

Risktec Solutions

risk management and assessment for business

ALARP: when is enough, enough?

Overview

- ALARP in GB rail
- Level of detail, time & effort in safety decision making process
- Qualitative or quantitative approach?
- Real world examples

SFAIRP and ALARP
generally
interchangeable

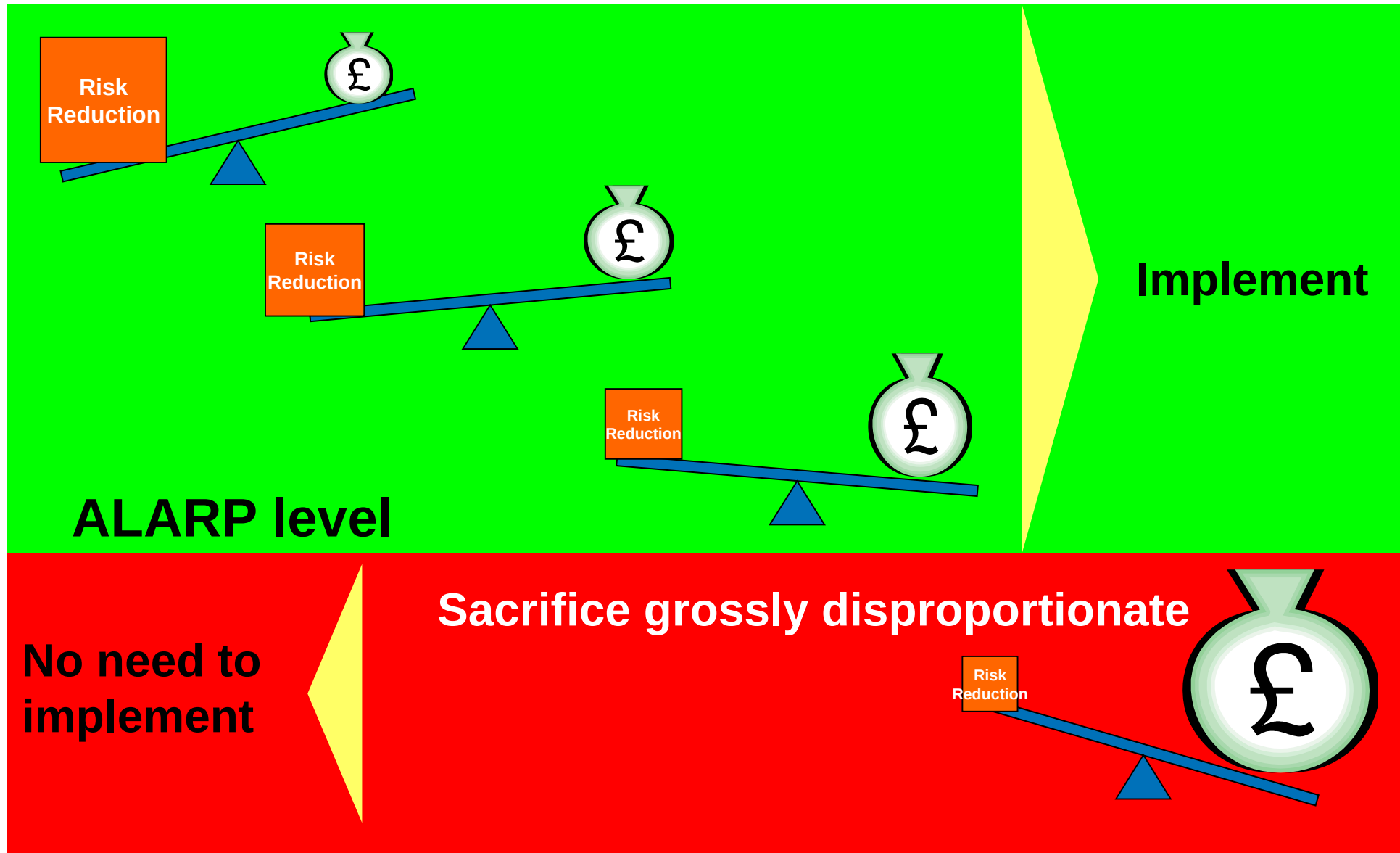
ALARP concept in GB rail

‘...a computation must be made...in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed on the other’.

