

A

+ Safety Case +

for
Haul Truck
Brakes

Braking throughout the Ages

Keith Larsen
Manager,
Engineering Services Dept

Hastings Deering (Australia) Ltd ■



A member of the  Sime Darby Group



Product People Commitment.

+ Safety Case +

A Tool to Prove Safety of Use of the Specifics Determined in the Case

Confines
of the
Case...

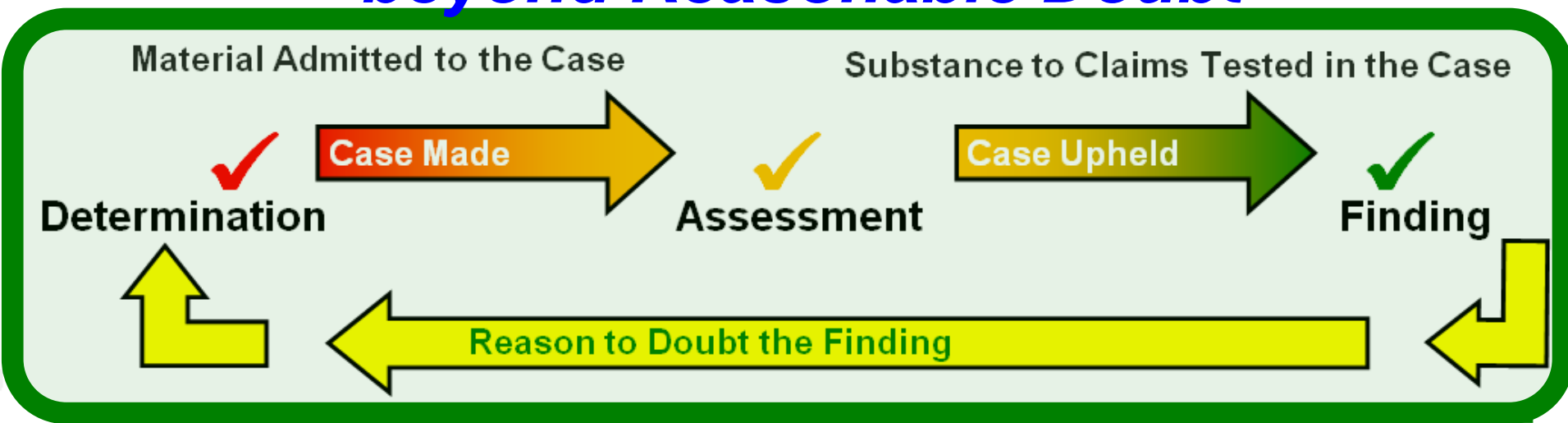


not **all**
Material
Admitted



+ Safety Case +

*The Brake Safety Case Report
is a Tool to provide
Proof of Continued Brake Effectiveness
beyond Reasonable Doubt*



Confines
of the Case...

not all Material
Admitted

Reason to Doubt is a test of the

+ Safety Case +

Used How?



*To allow
High Consequence
Workplaces*

Reason (Excuse)

*To allow
Major Hazard
Facilities*

*To allow
Advanced
Technology
Critical Systems*

+ Safety Case +



To keep away from the Edge of the Abyss
Away from the limit of recklessness

+ *Safety Case* +

Should demonstrate ongoing *Proof of Safety* of *High Consequence Workplaces* well away from the *Edge of the Abyss*.

The *proof of safety* provided also provides the “*Excuse*” Permit or Licence for operating such workplaces.

Safety Case Proof is Ample Excuse to use Haul Trucks on Steep Grades

Excuses are already implicit, but in
next year's Model WHS laws
Excuses are more explicit...

They specifically require us to be
able to have ***Excuses*** for providing
High Consequence Workplaces.

Proof of Zero Harm

Proof of Zero Harm is a presumption of proof of Continued Brake Effectiveness in the case.

***Zero is not “a one in 10^6 chance”.
Zero is Zero achieved by relentless commitment to excellence over normal expectation of failure against a standard of proof...***

(we say is Beyond Reasonable Doubt)

How ?
→

Brakes !

What
Why
& How
We
prove
Zero
Harm

System Specific

+ Safety Case +

Report

Proof of Continued Brake Effectiveness

- *Applies to Cat 793D Trucks supported by Hastings Deering.* ✓
- *Continued Brake Effectiveness proven - the Case Rests.* ✓
- *Zero Harm proven as a presumption in the Case.* ✓



Zero means taking Control of Probability

■ **Unplanned - Normal**

Useless
Outcomes

Edge of Inefficiency

Higher < **Cost** > Lower
of
Zero Harm

Reckless
Outcomes

Edge of Expediency

**Zero Harm
Excellence**

Brake Safety Outcomes Unplanned

No Planning... A Poor Excuse

Taking Control of Probability

■ **Unplanned - Normal**

Step 1

Stakeout The
Edge of the Abyss

Useless
Outcomes

Higher < **Cost** > *Lower*

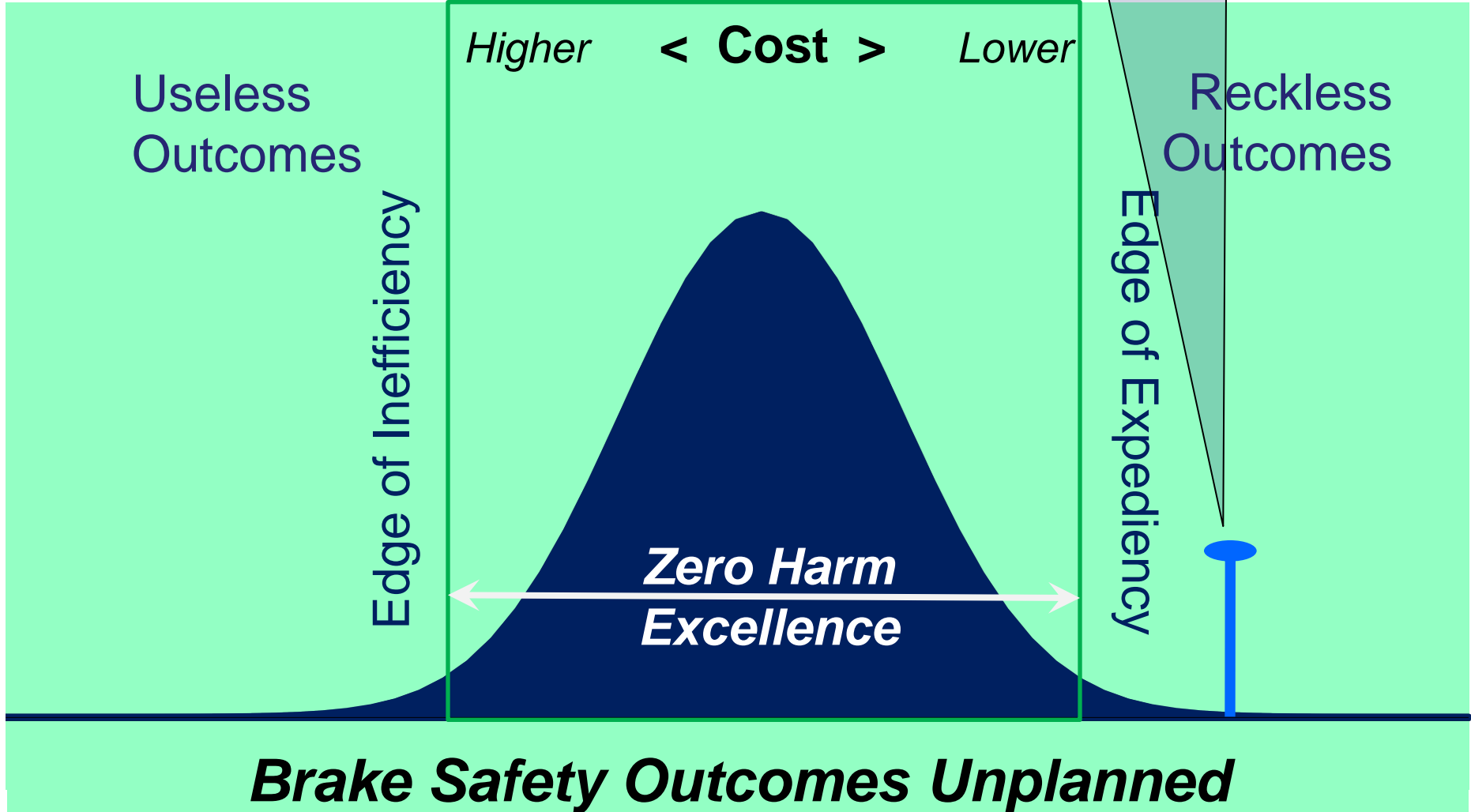
Reckless
Outcomes

Edge of Inefficiency

Edge of Expediency

*Zero Harm
Excellence*

Brake Safety Outcomes Unplanned



Taking Control of Probability- Start Planning

■ **Unplanned**

■ **Planned**

Step 2

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

Obvious
Inefficiency

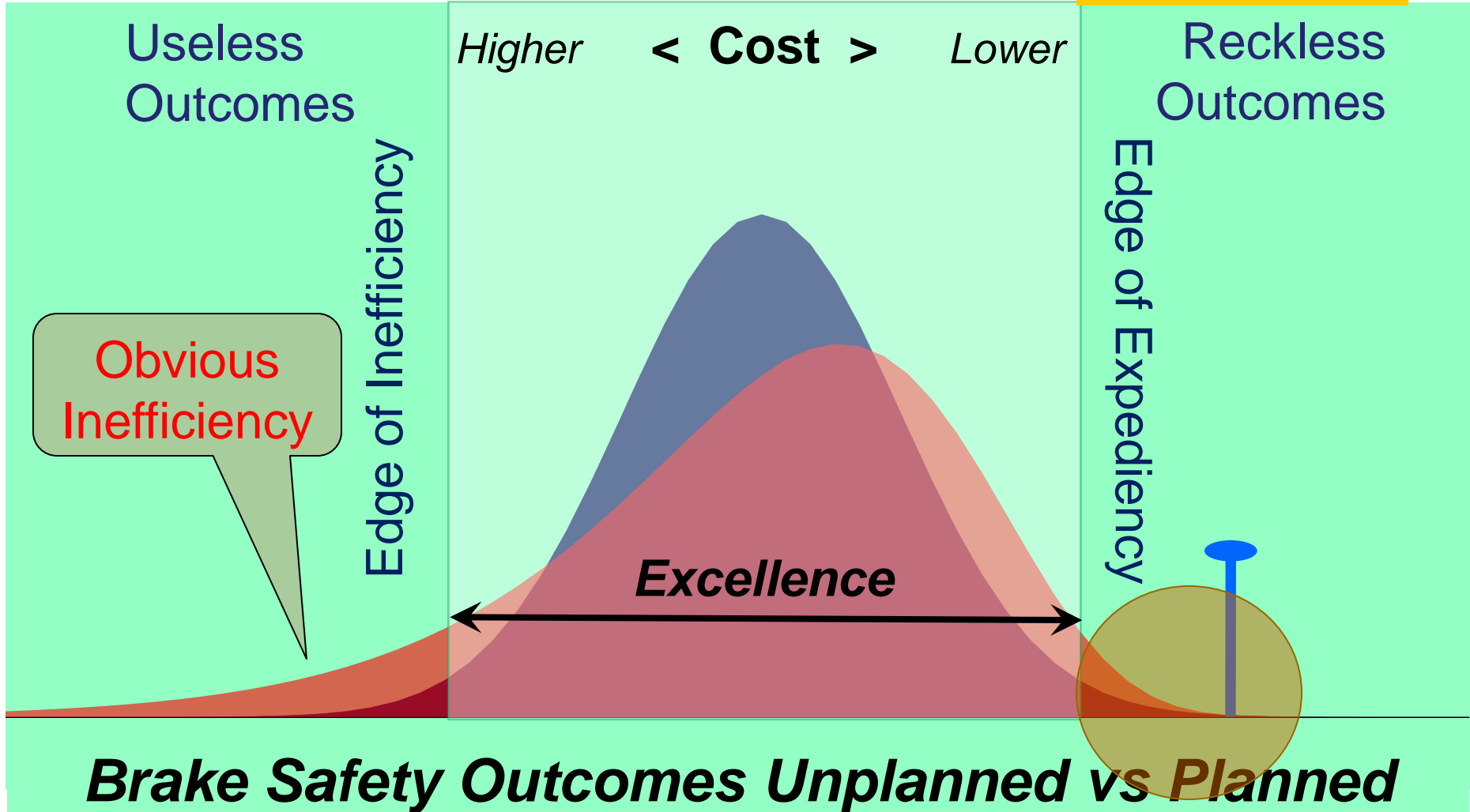
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Poor Planning... Must Improve



Taking Control of Probability

■ Unplanned

■ Planned

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

Edge of Inefficiency

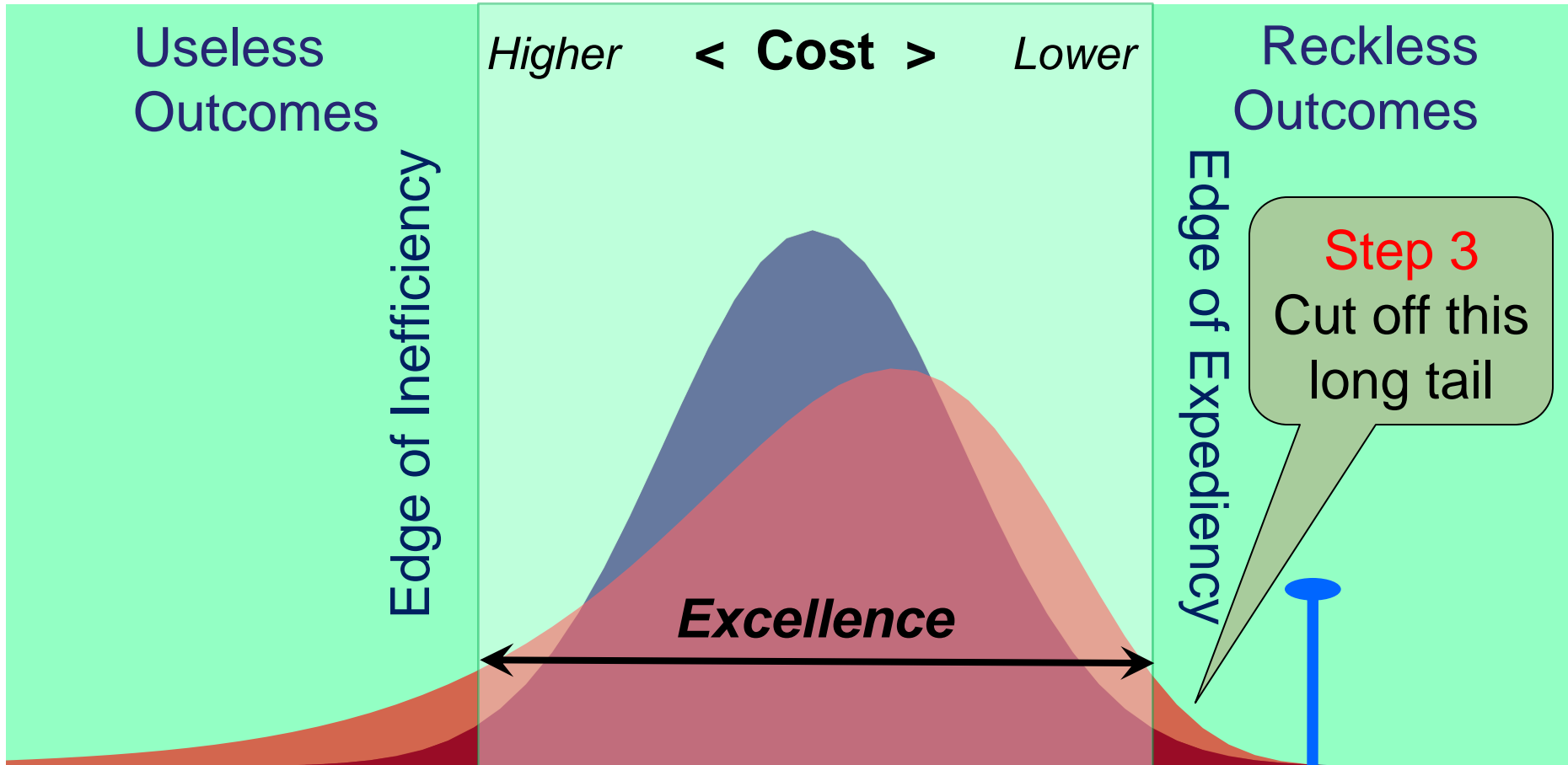
Edge of Expediency

Excellence

Step 3
Cut off this
long tail

Brake Safety Outcomes Unplanned vs Planned

Poor Planning...A Poor Excuse



Systems Engineering controls Probability

Taking control via Excellence & Certainty :

- ✓ Knowledge and treatment of the Risks
- ✓ Operating Limits for Grade, Speed and Payload
- ✓ Technical Standards for Performance
- ✓ Redundant Systems
- ✓ Secondary Systems
- ✓ Dedicated Systems
- ✓ Fail to Safe Systems
- ✓ Simplicity & Robustness in Design
- ✓ Pre-failure Maintenance
- ✓ Planned regular Inspection and Testing
- ✓ Continuous Monitoring and Alarms
- ✓ Excellence in Design, Manufacture, Supply, Commissioning & Lifelong Supplier Support
- ✓ Excellence in Operations & Asset Management

