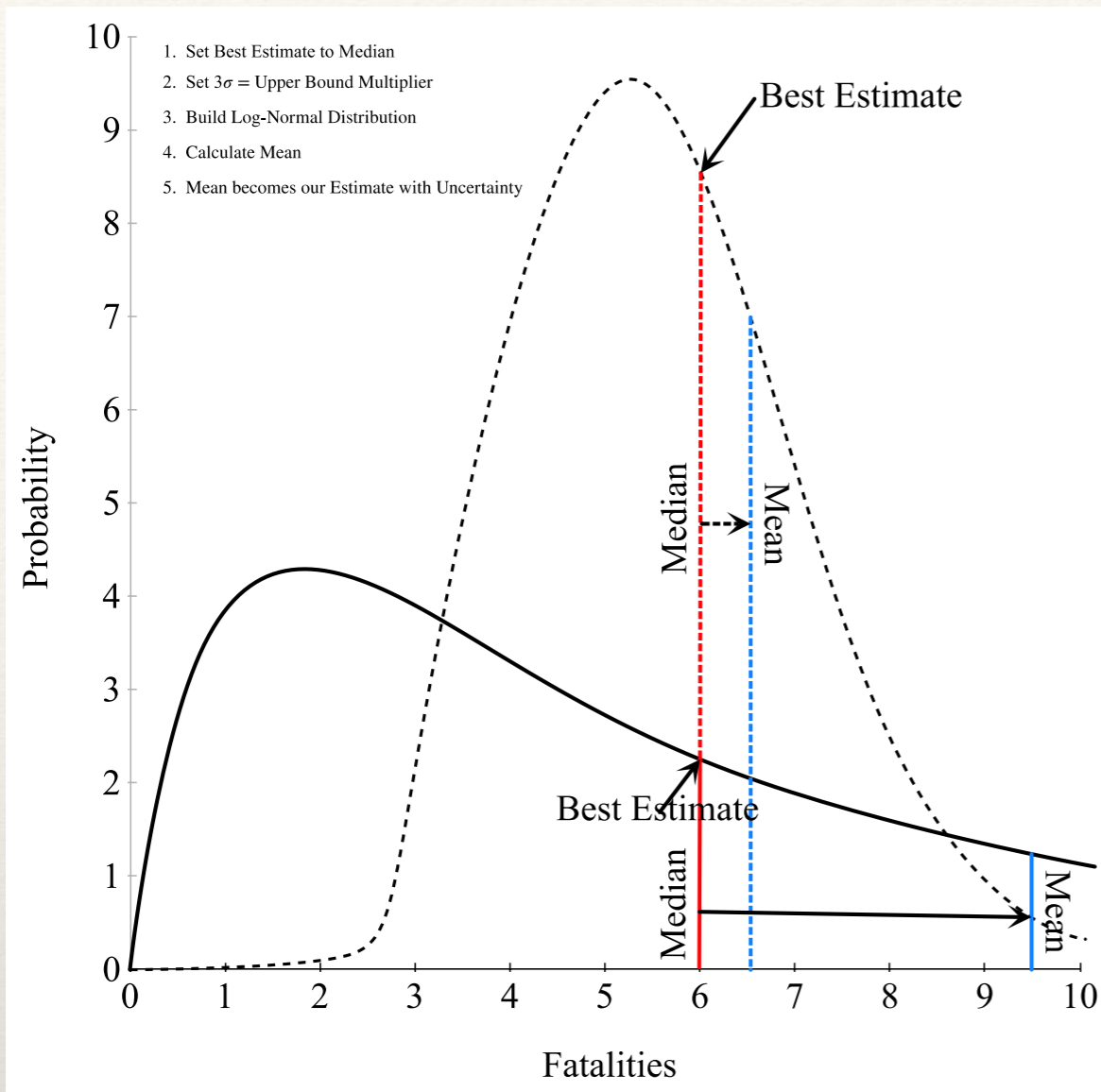
# Side Impact Debris Barricades

Allows the user to specify what percent of the side-impact debris is blocked (up to 100%)



# Vertical Debris Barricades

Allows the user to specify the KE “blocking power” of the barricade



# Uncertainty

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# Numerical Risk Criteria

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- ❖ Just like Q/D, QRA requires a pass/fail (possibly with shades of grey) standard
  - ❖ Three level paradigms, e.g. Pass/ALARP<sup>1</sup>/Fail, are recognized
- ❖ Science Panel supports:
  - ❖ Individual Risk 1E-06
  - ❖ Group Risk 1E-05
- ❖ Catastrophic Risk Aversion criteria are not widely published/used
- ❖ The IME proposed individual risk of 1E-06 to the ATF
  - ❖ The ATF has requested an external review of the  $P_e$  methodology
  - ❖ This has been completed and the SP will make a recommendation to ATF.

1. as low as reasonably practicable



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# Test Program

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- ❖ Whenever possible, the IMESA FR algorithms are either based on large scale test data or validated by such data
- ❖ The Development Team put together a Maturity Matrix several years ago
  - ❖ The Matrix shows program areas where bigger or more critical gaps exist
  - ❖ From this a test program is generated
    - ❖ Large scale tests are expensive and difficult to organize and carry out
    - ❖ The assistance of the ATF on the ISP is hugely beneficial
- ❖ The current test program includes:
  - ❖ Iron Warrior IV (completed, IME 'piggyback')
  - ❖ AN Railcar (very soon, IME 'piggyback')
  - ❖ Overhead silo (blasting agent, ATF/IME, 2019(?))
  - ❖ Perforating guns (IME, 2019(?))
  - ❖ ATF Magazine

# Questions