Hence the ‘sacrifice’ is taken to be the cost of a potential measure and the ‘quantum of risk’ the safety benefit associated with it. The quantum of risk is a *collective risk* estimate. The VPF is used to translate the safety benefit to a financial value.

Case law establishes that a safety measure is reasonably practicable unless the cost is ‘grossly disproportionate’ to the safety benefit. This is determined by professional judgment, paying particular attention to the degree of uncertainty in the assessment of costs and safety benefits. See *Taking Safe Decisions* for more on ‘gross disproportion’.

Source: RSSB, CBA guidance



Rail industry standards & guidance



Transport for London
London Underground



Guidance on the use of cost-benefit analysis when determining whether a measure is necessary to ensure safety so far as is reasonably practicable

Internal guidance on cost benefit analysis (CBA) in support of safety-related investment decisions

February 2016

Category 1 Standard
S1521 Safety Decision Making

Taking Safe Decisions -
How Britain's railways take decisions that affect safety



Reverse burden of proof

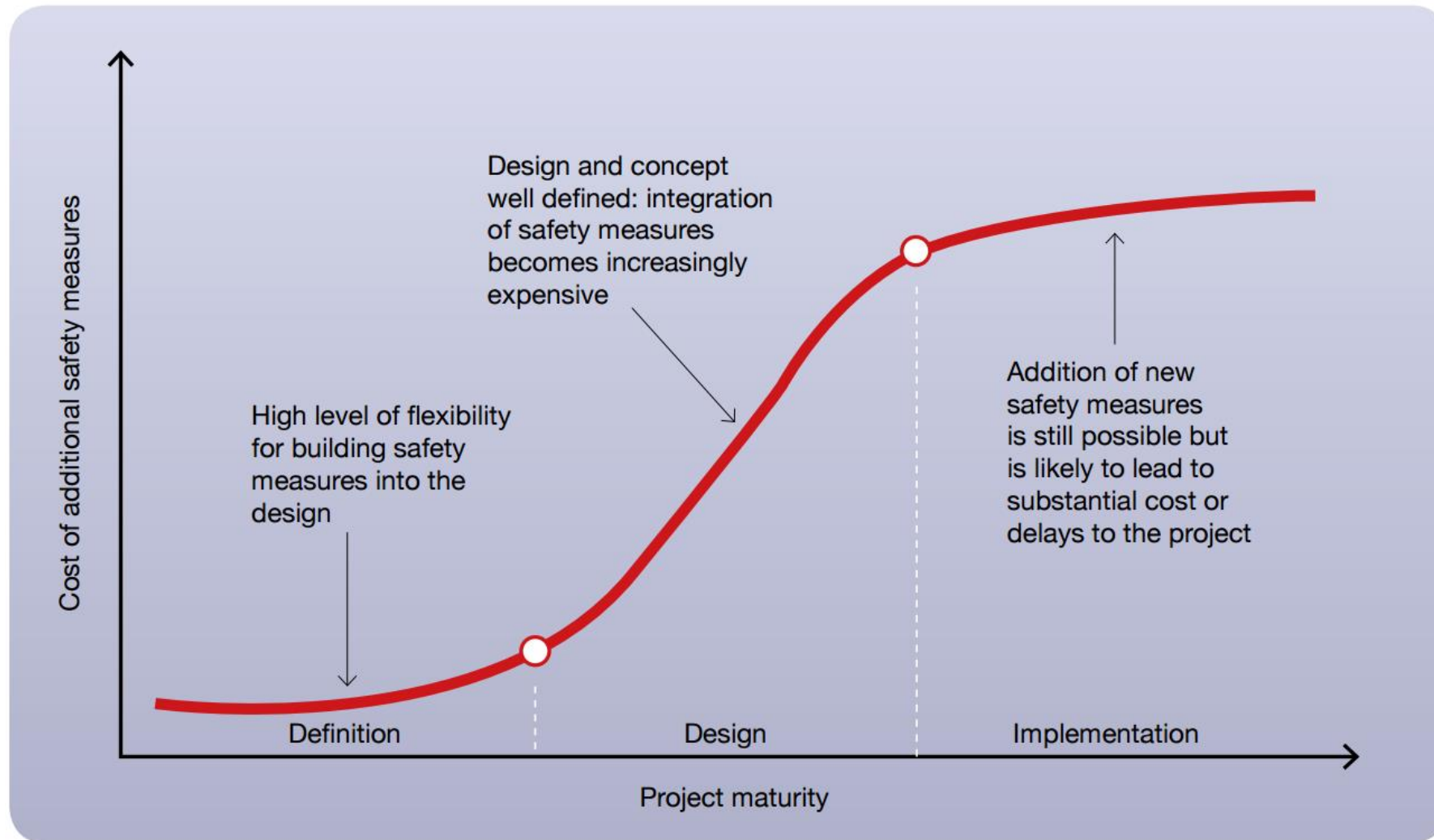
Gross disproportion acknowledges that accidents & their consequences difficult to predict – estimation of risk is an inherently uncertain process