***Putting Up
Quality
Safety
Barriers***

Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

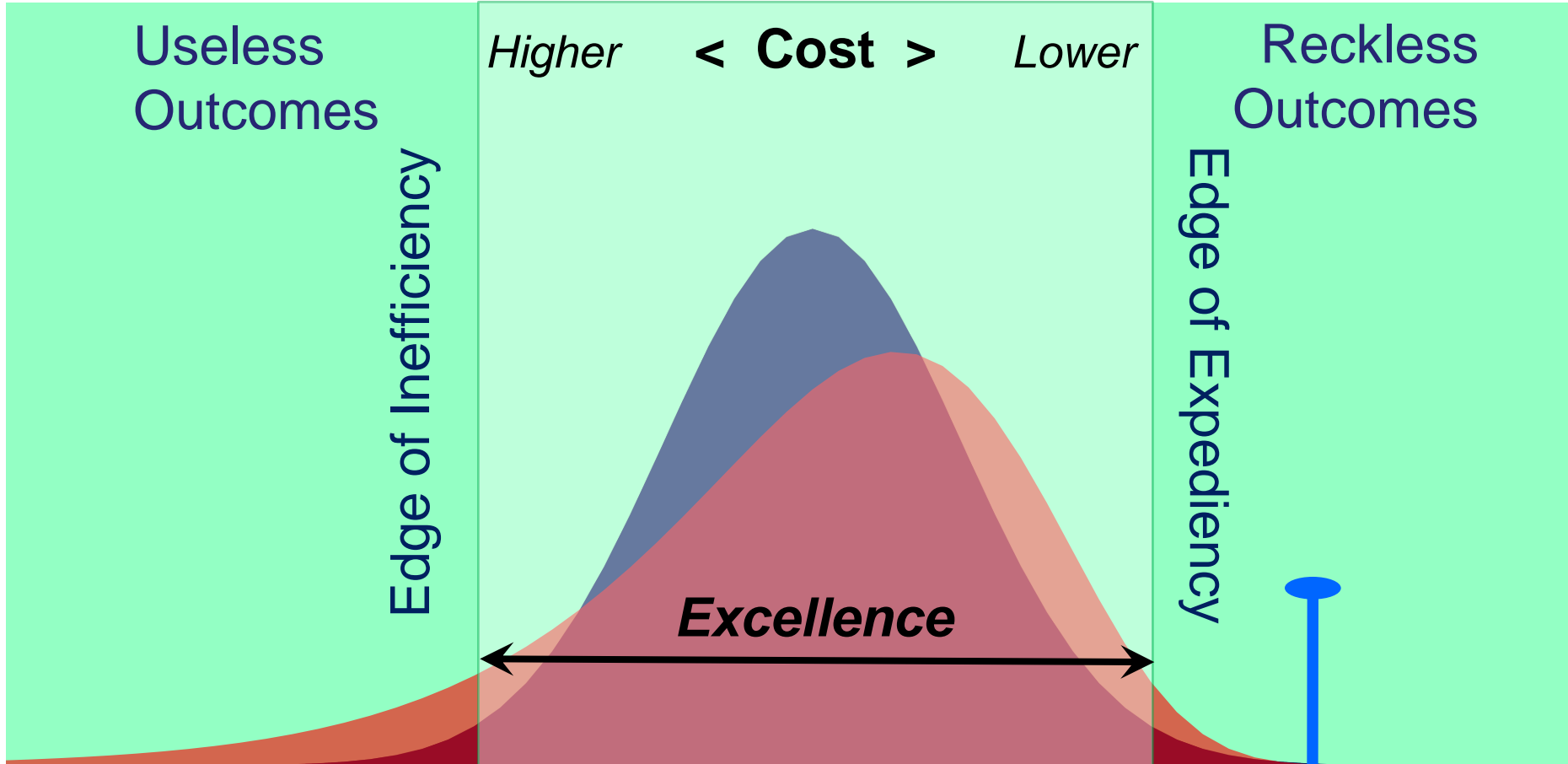
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Poor Planning... A Paltry Excuse



Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

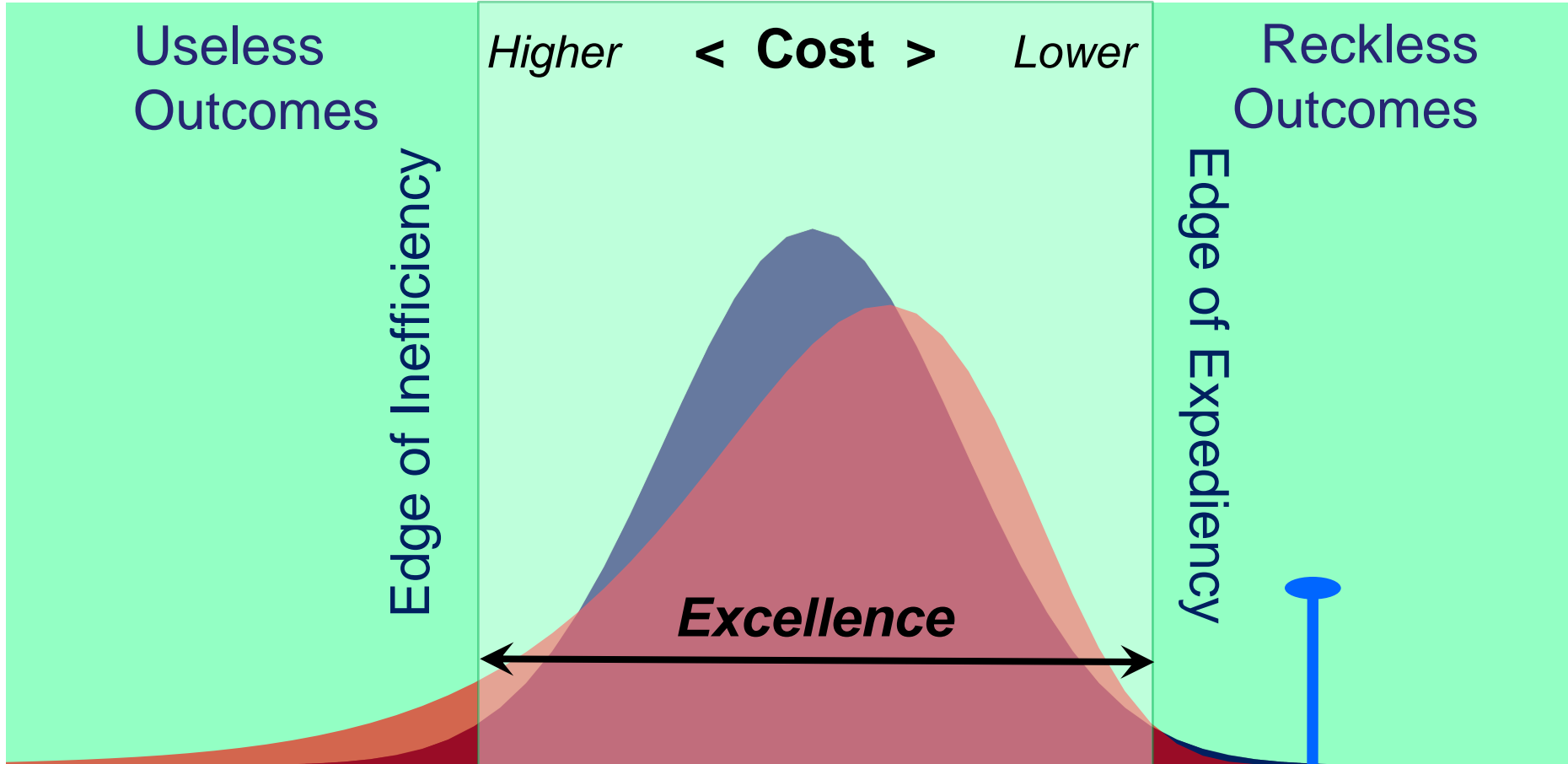
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Poor Planning... A Paltry Excuse



Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< Cost >

Lower

Reckless
Outcomes

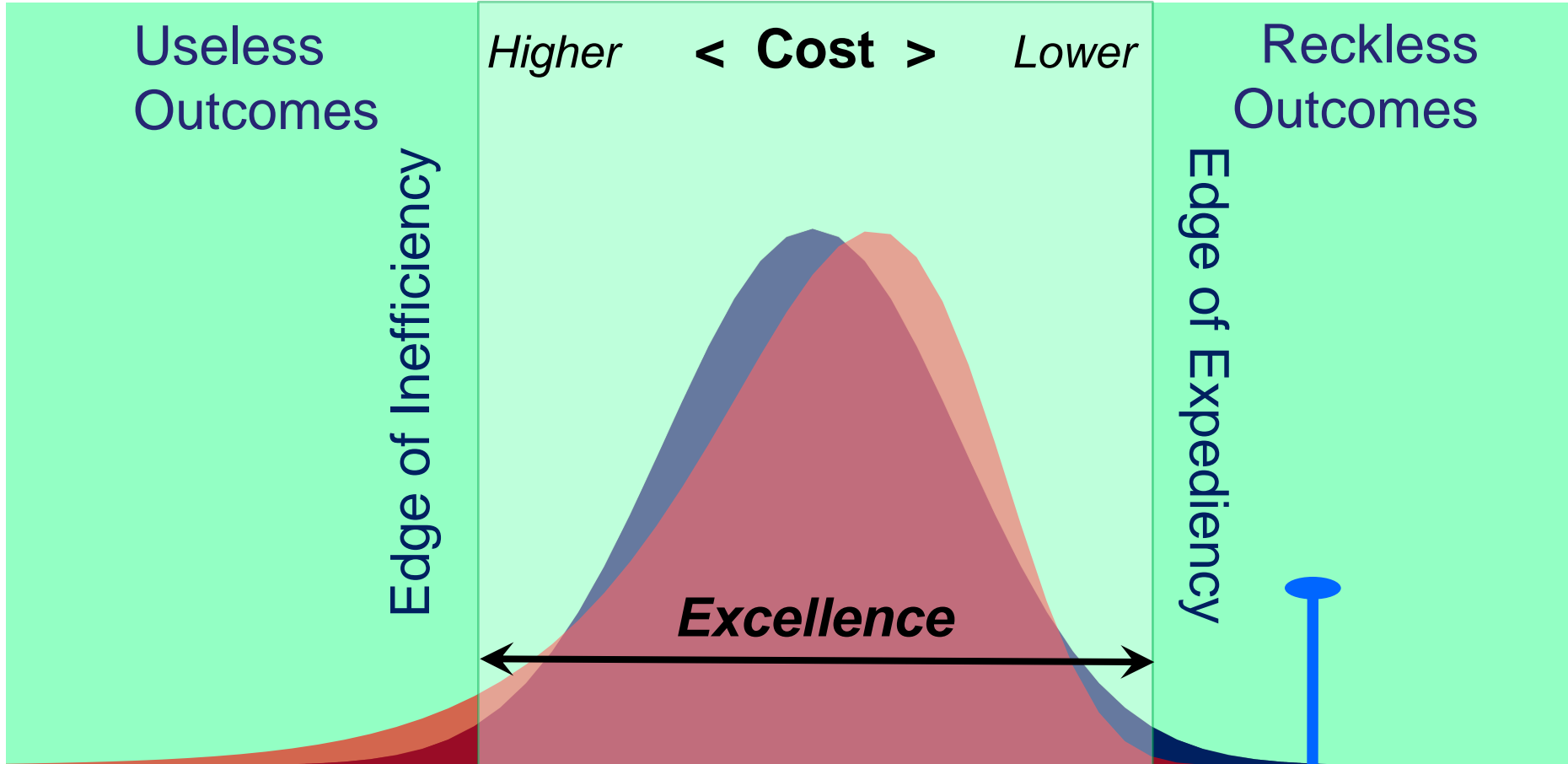
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Poor Planning...A Paltry Excuse



Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Better Planning... Still No Excuse



Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Some loss
in Efficiency
noticed

Edge of Inefficiency

Higher < **Cost** > Lower

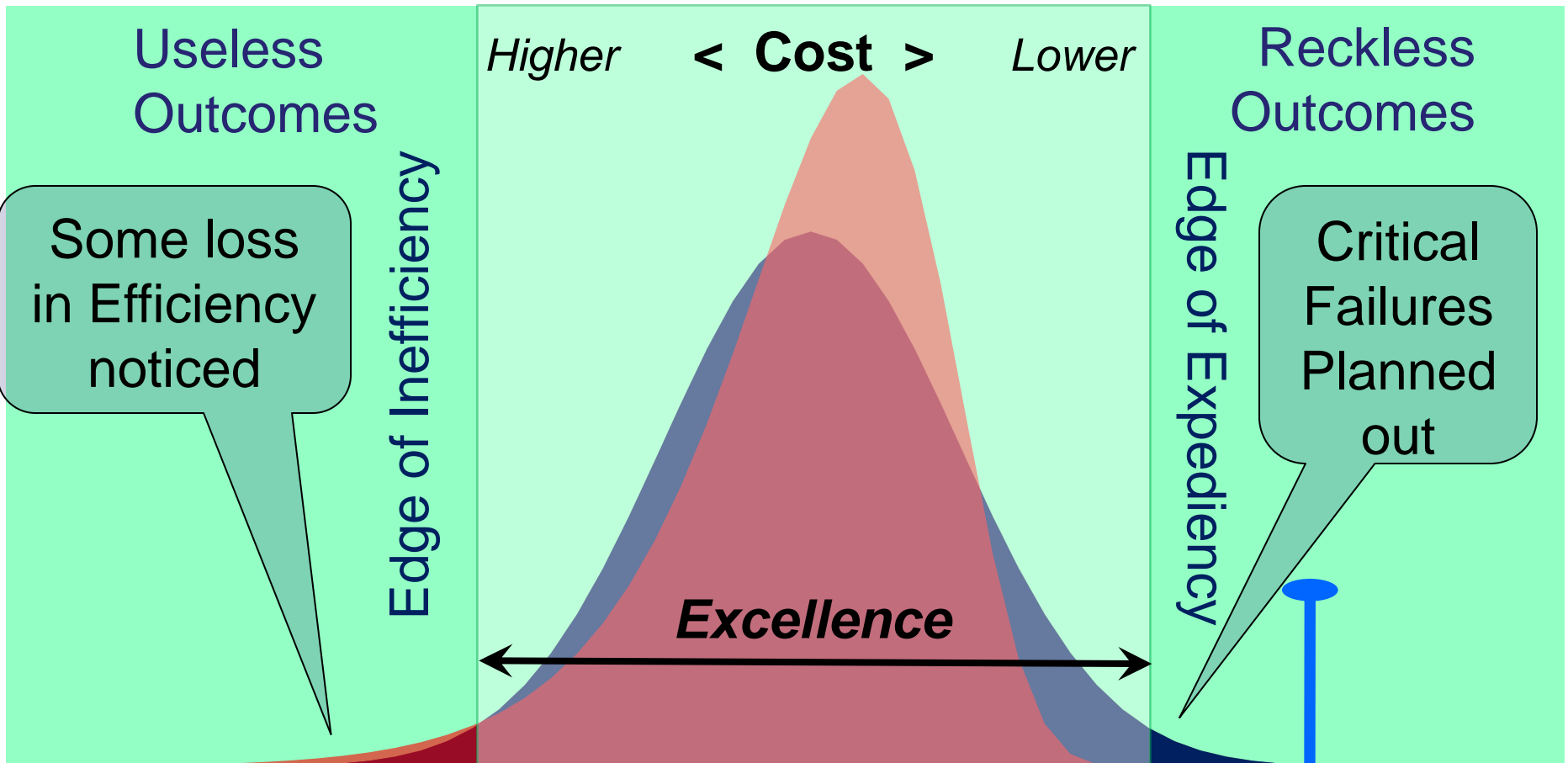
Reckless
Outcomes

Edge of Expediency

Critical
Failures
Planned
out

Excellence

Brake Safety Outcomes Unplanned vs Planned
Ample Excuse



Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

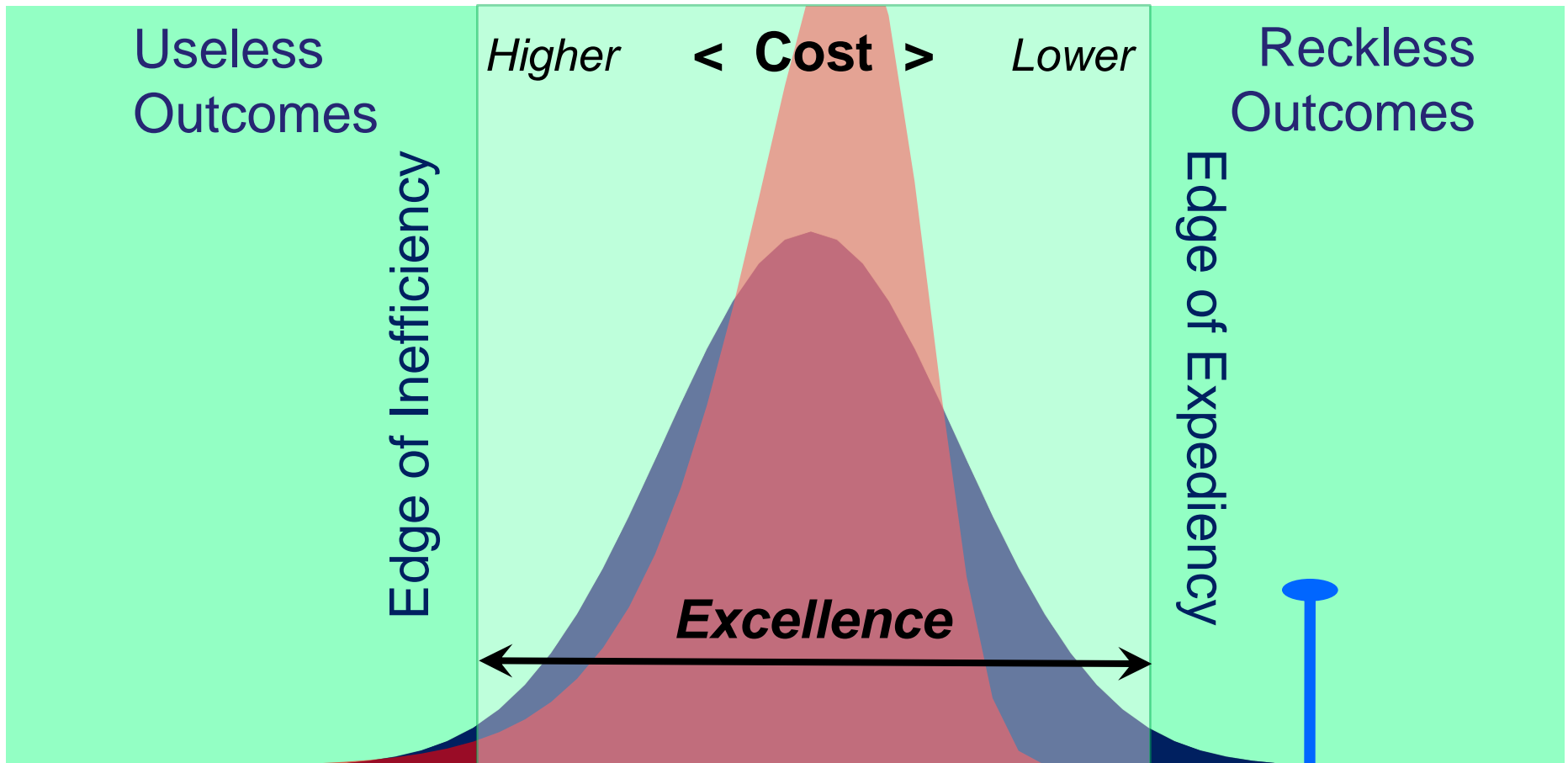
Reckless
Outcomes

Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned
Ample Excuse



Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

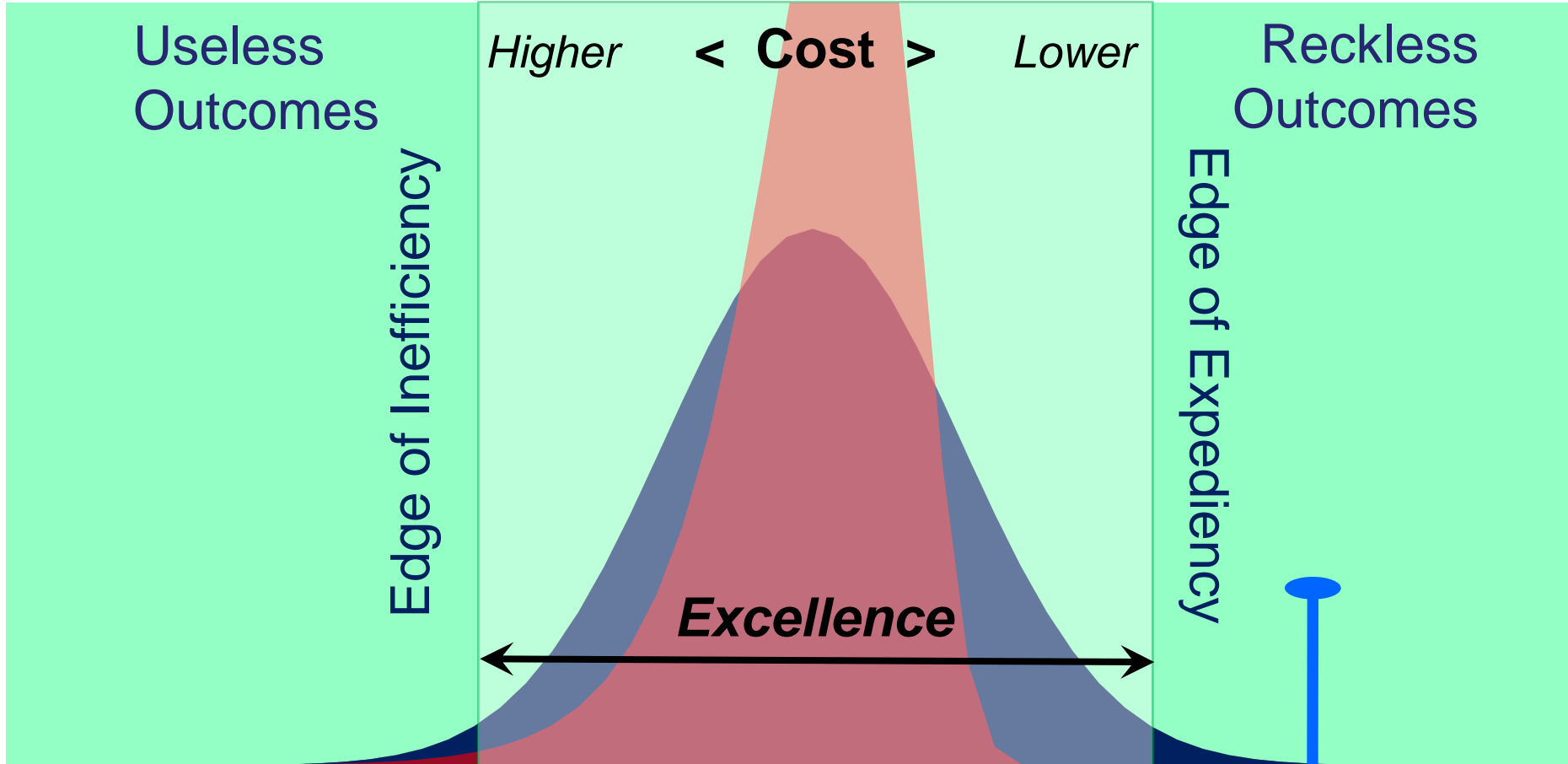
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Ample Excuse



Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

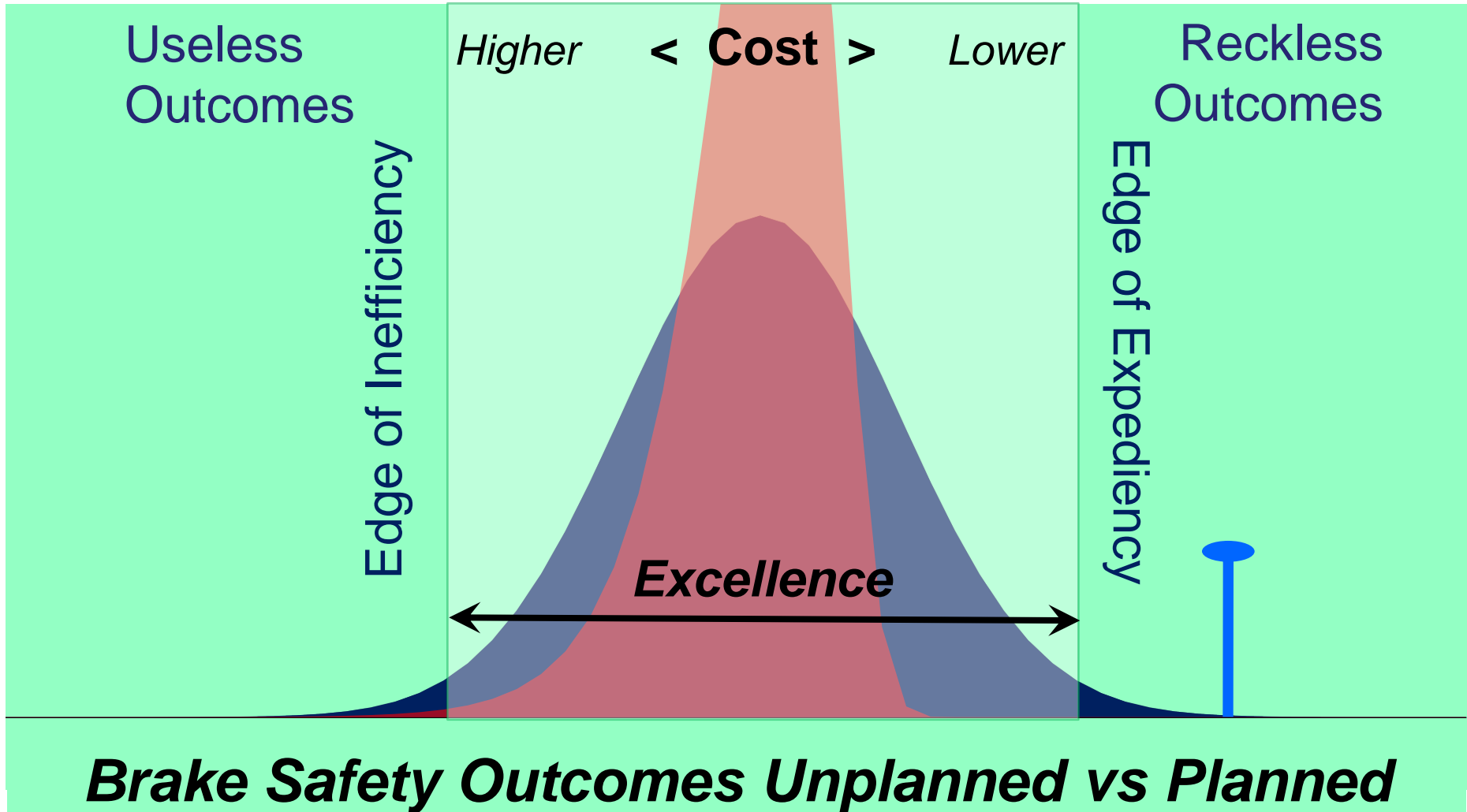
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Ample Excuse



Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

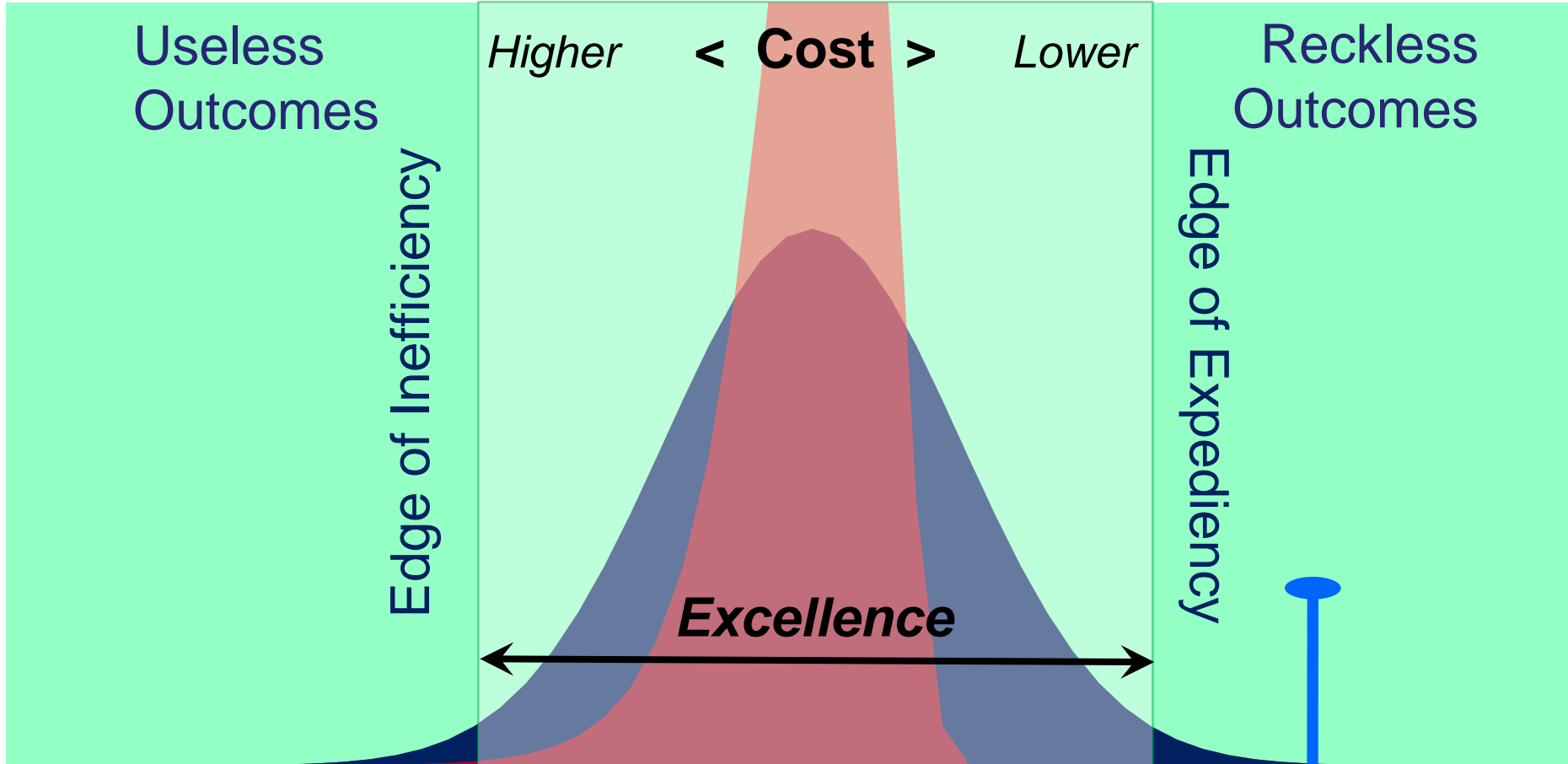
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Ample Excuse



Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Ample Excuse



Taking Control of Probability

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

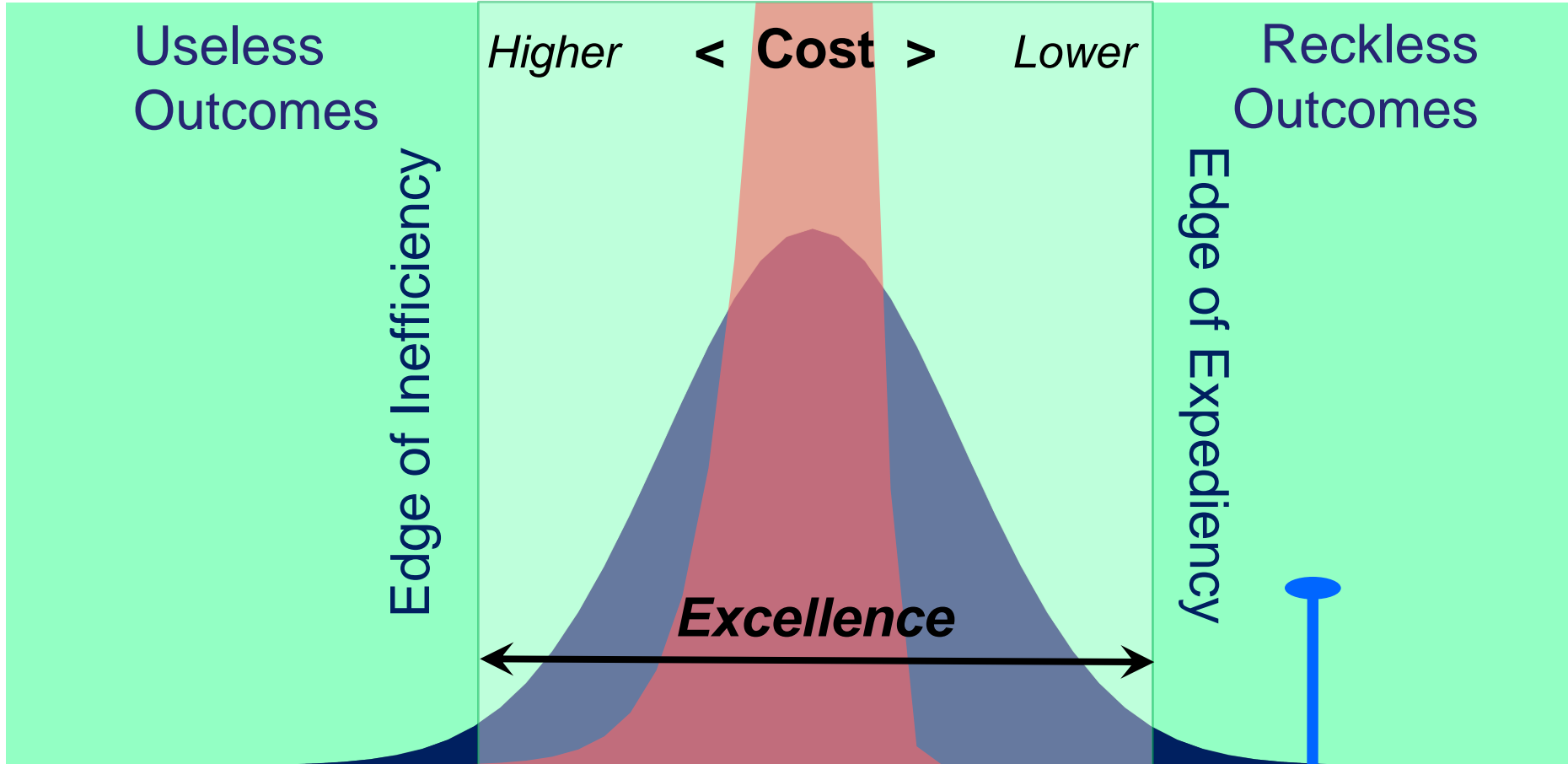
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Ample Excuse



Controlling Costs with Certainty

■ Unplanned

■ Planned

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

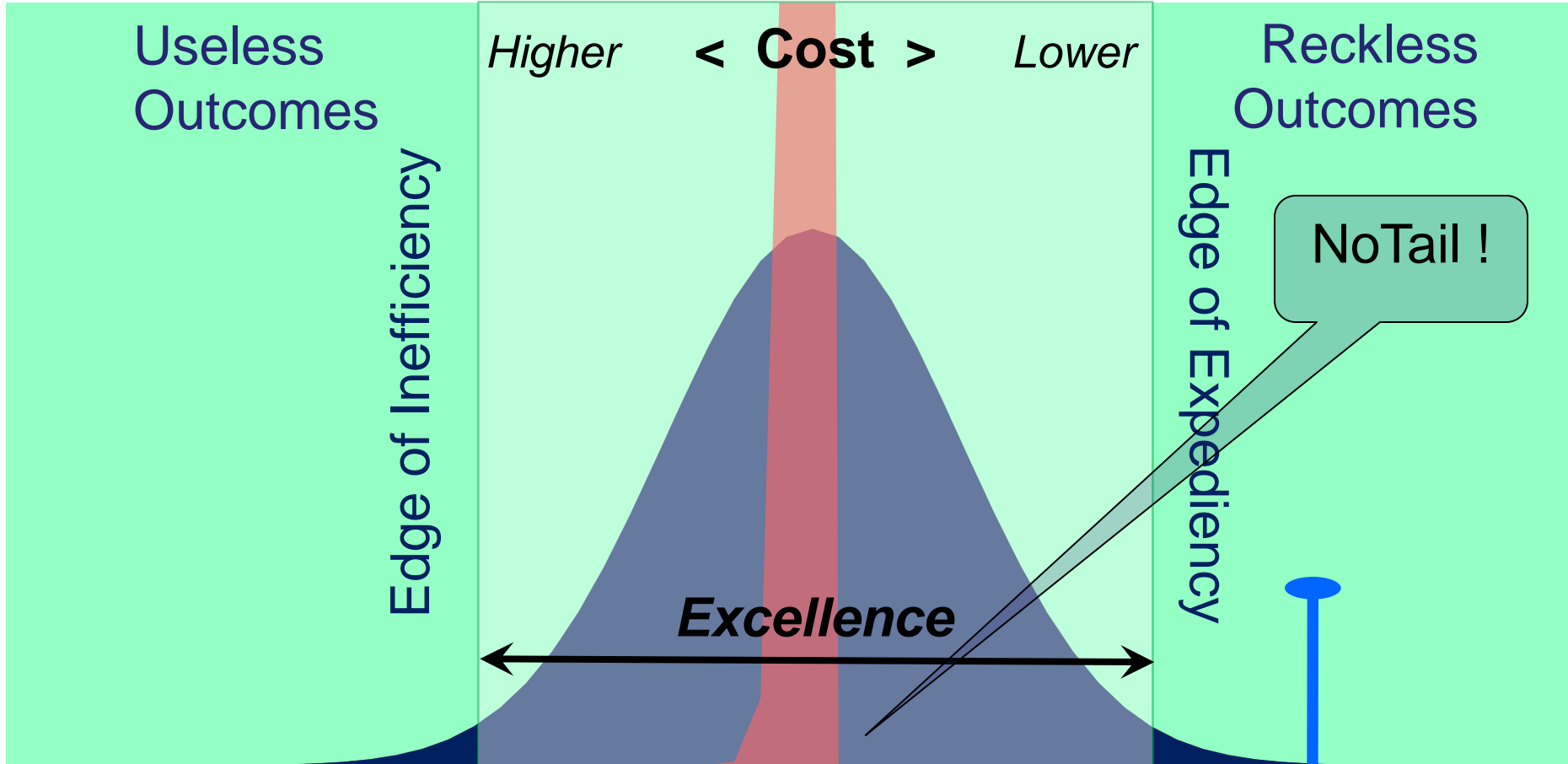
Edge of Inefficiency

Edge of Expediency

NoTail !