Degree of uncertainty in risk estimates considered in judgment they are used to inform

Source: RSSB, TSD

Section 40 of HSWA says that *“it shall be for the accused to prove... that it was not practicable or not reasonably practicable to do more than what was in fact done...”* sometimes referred to as ‘**reverse burden of proof** – anyone taking decision *not* to introduce a safety measure needs to be confident that it is not reasonably practicable

Timing is key



Source: RSSB, TSD

Delay not an excuse

It is *not* acceptable to argue that a measure is not necessary to ensure safety SFAIRP on the basis of excessive cost if that measure could and should have been identified at an earlier point in the project when its implementation would have been required

Source: RSSB, TSD

Demonstrating ALARP is a *process*

1

Identify & assess hazards

2

Confirm minimum acceptance criteria met

3

Identify all possible risk reduction measures

4

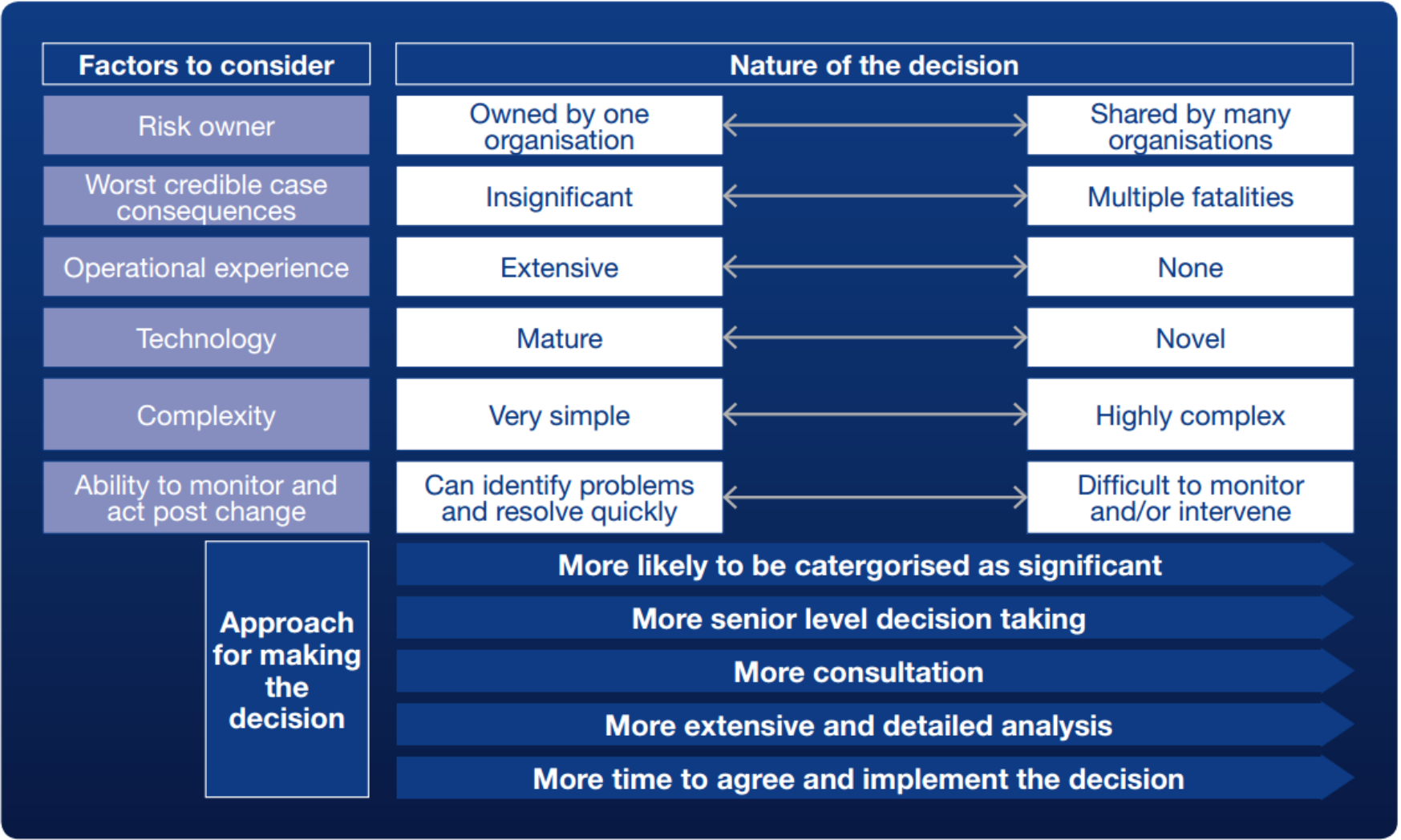
Implement unless proven not reasonably practicable

5

Document process & justify decisions

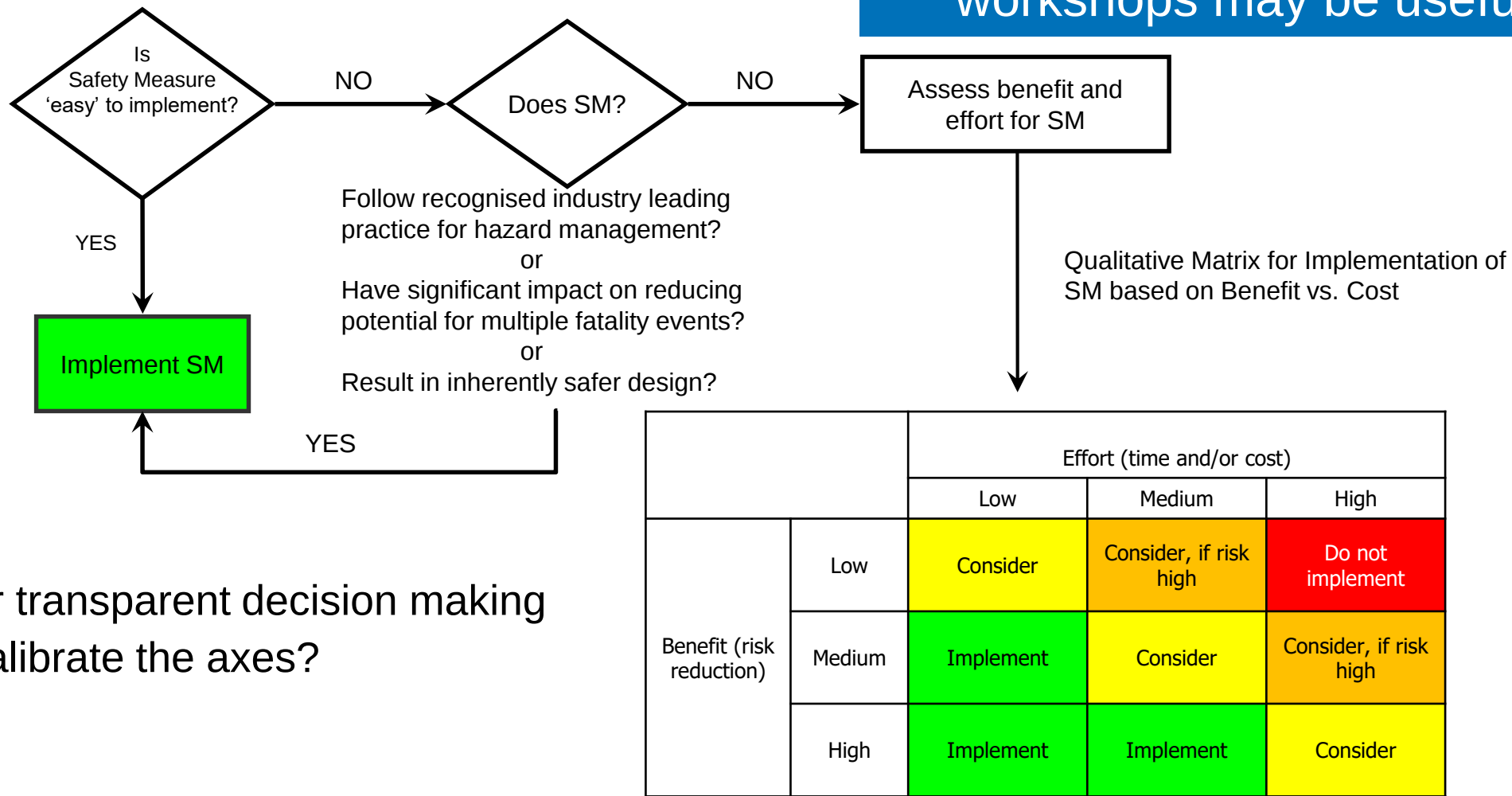
Risk reduced ALARP once every measure identified either implemented or proven to be not reasonably practicable