Excellence

Brake Safety Outcomes Unplanned vs Planned
Ample Excuse



Lowering Costs with Certainty

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

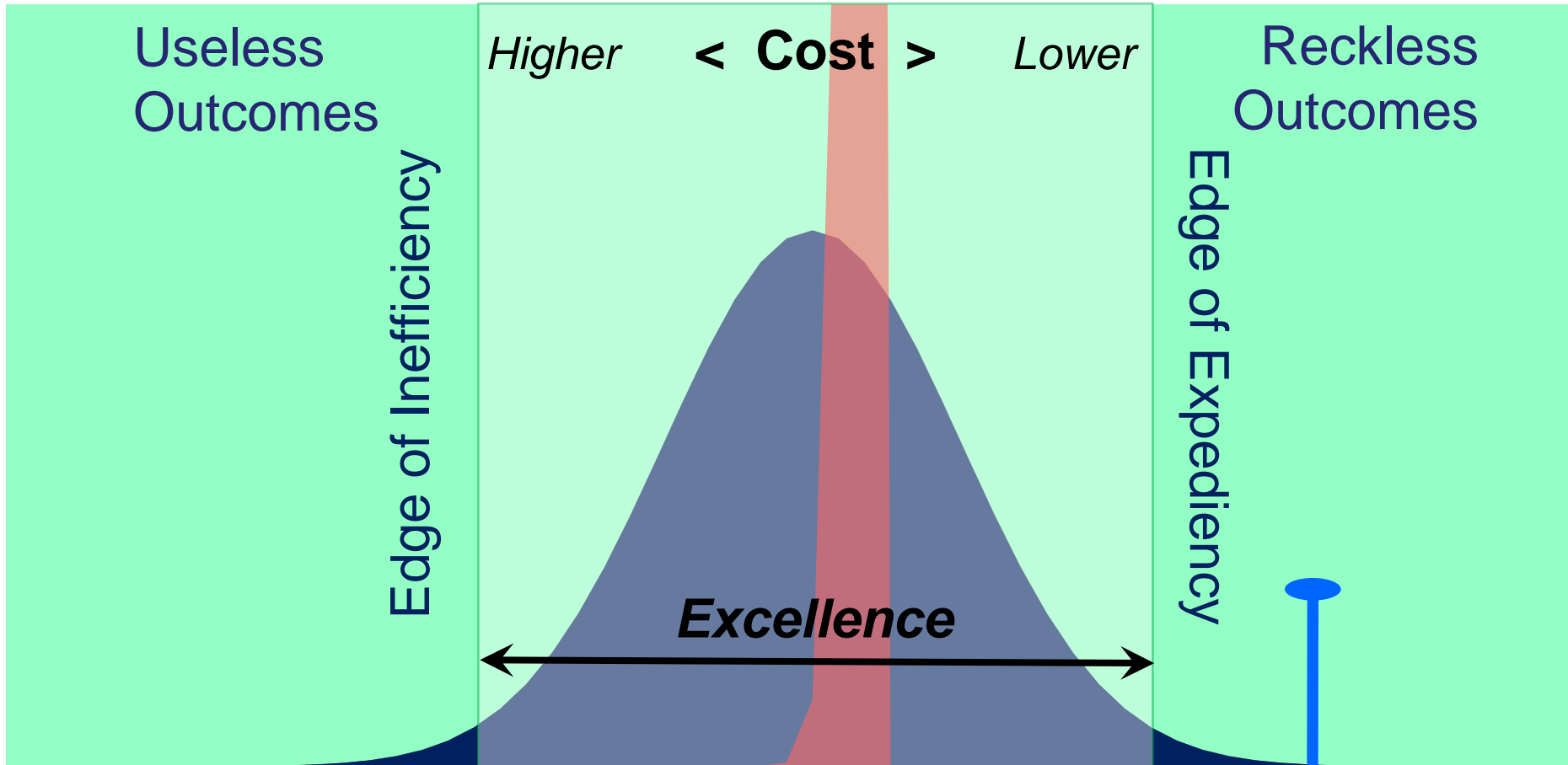
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Ample Excuse



Lowering Costs with Certainty

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< Cost >

Lower

Reckless
Outcomes

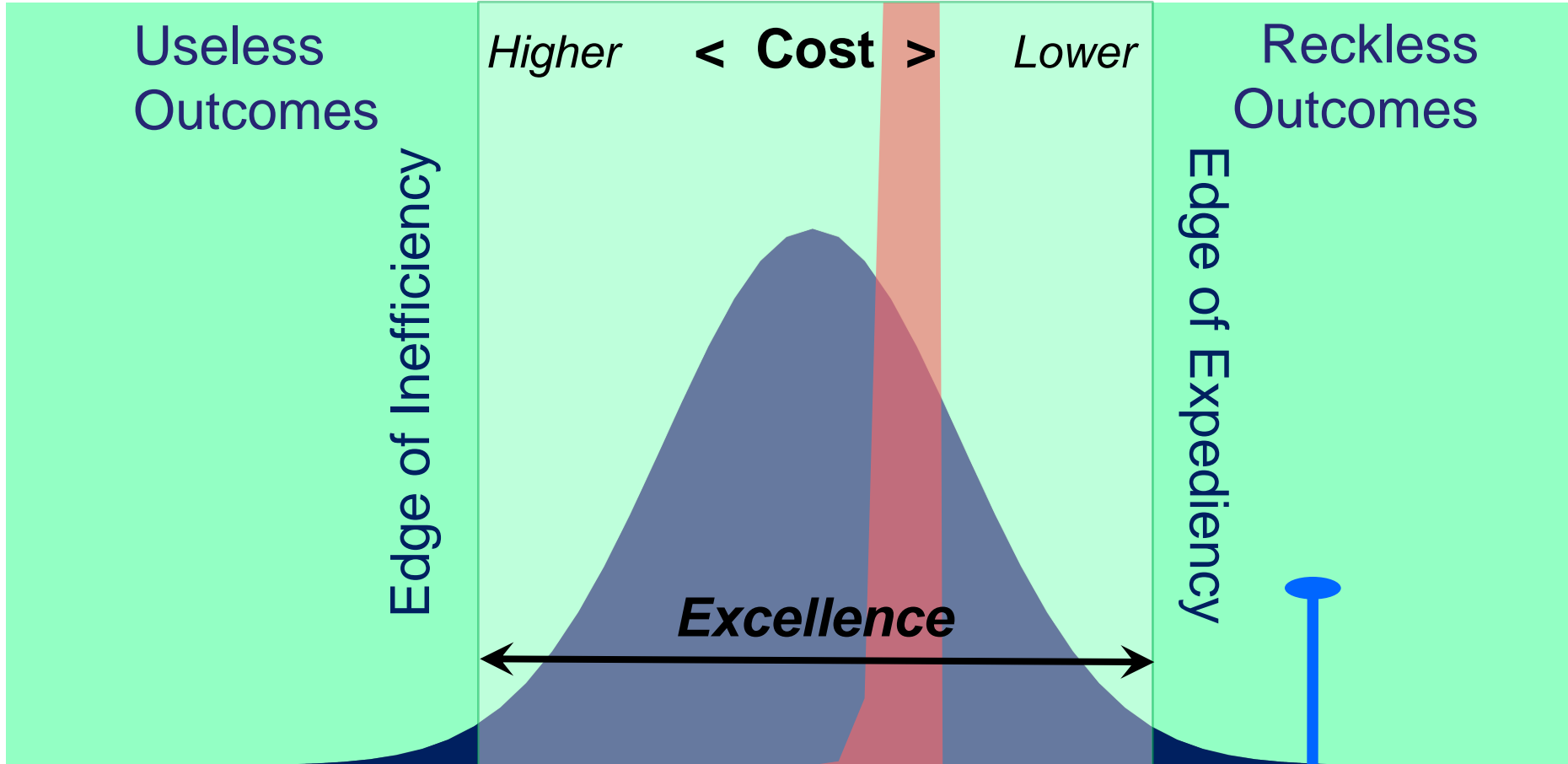
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Ample Excuse



Lowering Costs with Certainty

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

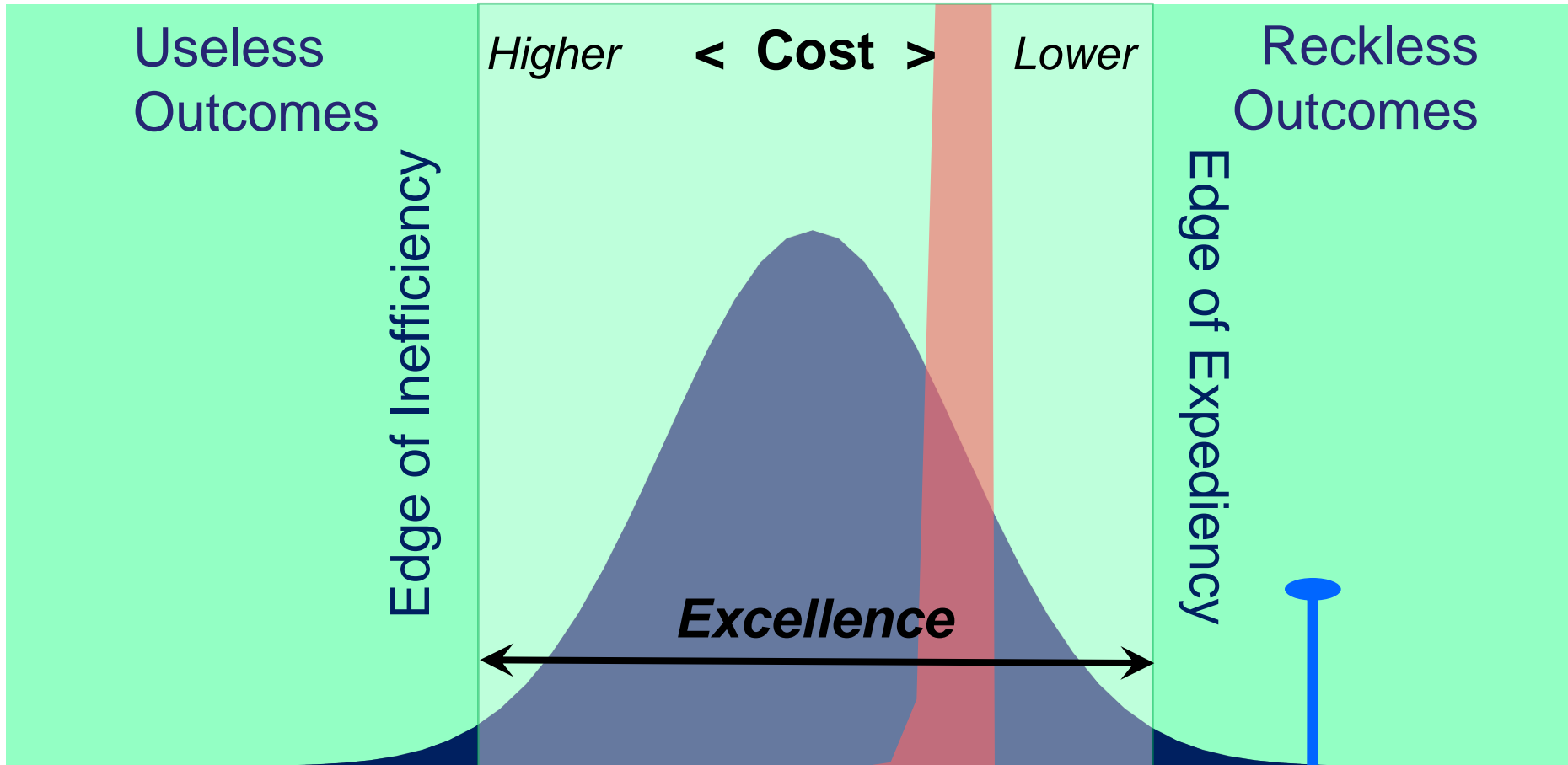
Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned

Ample Excuse



Lowering Costs with Certainty

■ **Unplanned**

■ **Planned**

Useless
Outcomes

Higher

< **Cost** >

Lower

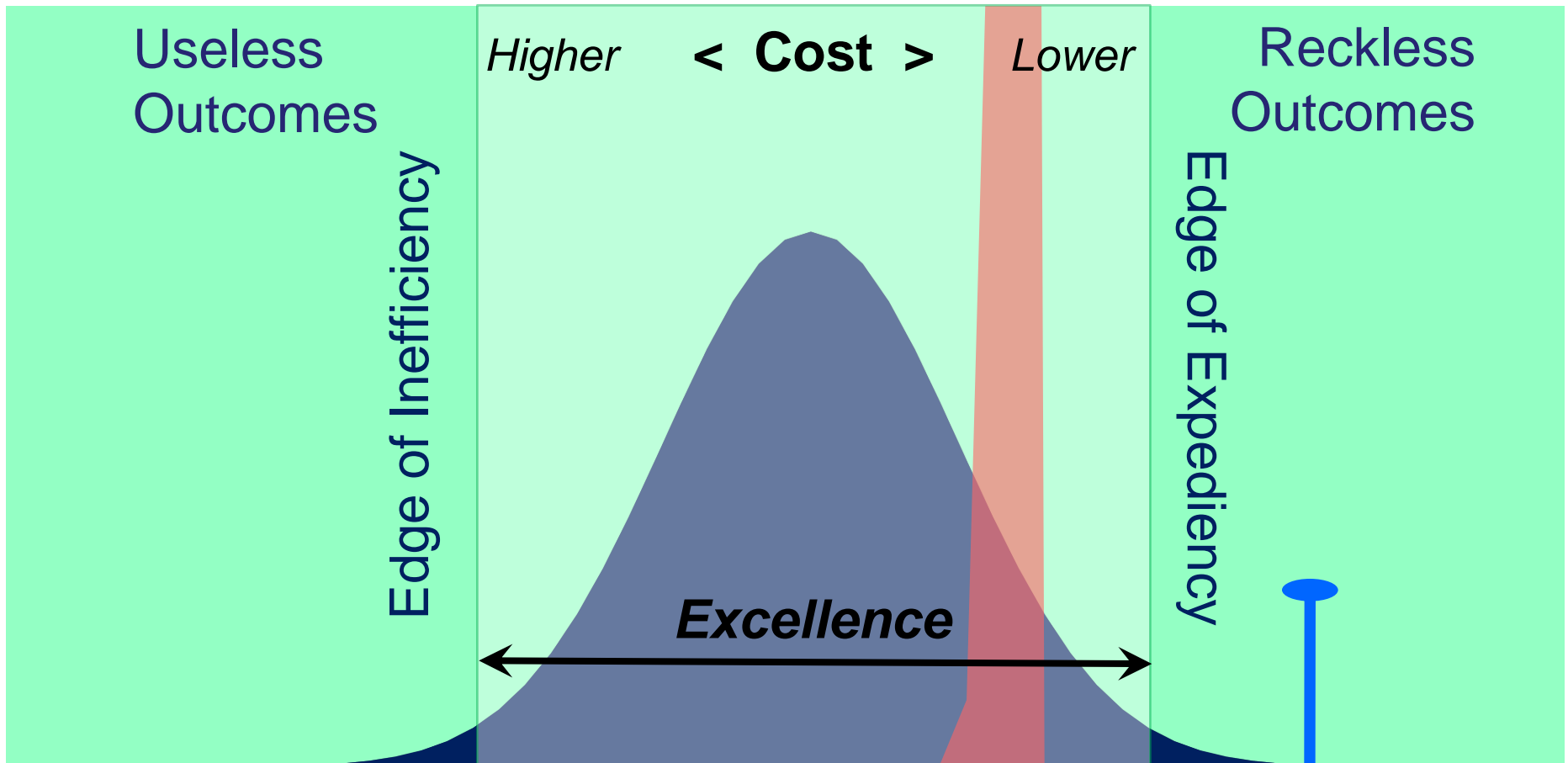
Reckless
Outcomes

Edge of Inefficiency

Edge of Expediency

Excellence

Brake Safety Outcomes Unplanned vs Planned
Ample Excuse



Lowering Costs with Certainty

■ Unplanned

■ Planned

Useless
Outcomes

Higher

< **Cost** >

Lower

Reckless
Outcomes

Edge of Inefficiency

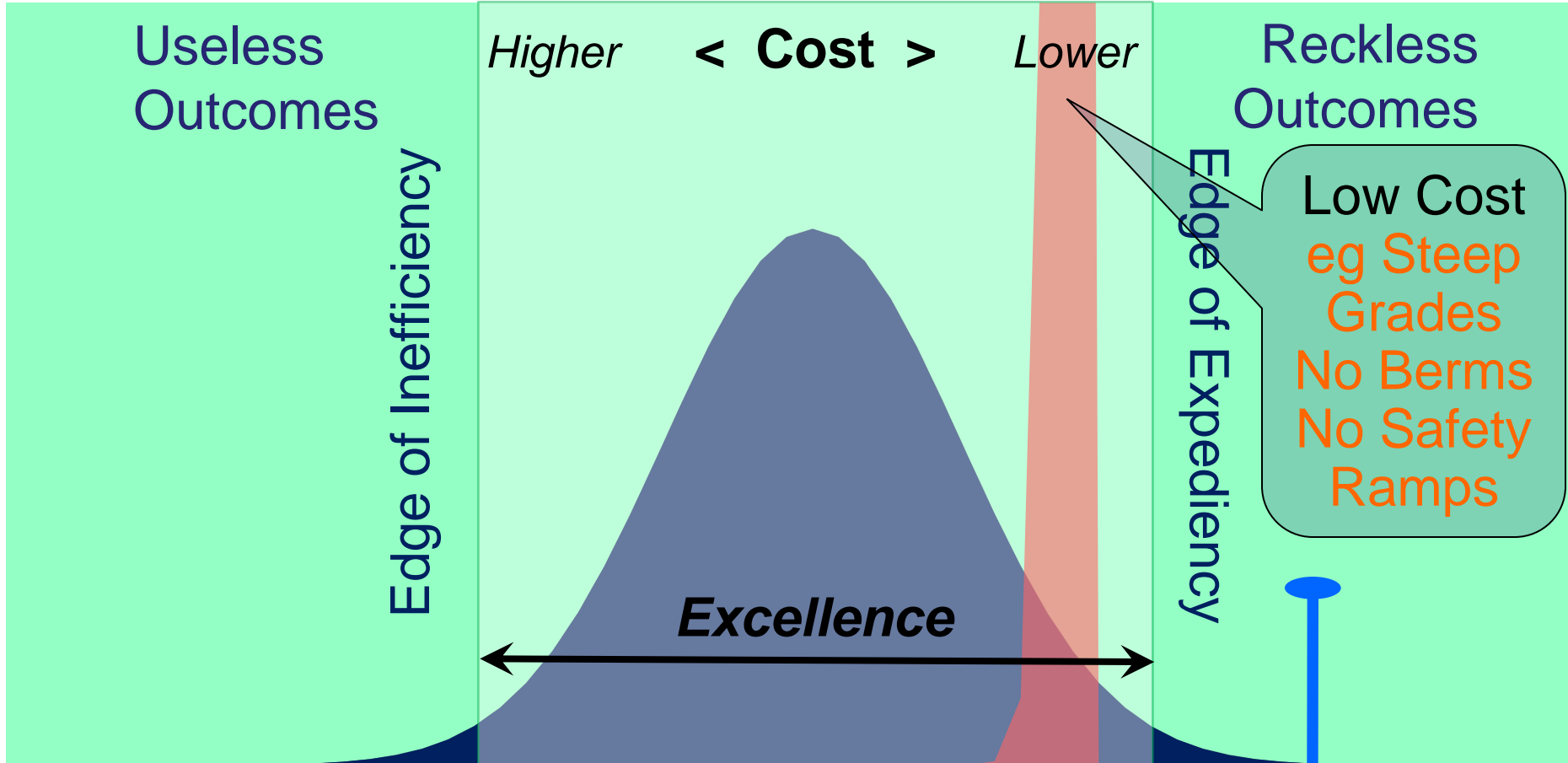
Edge of Expediency

Low Cost
eg Steep
Grades
No Berms
No Safety
Ramps

Excellence

Brake Safety Outcomes Unplanned vs Planned

Ample Excuse *Power over Probability*



Turbine Powered Runaway...40 years ago



Brake Safety meant Infrastructure :

- Whopper Stopper Berms
- Edge Berms
- Safety Ramps
- Shallow Grades

***In an Age
when truck
runaway was an
accepted Norm***

A Safety Case *proves Facts not Age old Rules*



New Age Brakes
Except Chocks... Old Age Brakes

So why keep old Age Site Brake Safety Infrastructure :

- **Whopper Stopper Berms**
- **Edge Berms**
- **Safety Ramps**
- **Shallow Grades**

**In an Age
where truck
runaway *is not* an
accepted Norm**

Written in a prior Age

Information Circular 8758

Design of Surface Mine Haulage Roads - A Manual

By Walter W. Kaufman and James C. Ault



UNITED STATES

BUREAU OF MINES

Still the Bible of the Age ?