When *is* enough, enough?



Qualitative ALARP

Expert judgement & structured workshops may be useful



- Allows for transparent decision making
- How to calibrate the axes?

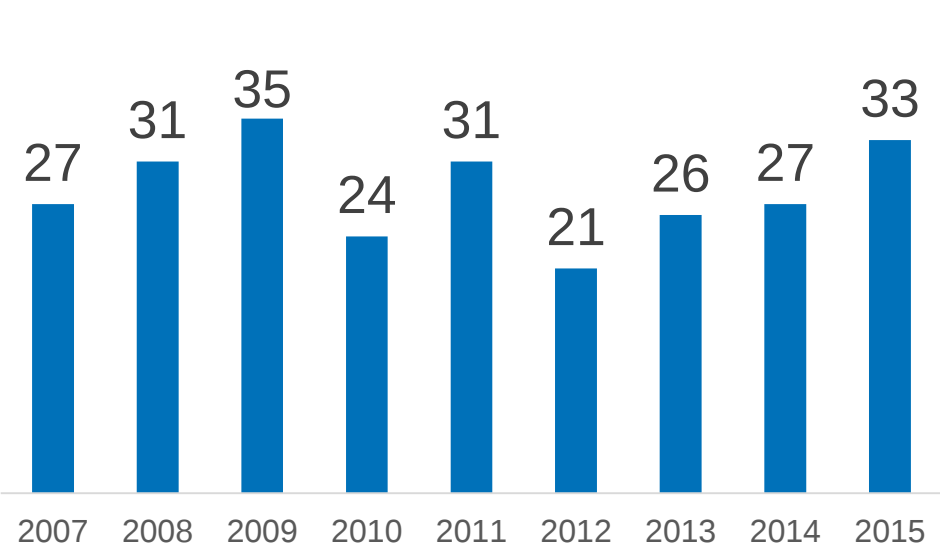
ALARP assessment should *start* with a qualitative approach before considering quantitative

Kirkstall Forge station

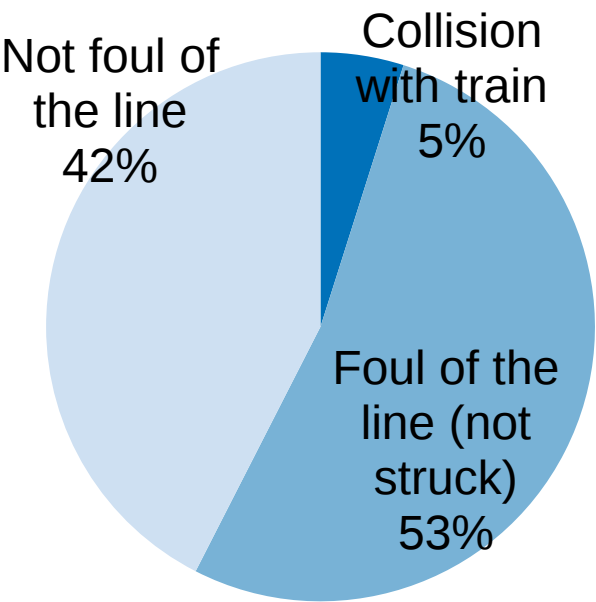


- New station near Leeds (opened June 2016)
- Independent safety review raised concern of potential vehicle incursion onto station and track

Vehicle incursion data



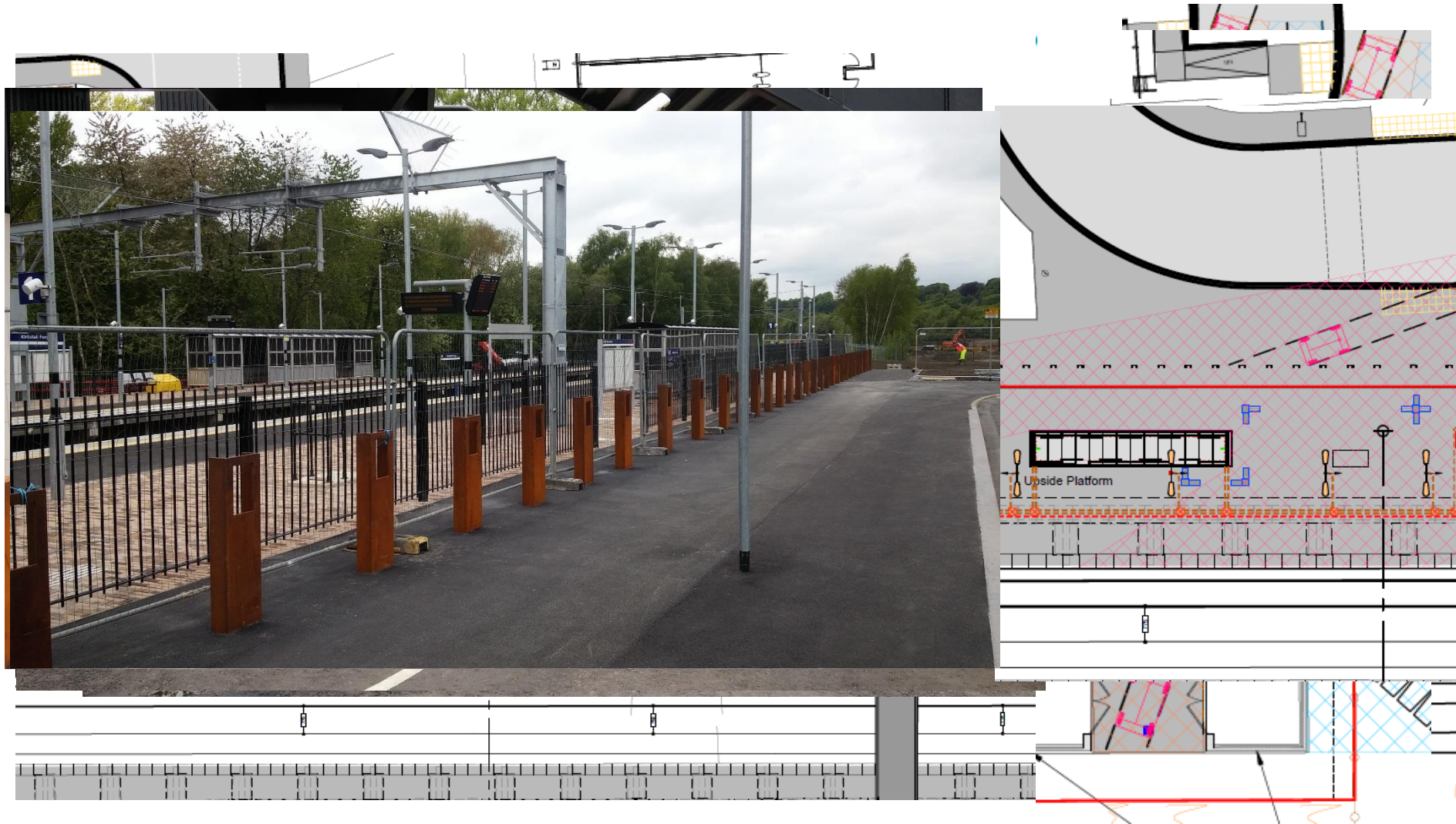
Number of Road Vehicle Incursions
at Stations (2007 – 2015)



Vehicle Incursion Outcome by Final
Resting Place (2005 – 2015)