- **Whopper Stopper Berms**
- **Edge Berms**
- **Safety Ramps**
- **Shallow Grades**

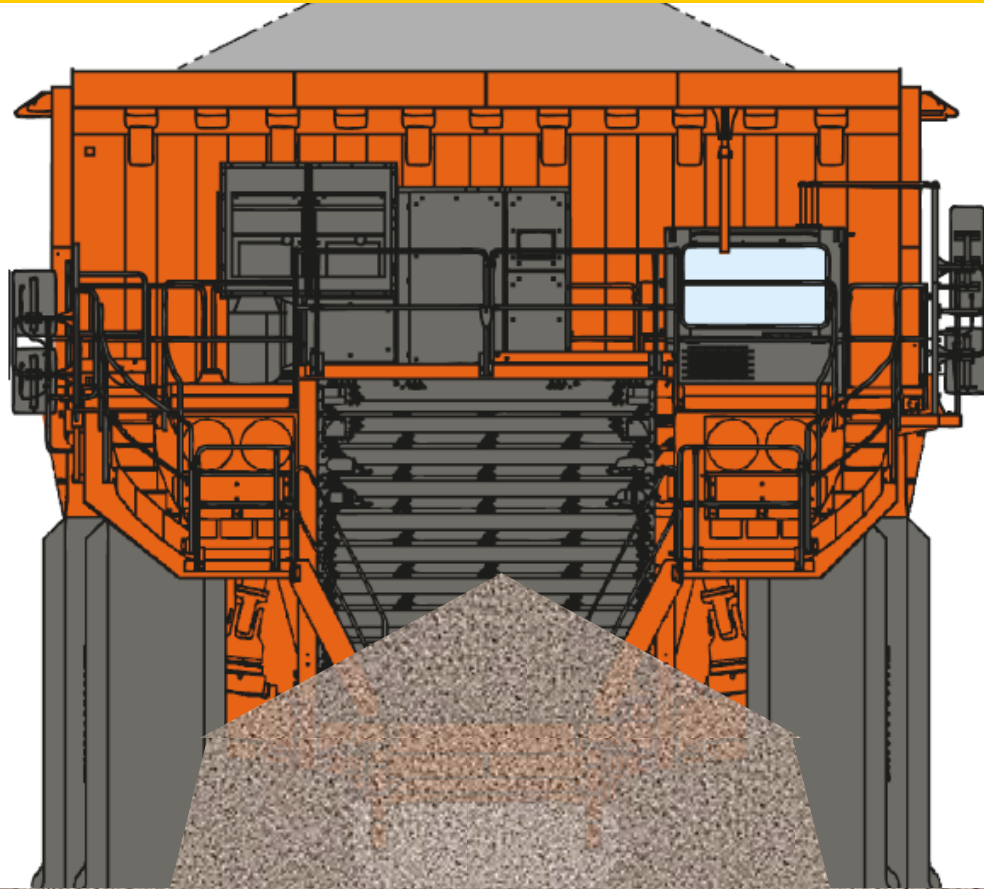
*Are these site infrastructures
the answer to brake runaway?*