Source: RSSB, SMIS & ASPR

Vehicle incursion scenarios



ALARP review: example site

Mitigation Measure	Benefit	Effort	ALARP Review	Notes
Droppable bollards between two substations (front line of substations)	High	High	Consider	
Droppable bollards between two substations (back line of substations)	High	High	Consider	
Concrete lane guard barrier between two substations (back line of substations)	Medium	Medium	Consider	Barrier will bend/shift on impact and may not be a permanent solution
Large planters between two substations (back line of substations)	High	Low	Implement	

Outcome: example site

- Concrete planters with rebar
- PAS 68 rated – stop a 2.5 tonne vehicle at 40 mph
- Shallow foundations – limitations due to buried services
- <http://www.securiscape.co.uk/compare-our-products/planter>

$$NPV \text{ safety benefit over } T \text{ years (£)} = DF \cdot \sum_{t=0}^T VPF \cdot Risk \text{ Difference} \cdot \frac{1}{(1+r)^t}$$

- NPV: net present value
- DF: disproportion factor (1 – 10)
- VPF: value of preventing (statistical) fatality e.g. using published RSSB figure (£1,826,000)
- Risk difference = base risk – option risk
- t: time from 0th to Tth year
- r: discount rate (%)
 - Safety benefit @ 1.5% (1% for > 30 years)
 - Costs @ 3.5% (3% for > 30 years)



HM TREASURY

THE GREEN BOOK

Appraisal and Evaluation in Central Government

Note explaining changes made to the Green Book in July 2011:

This is the 2003 edition of the Green Book. However, pages 57-58, which deal with the valuation of non-market goods have been updated alongside the release of a Green Book discussion paper on this subject - Fujiwara and Campbell (2011), Valuation Techniques for Social Cost-Benefit Analysis: Stated Preference, Revealed Preference and Subjective Well-Being Approaches.

The changed text on pages 57-58 has been highlighted in red within this updated document. Because of the changes there is some duplication of paragraph numbers, and there is some change to the sequence of footnotes in this section.

Derailment containment in the Connaught tunnel



- Twin track, single bore tunnel → secondary collision
- Reduced clearances
- Evacuation walkways in 4 foot only
- Alignment – tight radius of curvature on entry/exit

Standards & requirements

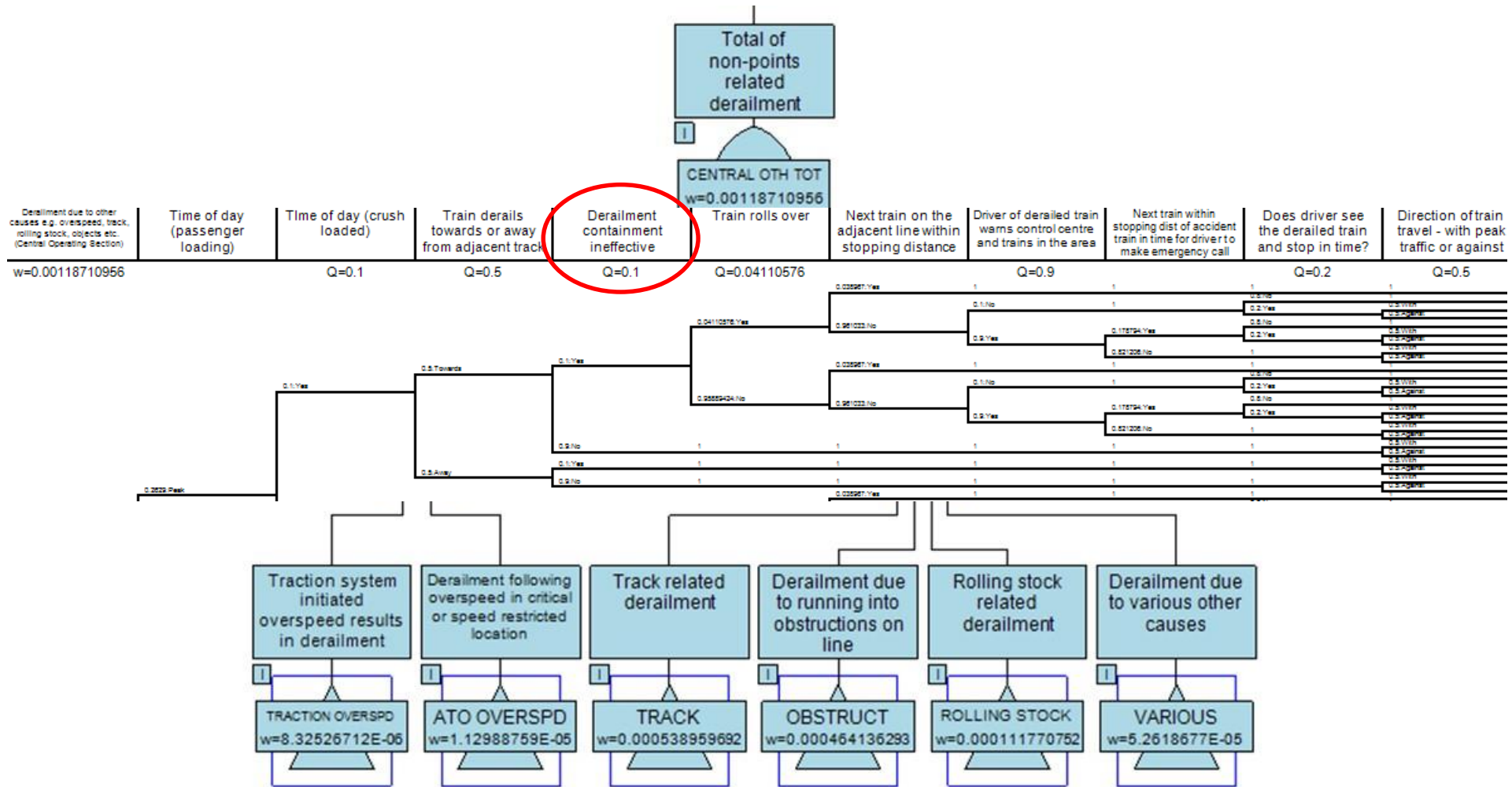
CPFR: Derailment containment shall be included in the design of the subsurface sections

RGS: The track should provide for the safe guidance and support of trains. The factors for consideration should include...the provision of adequate containment arrangements where the effects of derailment would be severe

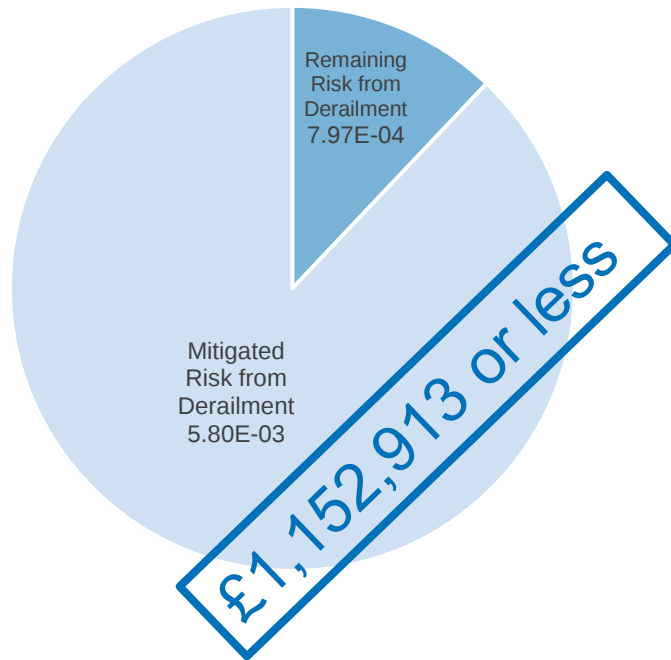
History of ALARP studies

Date
November 2012
July 2013
June 2014
October 2014
April 2015
May 2016

Fault & event trees



Outcome



QRA shows DC *risk reduction* of 0.00581 FWI/year

50 year *safety benefit* calculated using 2015 VPF

Gross disproportion factor of 3 applied by project in this case

50 year cost of DC options to be compared with safety benefit

If 50 year NPV CAPEX + OPEX of designing, installing & maintaining chosen DC option is equal to or less than the safety benefit, then it *should* be implemented on grounds of reasonable practicability

Summary

- ALARP as used in GB rail
- Qualitative or quantitative approaches possible depending on application
- Real world approaches to ALARP & safety decision making

Thank you for your attention

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