When Brakes Fail ***Heads Fail...***

Administrative Infrastructure Fails

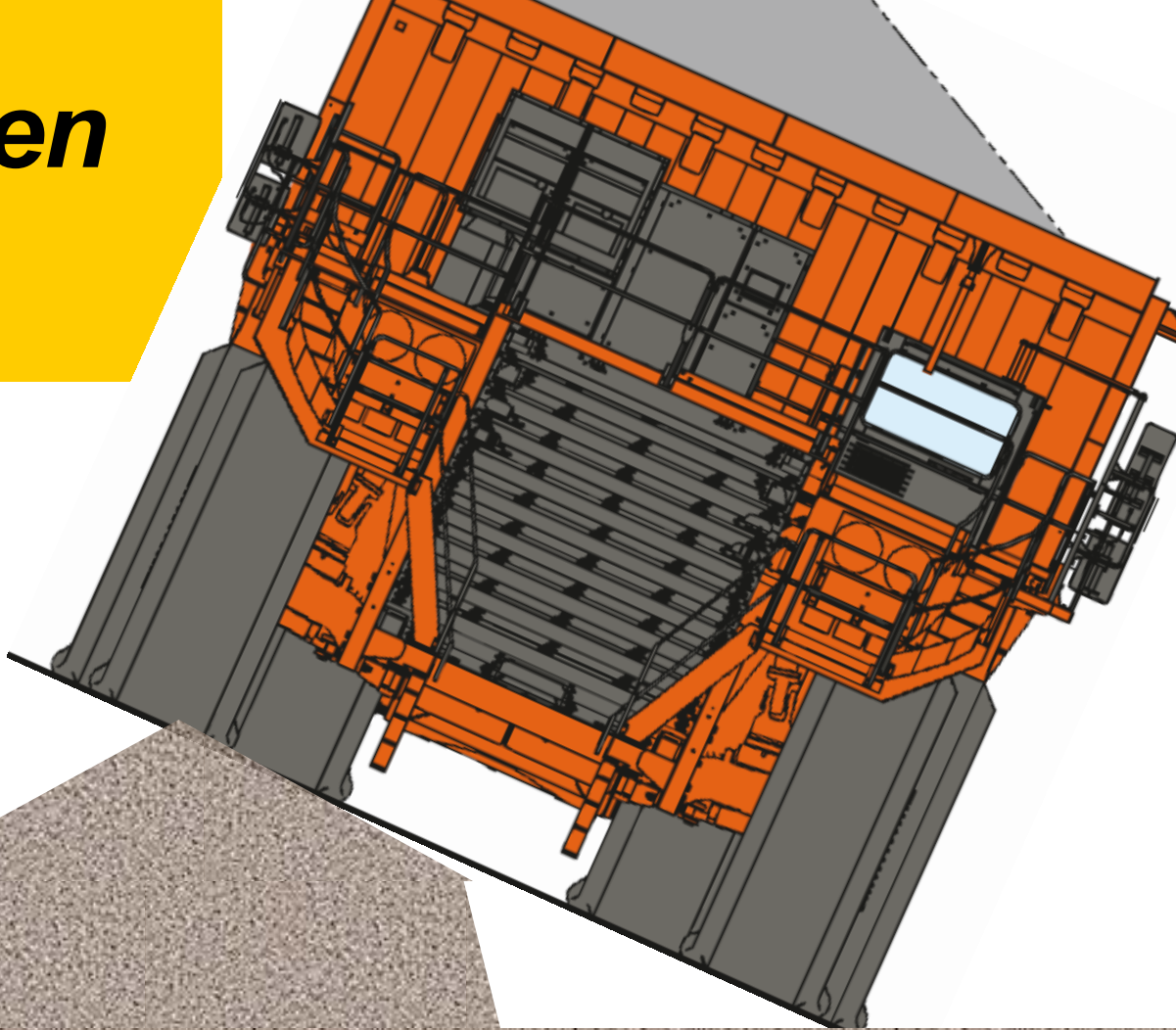


When Brakes Fail...Berms (Heads) Fail



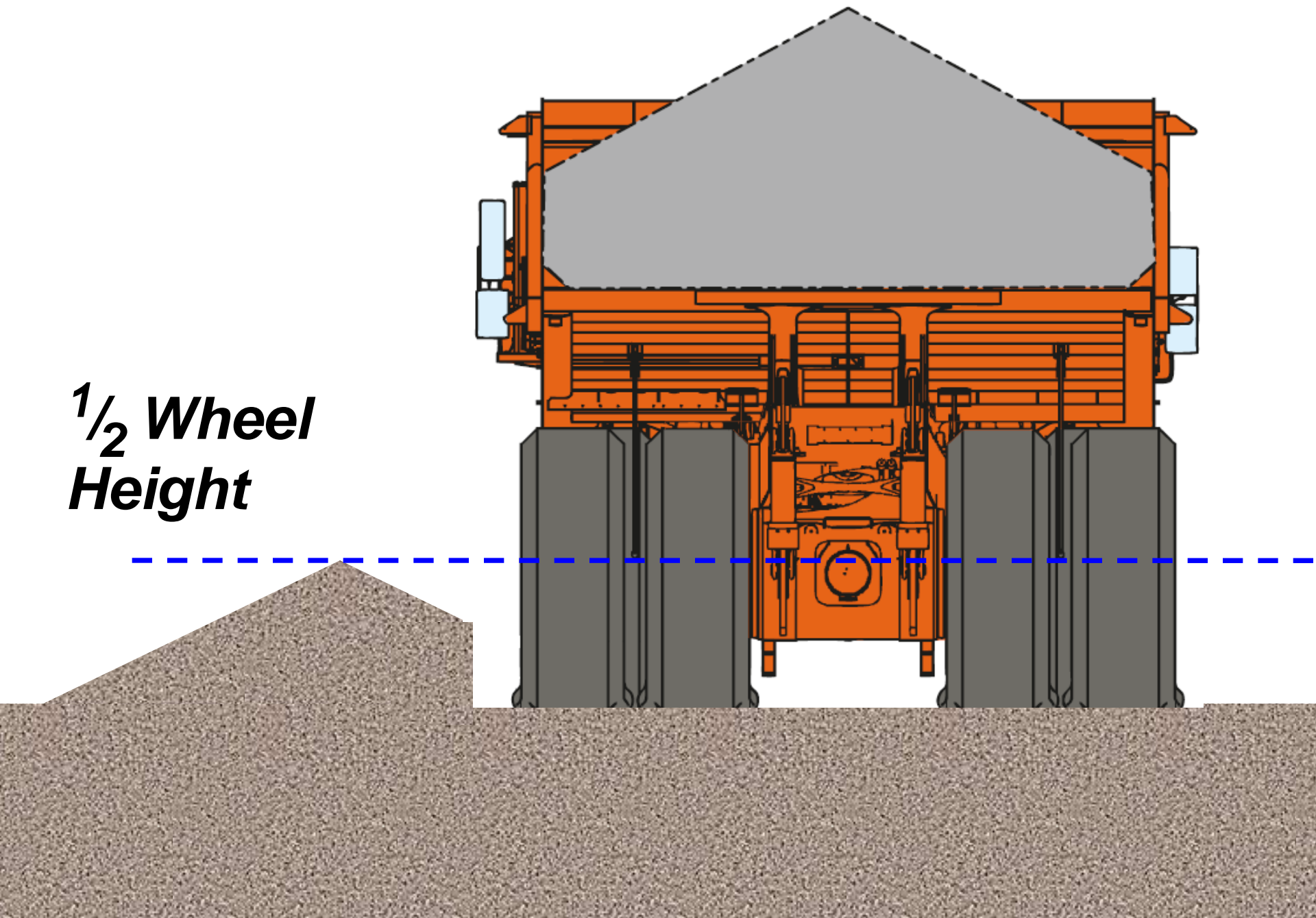
Whopper Stopper Berm

***Heads Fail then
Berms Fail***



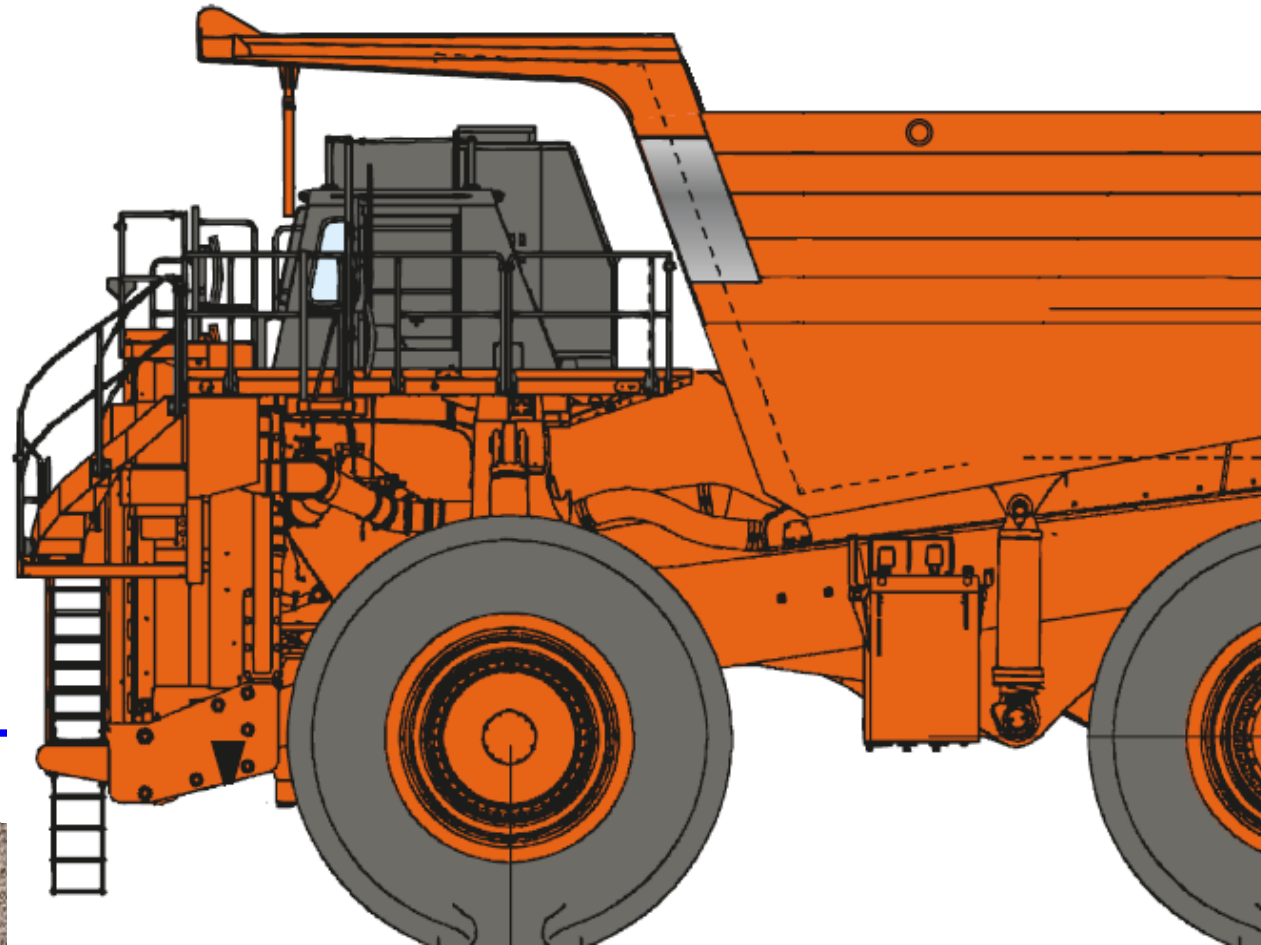
Whopper Rollerover Berm

***$\frac{1}{2}$ Wheel
Height***



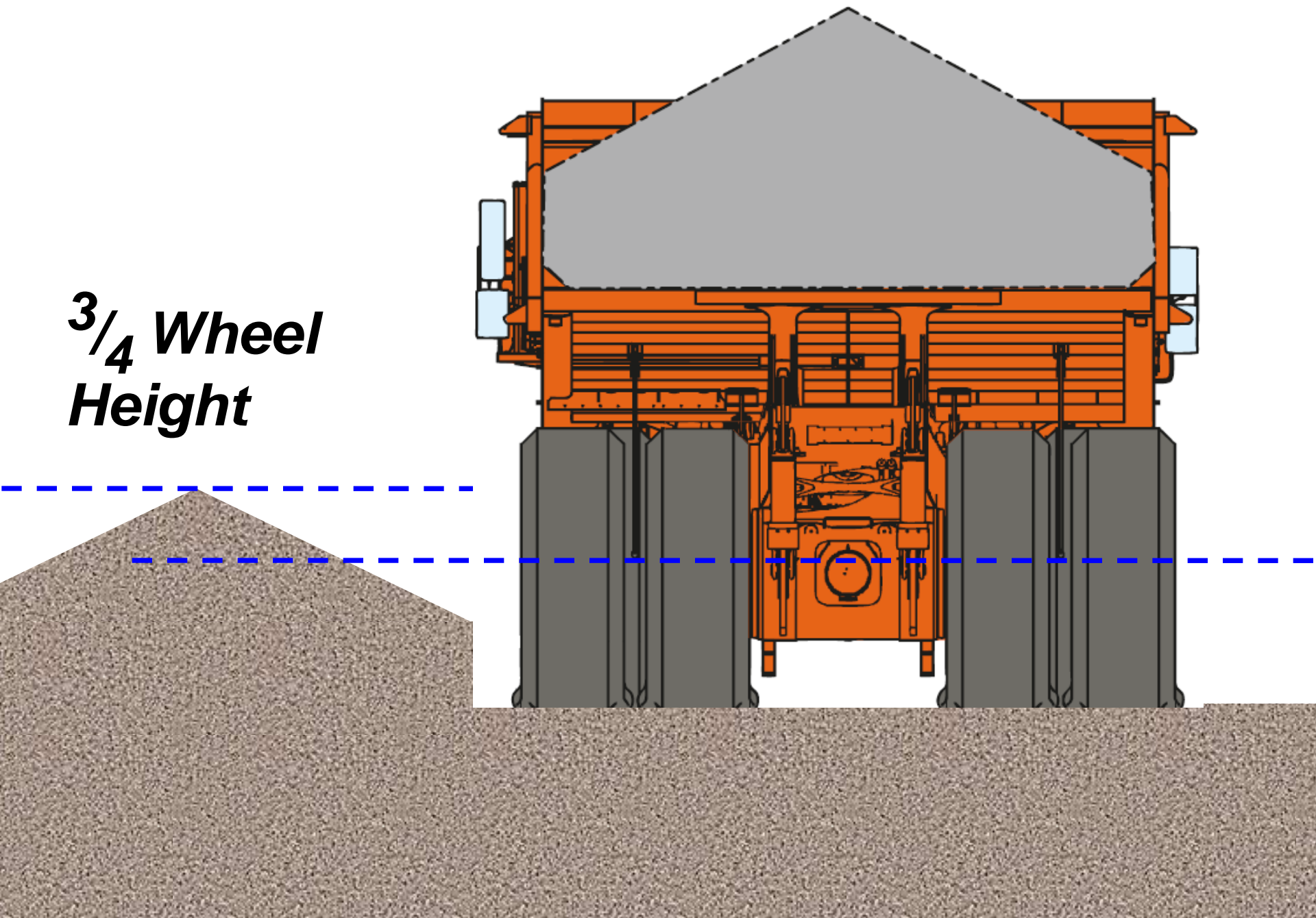
***When
Brakes Fail
Berms Fail***

***$\frac{1}{2}$ Wheel
Height***



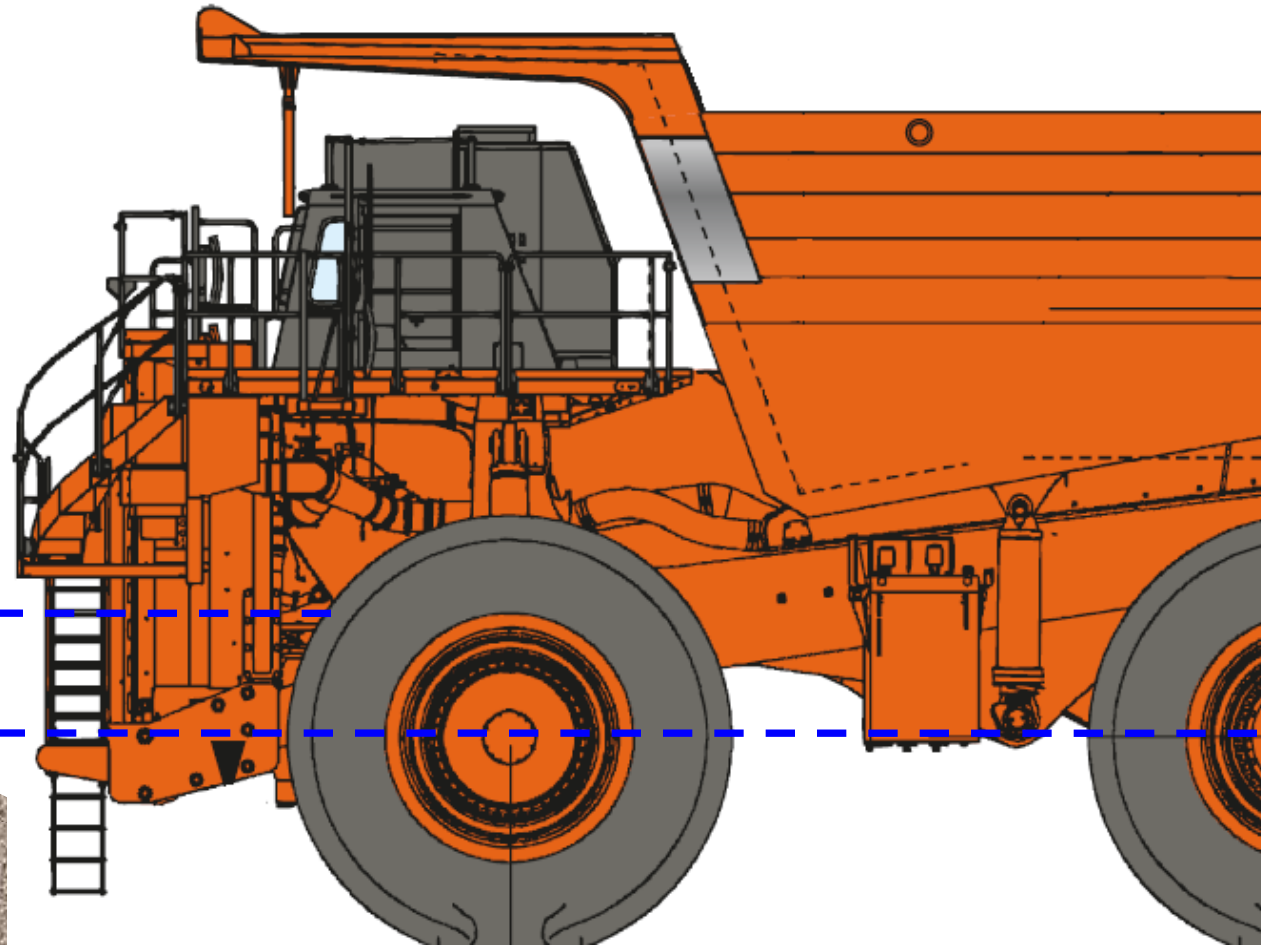
Berm Mass: 20% GVW 50% TVW

***$\frac{3}{4}$ Wheel
Height***



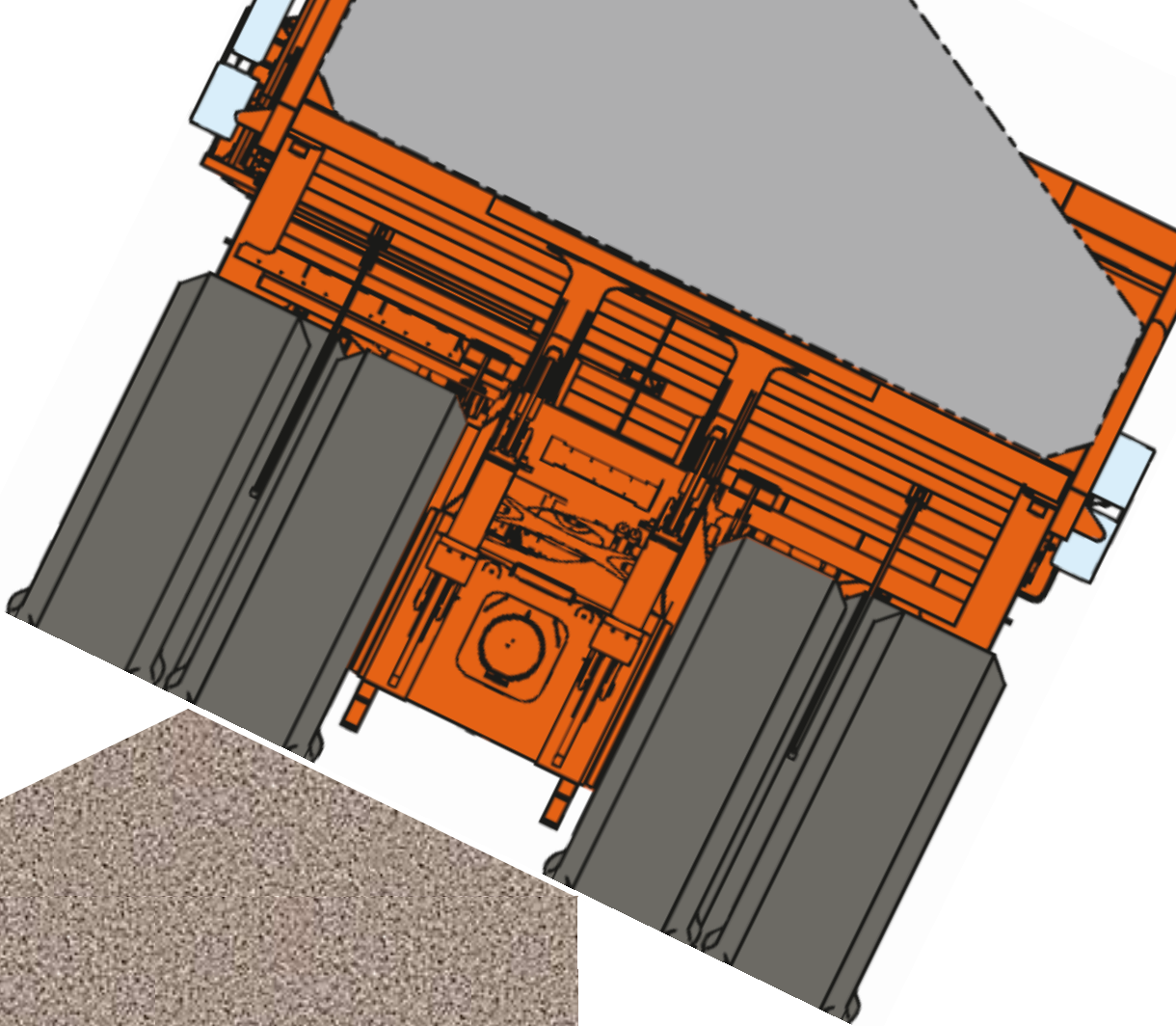
***When
Brakes Fail
Berms Fail***

***$\frac{3}{4}$ Wheel
Height***



Berm Mass: 27% GVW 66% TVW

***When
Heads Fail
Berms Fail***





Berm Infrastructure doesn't work
But this site Infrastructure does

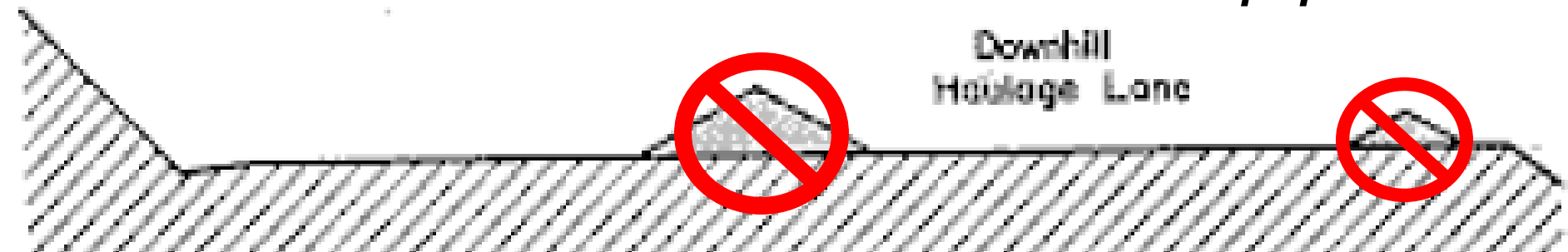
A Mission...to Ban the Berm

Berm Designers take note:

“A poorly designed or badly maintained berm could conceivably be worse than no berm at all.”

Berms waste 25% of Haul Road width

Berms limit economic life of deep pits



Responsibility... Brake Failure or Berm?

SECTION A-A

FIGURE 26. - Runaway-vehicle collision berms.

*High Cost
to tear
down &
haul these
waste
structures
to spoil*

\$

CO₂

A Haul Truck Brake Safety Case can contain
good excuses to avoid these
ineffective safety infrastructures



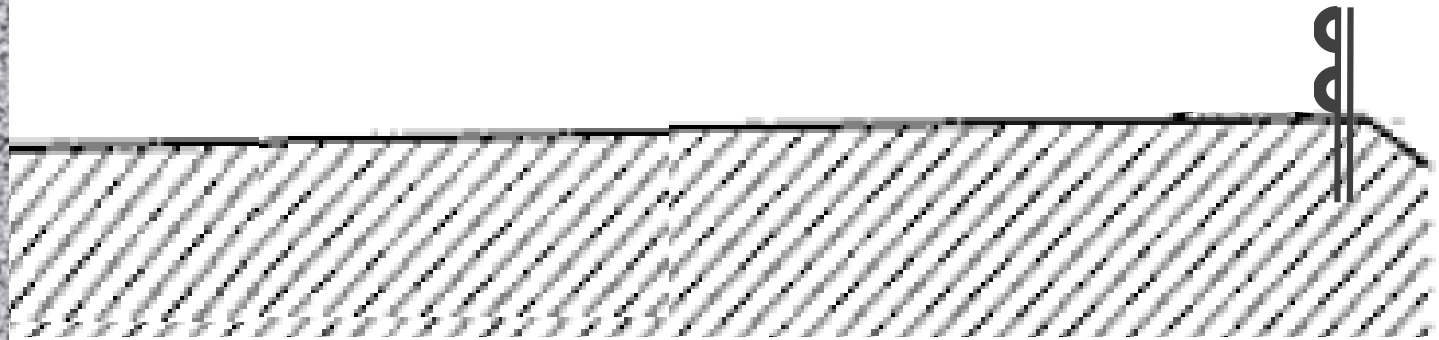
***When
Heads Fail
Berms Fail***

***Preventing
Brake Failure
will prevent
Head Failure in
the 1st Place***

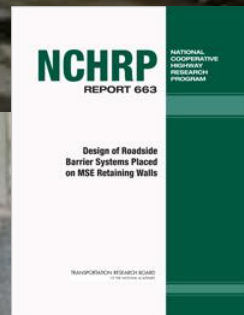




**Narrow Road
Save Lives
& the Planet**



**Brake Service in place... Berms Gone
Edge guarded by Proximity Detection &
Certified Light Vehicle Crash Barrier**



Engineered Light Vehicle Barriers

**From this
expensive
structure**

**Saving Lives
& the Planet**



**To these economic
structures**

**Suppliers can help make
a Safety Case to prove it**

What is
a reliably

Safe Grade ?
Safe Speed?

*Part of the Specific
Conditions of Use
(SCU) for each model
Haul Truck in a
Regulator Free*

+ Safety Case +



+ Safety Case +

Safety Case Reports	6 month Timetable
793D	August 2011
789C	September 2011
785D	October 2011
785C	November 2011
777D	December 2011
773D	December 2011
769C	January 2012
797B	January 2012



Protection from the Edge of the Abyss

The Cutting Room Floor

*The Slides which follow
were cut out of the
Delivered Presentation
To meet time constraints*



A member of the  Sime Darby Group



Product People Commitment.

Specific not Generic

*This Supplier **Safety Case Report** and its User Tools are a means of managing specific technological risk in local conditions by model.*

Provided by the importer/supplier with provision for input from the OEM and feedback and revision as is necessary

Proof not Probability

*A Supplier Safety Case Report Provides **Specific Conditions of Use (SCU)** for Mines & Quarries to make a declaration of Proof of Zero Harm*

*The standard of Proof is “**beyond reasonable doubt**” because the adopted risk controls are considered reasonably practicable.*

Regulator Free

Supplier Safety Cases are made & upheld by the Importer/Supplier.
Proof established carries no legal authority, and Findings are subject to and open to stakeholder scrutiny.

Reasons to Doubt the Findings of Rested Safety Cases are expected from Stakeholders & Regulators as feedback to the case.

Our Excuse is Primarily our Brakes

***Brakes are the principle means of
controlling energy release from High
Consequence Workplaces (Haul Trucks
on steep grade)***

***The Safety Case **proves** the Continued
Effectiveness of the Braking System.***

***This provides the “Excuse” or Permit
to operate the Haul Truck***

Our Excuse is Primarily Brake Servicing & Maintenance

Queensland Mining and Quarrying
Regulation 2001. Section 109.(2) says:

If a breakdown of the plant is likely to cause an unacceptable level of risk, the operator or site senior executive must ensure the servicing and maintenance is based on a preventive strategy.

Preventing failure provides the “Excuse” or
Permit to operate the Haul Truck



After an event there is **proof** these were not
Safe Places to be at the time

Best to be ready with Ample Excuse
*Specific Conditions
of Use (SCU) Tool*

*Now Once Upon a Time...
Fred & Barney were
Embracing the Stone Age*



Supporting People and Technology

Fred's Never-Fail Park Brakes

My 100% Reliable Maintenance Free

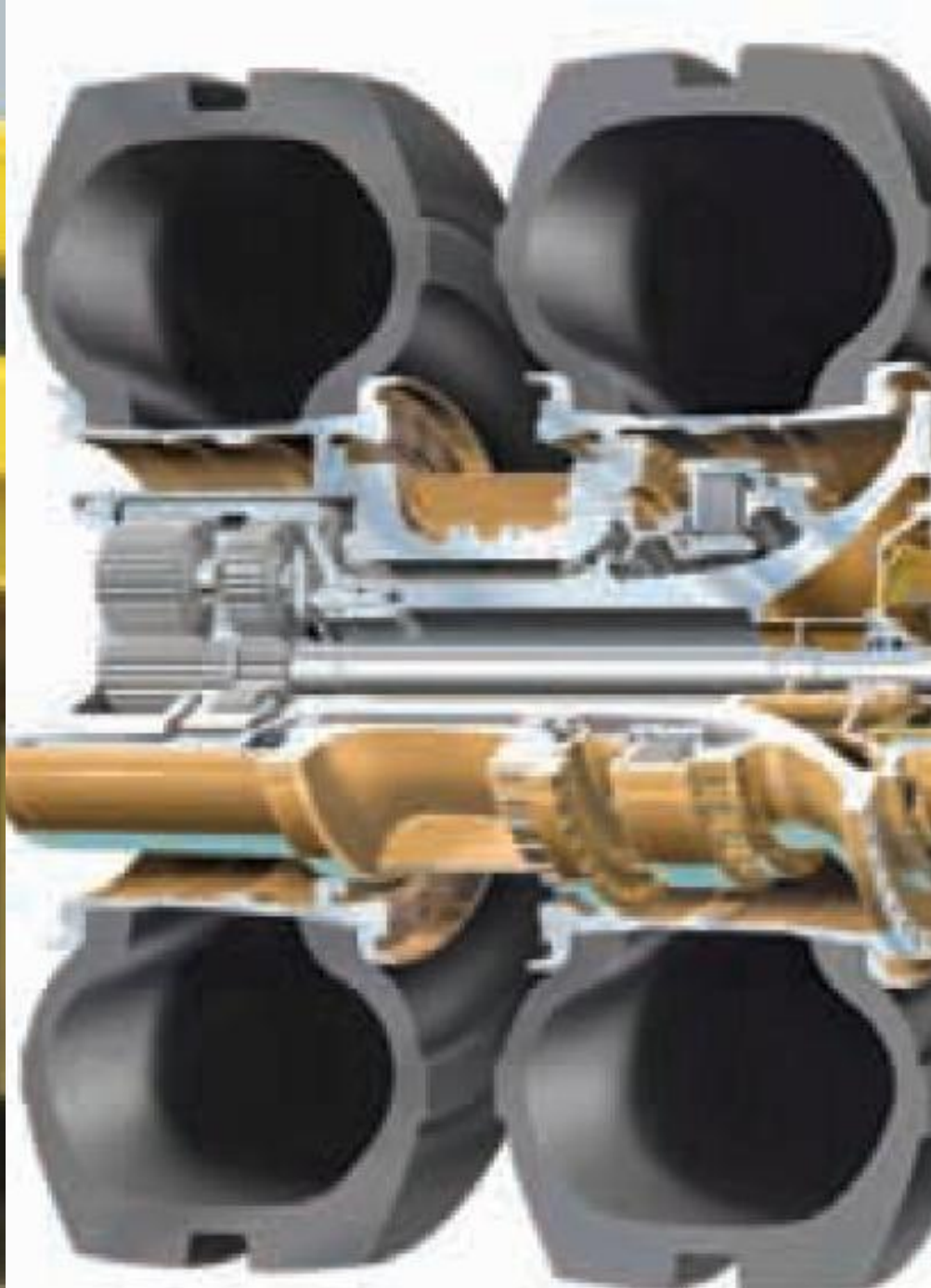
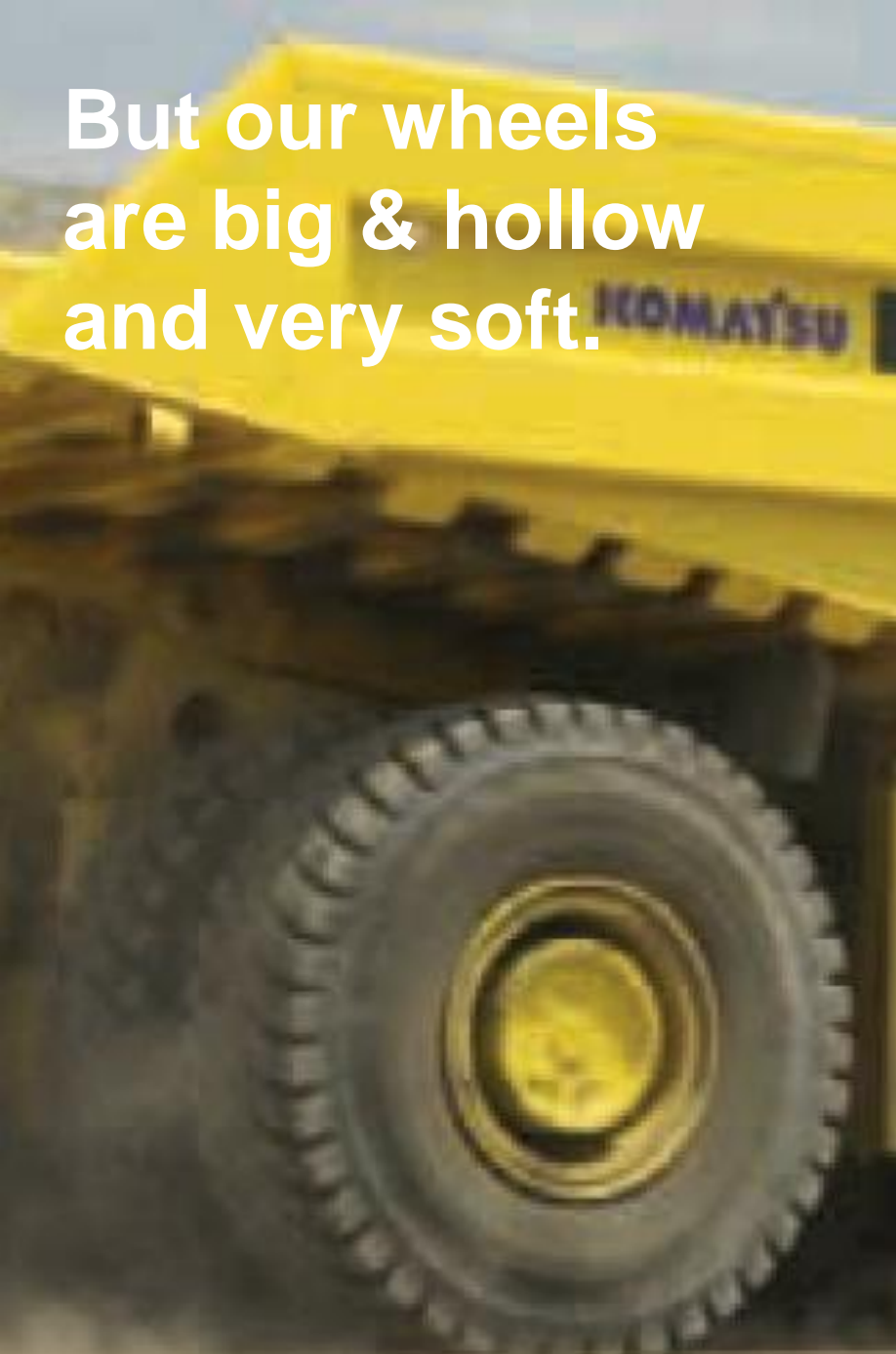
Solid
Stone
Chocks !

Solid
Stone
Wheel

Solid
Stone
Road



But our wheels
are big & hollow
and very soft.



Our Forever-Fail Park Brakes

Soft Road, Hollow Tyres & Plastic Brakes



**“Brake” Holding Test
Chocks as the Park Brake**

Soft Road, Soft Tyres & Hollow Plastic *Breaks*

Before

After



Cheap Plastic
Disposable Brakes



Catastrophic
Brake Failure



You sure
this is
Safe ?

Are these the right Brakes
for parking on a slope?



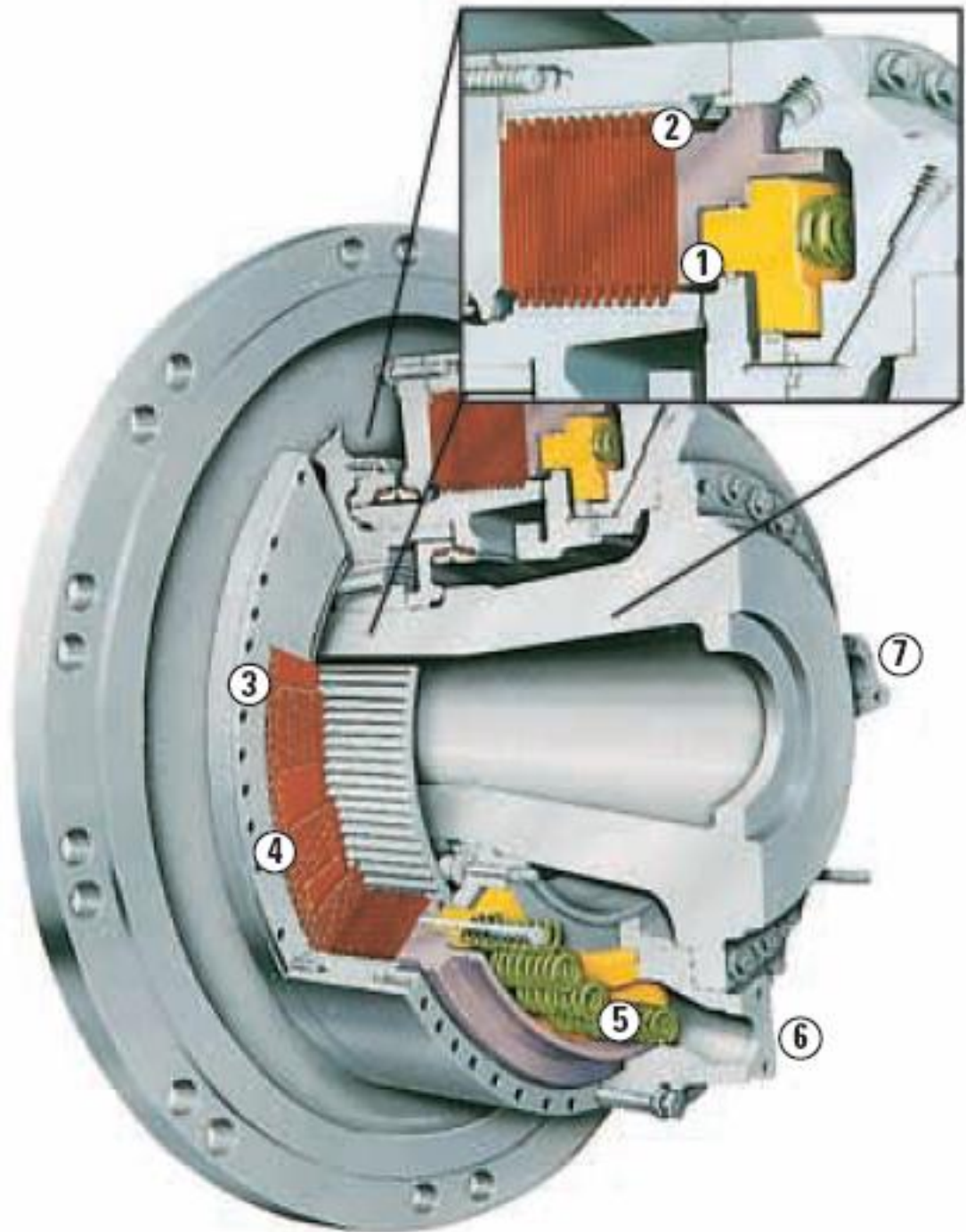
Grade Enhanced Image

*We have moved
on from the
Stone Age*

*Robust
Redundant
Park Brake*

*Fails to
Safety*

*Tolerant to
Drive
Through*



Chockbuster Solution

***Robust
Redundant
Park Brake***

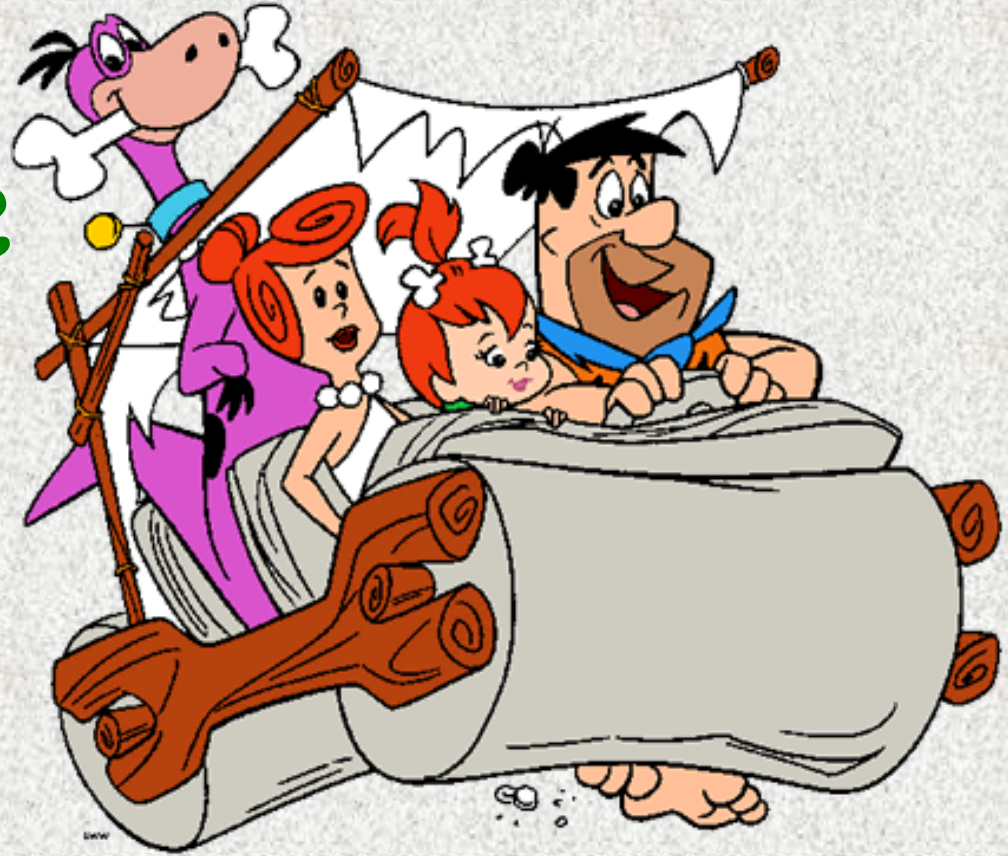
***Fails to
Safety***

***Tolerant to
Drive
Through***



Fred Invented Foot Brakes

**Maintenance
Free
Dynamic
Brake !**



And still the only one !

Soon Found a Problem !



Exposed Brakes Fire Down Below !

Fundamental Problem of All Ages !



Fire Down Below !

Fire Down Below video

Carbon Brake Testing Specific Risk Test for a Foreseeable Specific Event

Click this <http://www.youtube.com/watch?v=f4LFErD-yls> for web link or

Click this [777 PTO Brake Test.MP4](#) for linked video clip in same directory

The Message...

Have Certainty of Outcome

Examine the Specific Risk for
Foreseeable Specific Events
(eg Engine/Dynamics/Brake Failure)

Equivalent Heat Exposure



Boeing 777 laden to 260t stopping from 340 kph (Rejected Take Off Test)...Rare

240 US Ton Haul Truck laden to 380t descending 275m overall...Hourly

Generic Haul Truck Brake Testing

- ***AS 2958.1:1995***
- ***ISO 3450:1996***
- ***SAEJ1473***

Certified Testing all OEMs use



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

SAFETY ALERT

**Braking standards for trucks may
not be fit for purpose**

Mine Safety Report No: SA06-13

***Standards are not a “proof test” of
Specific Risk Control***

Generic/Standard Brake Tests

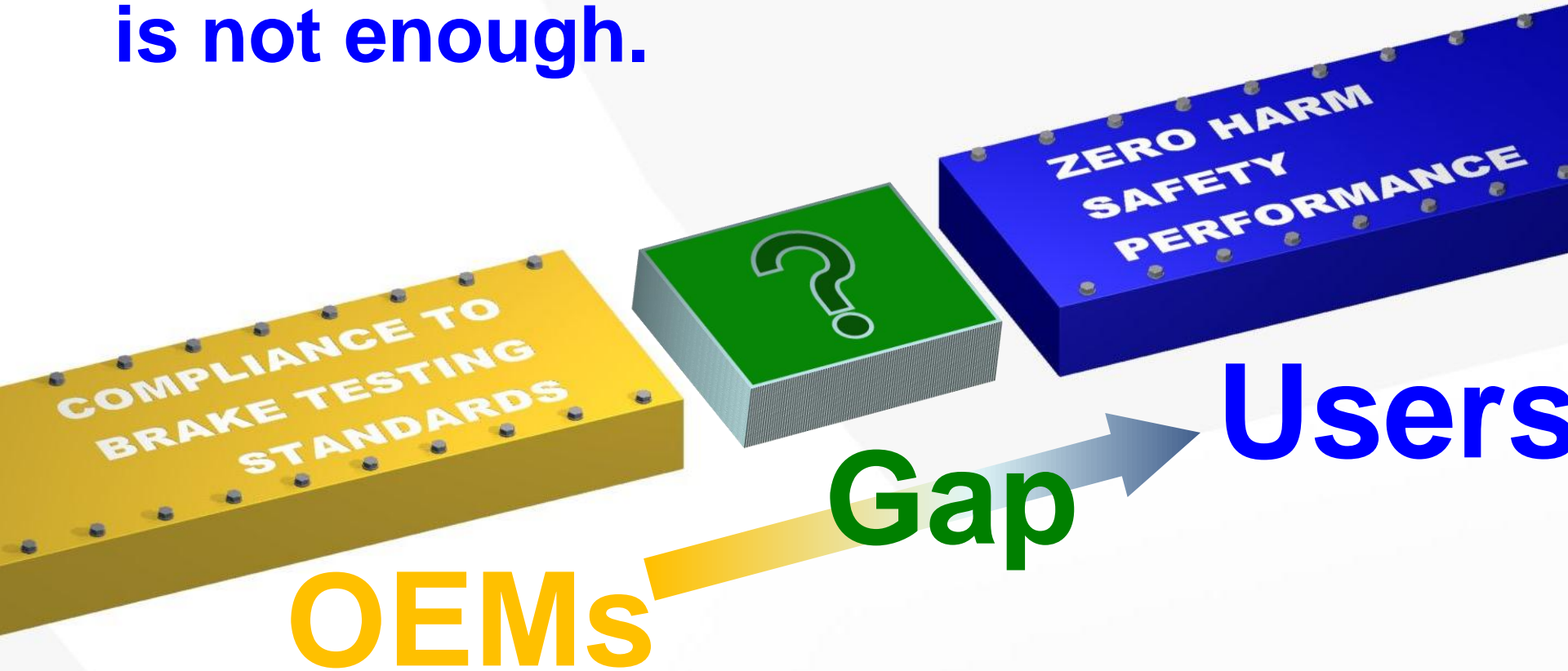
***But no simple standard
Truck/Minesite***

***Should we “proof test” Haul Truck
Brakes for specific risks faced ?***

***Yes and done in each
System Specific...***

+ Safety Case +

For Proof of Zero Harm as a simple
Yes✓ or **No**✗, Standards compliance
is not enough.



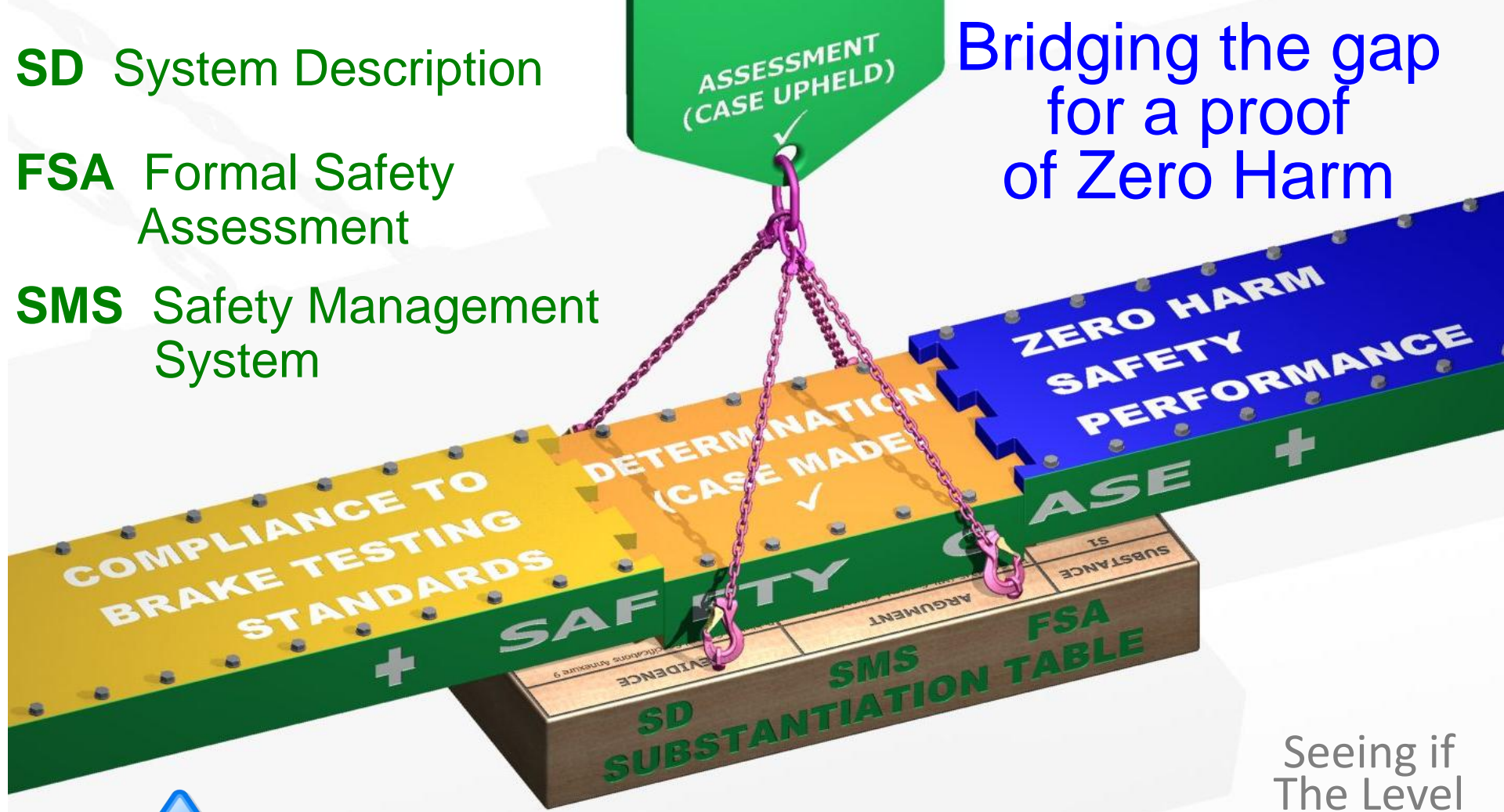
There must be a way to bridge the gap ?

SD System Description

FSA Formal Safety Assessment

SMS Safety Management System

Bridging the gap
for a proof
of Zero Harm



Safety Case
under
construction

Seeing if
The Level
is acceptable

*Finding of Yes
No Reason to Doubt*



+ Safety Case + Embracing the Information Age



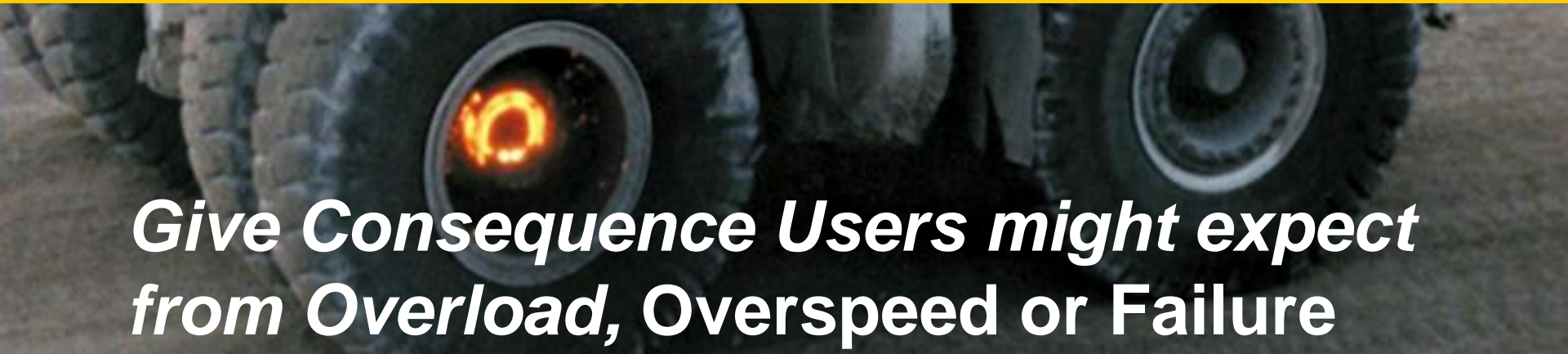
NSW DEPARTMENT OF
PRIMARY INDUSTRIES

SAFETY ALERT

Information to be supplied on safe operating grades for mobile equipment

“A person who supplies plant must provide adequate information to ensure its safe use”.

Suppliers need to say that on excessive grade...
“Every K over is a Killer” ☠



***Give Consequence Users might expect
from Overload, Overspeed or Failure***

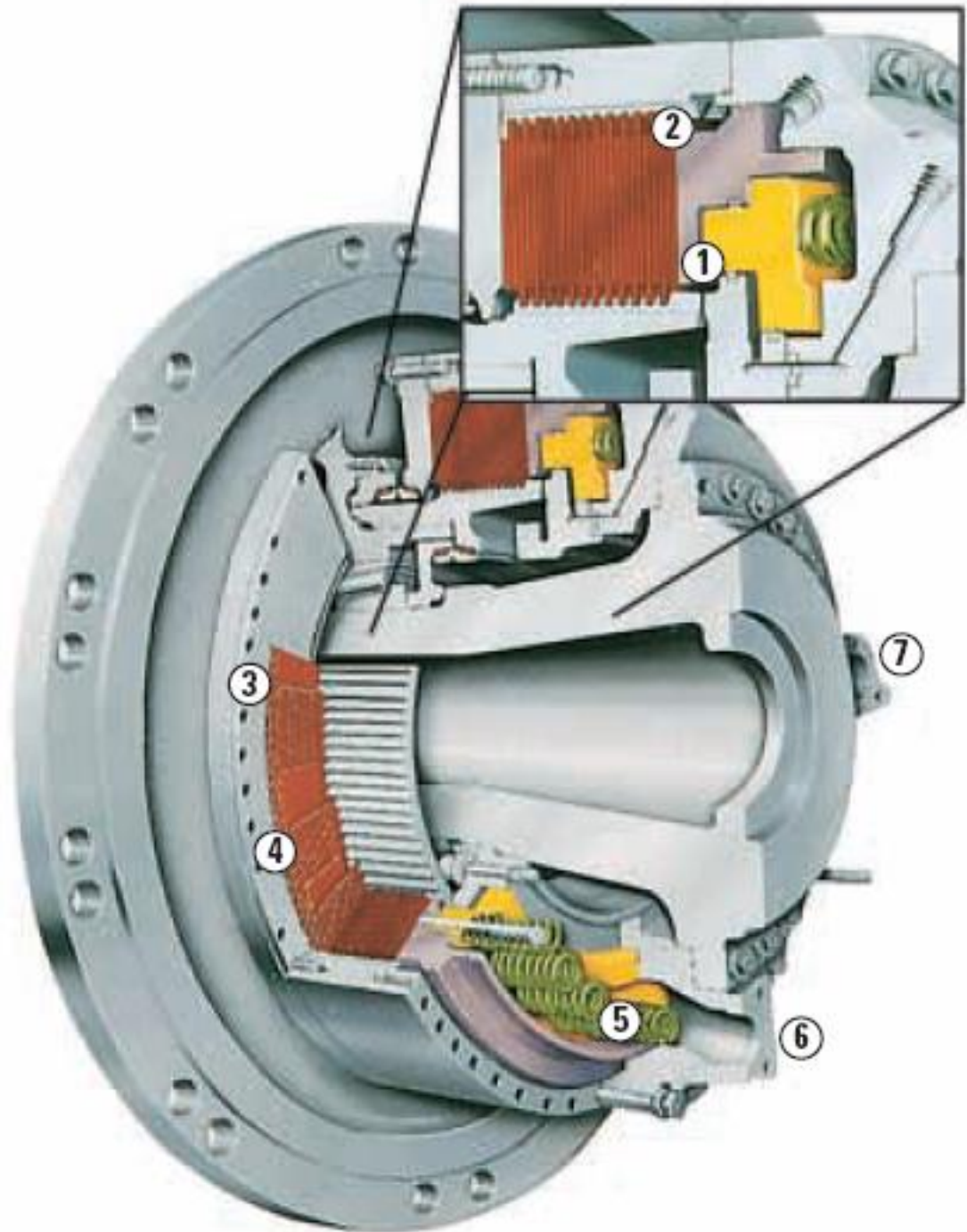
- **Runaway from worn service brakes**
- **Runaway from worn secondary brakes**
- **Fire risk from overheated brakes**
- **No inch of grade to be outside safe limits**
- **No critical component to ever fail**

No Overload, Overspeed or Failure

I can say if used properly

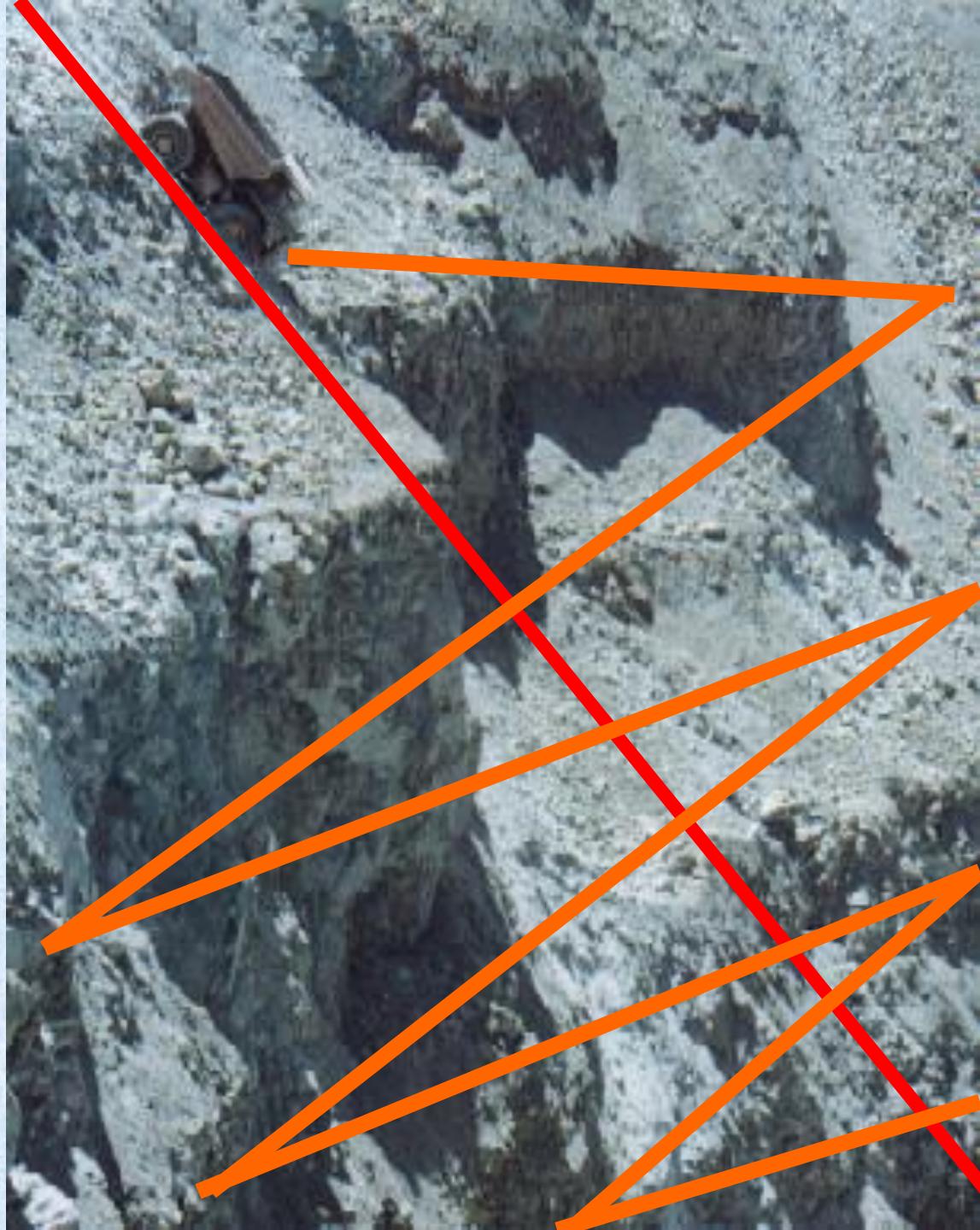
*Wet Brakes
won't critically
Heat or Fade*

*They Fail to
Safety !*



**Extreme Risk
of run away**
*Reason to Doubt
this grade*

**Removing
doubt...
add
switchbacks
to lessen
the grade**



*Every extra
switchback adds
to the good
excuses needed
to legally
descend this
slope*

*Add switchbacks
to achieve
a **Safe Grade** for
trucks on site*



What is a Safe Grade?

Try:

- **Braking Standards**
- **OEM**
- **Haul Road Manuals**



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

SAFETY ALERT

**Braking standards for trucks may
not be fit for purpose**

Mine Safety Report No: SA06-13

***Braking Standards do not give us
Safe Grades***

Generic Tests miss the Point

OEM Test... Grade 9%

- ***50kph Service + Retarder***
- ***25kph Secondary Only***

User Site Test... Grade 0%

- ***32kph...Useless...*** 

Only 19% of Heat of the OEM Test

SAFETY ALERT

**Braking standards for trucks may
not be fit for purpose**

***Braking Standards do not give
Safe Grades***

***The OEM
Should provide them***

SAFETY ALERT

**Braking standards for trucks may
not be fit for purpose**

***But OEMs do not give
Safe Grades***

Working Grades > Certified Grade


**18% @ 12.5kph
Wet Brake**





Standards Certified
Grade


9% @ 50 kph...OEM
0% @ 32kph...Site

**11% @ 26kph
Dry Brake**

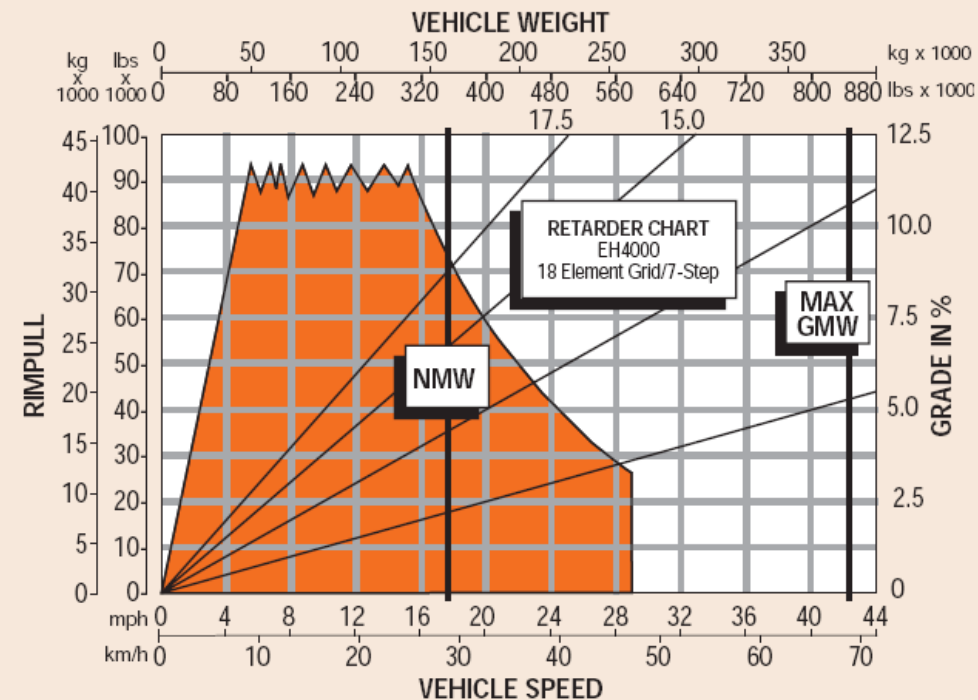


383 740 kg (846,000 LB)





	X > 610m (2000FT)	X ≤ 610m (2000FT)	km/h (MPH)
1	13-17	14-18	12.5 (7.8)
2	10-13	12-14	16.9 (10.5)
3	8-10	10-12	22.9 (14.2)
4	6-8	8-10	30.9 (19.2)
5	4-6	6-8	41.9 (26.0)
6	0-4	0-6	56.6 (35.1)



Safe Grade

*“Before actual road layout begins, manufacturers of the vehicles that will ultimately use the road should be contacted to verify the service brake performance capabilities of their products. In all cases, verification should reflect the capabilities of wheel brake components **without the assist of dynamic or hydraulic retardation.**”*



Prior quote from the Bible

Information Circular 8758

Design of Surface Mine Haulage Roads - A Manual

By Walter W. Kaufman and James C. Ault



UNITED STATES

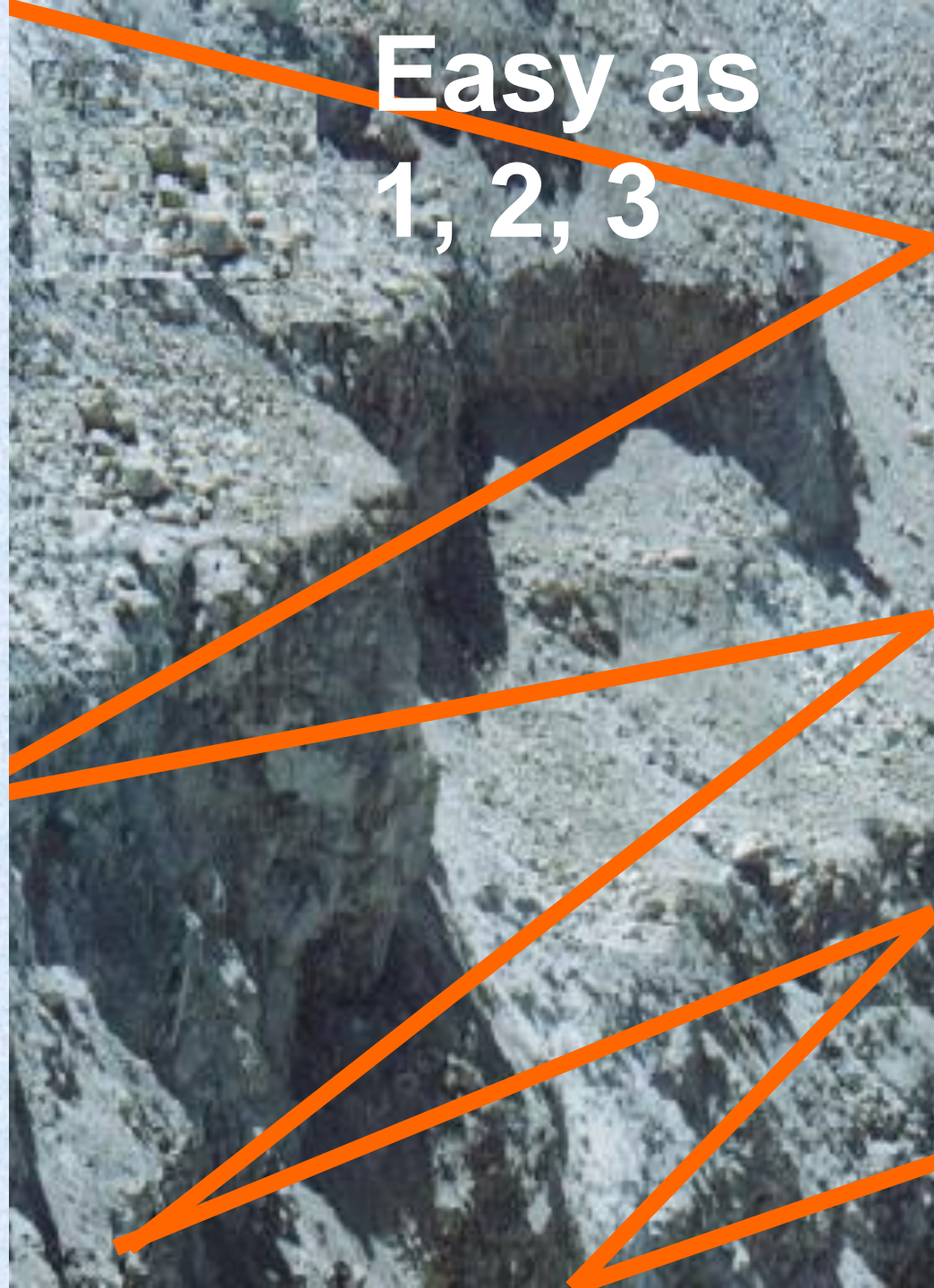
BUREAU OF MINES

Step 1
Select Truck

Easy as
1, 2, 3

Step 2
Select Truck's
Safe Grade

Step 3
Count cost of
Switchbacks
& runaway traps



So what is
a reliably

Safe Grade ?
Safe Speed?

*Part of the Specific
Conditions of Use
(SCU) for each model
Haul Truck in a
Regulator Free*

+ Safety Case +



+ Safety Case +

Safety Case Reports	6 month Timetable
793D	August 2011
789C	September 2011
785D	October 2011
785C	November 2011
777D	December 2011
773D	December 2011
769C	January 2012
797B	January 2012



Edge of the Abyss