Risk, Detriment and Hidden Conservatism – *how to price Nuclear out of the Marketplace*

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Risk

Bear in mind that……..

If you only had a one-in-a-million risk to worry about every year, you'd have a median life expectancy of about 611,700 years

now read on……..

Safety Risk and Regulation

Regulation of activities causing harm to people has two aims:

- **Welfare of the population – reducing overall detriment or harm**
- **Protection of the individual – reducing risk to the most exposed**

"The greatest good for the greatest number while safeguarding the welfare of the individual"

Nuclear Risk and Regulation

Most regulations built up over decades by trial and error – e.g. railways, mines, shipping

The advent of nuclear power brought different challenges!

Nuclear has understandably been at the forefront of developing concepts and methodologies of safety assessment and regulation ……but

Risk

Bear in mind that……..

If you only had a one-in-a-million risk to worry about every year, you'd have a median life expectancy of about 611,700 years

This standard was developed against the background of the frequency of large accidents causing considerable detriment for humans and the environment – e.g. core meltdowns etc

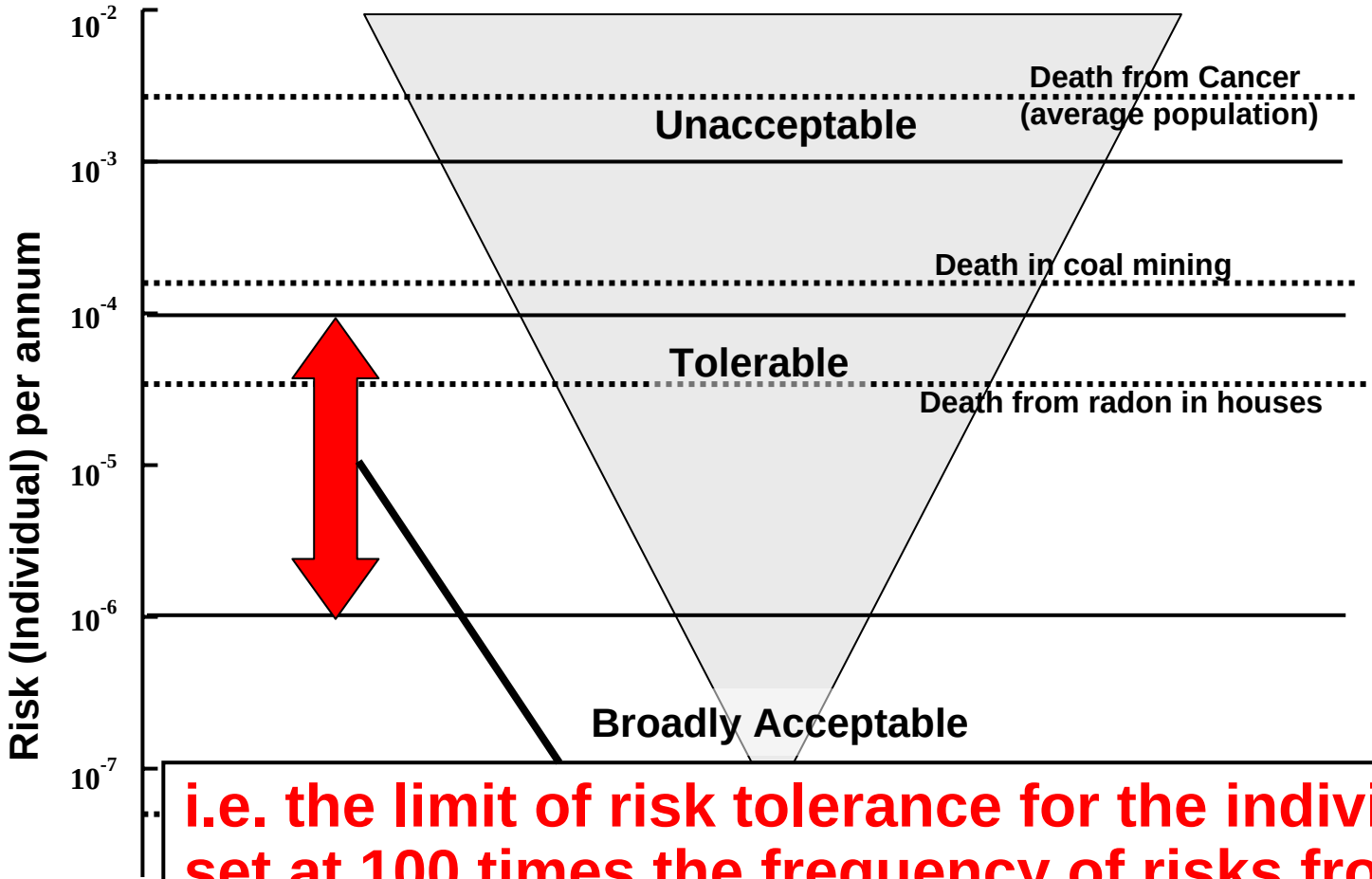
Nuclear Risk and Regulation

In UK, Tolerability of Risk examined risk to the individual – free from the 'large event – large detriment' background of the original nuclear safety regulation.

It proposes that:

- **No worker should experience a risk > 1 in 1000 per annum**
- **No member of the public should experience a risk > 1 in 10,000 per annum**
- **A risk lower than 1 in 1 million was 'broadly acceptable'**

Tolerability of Risk

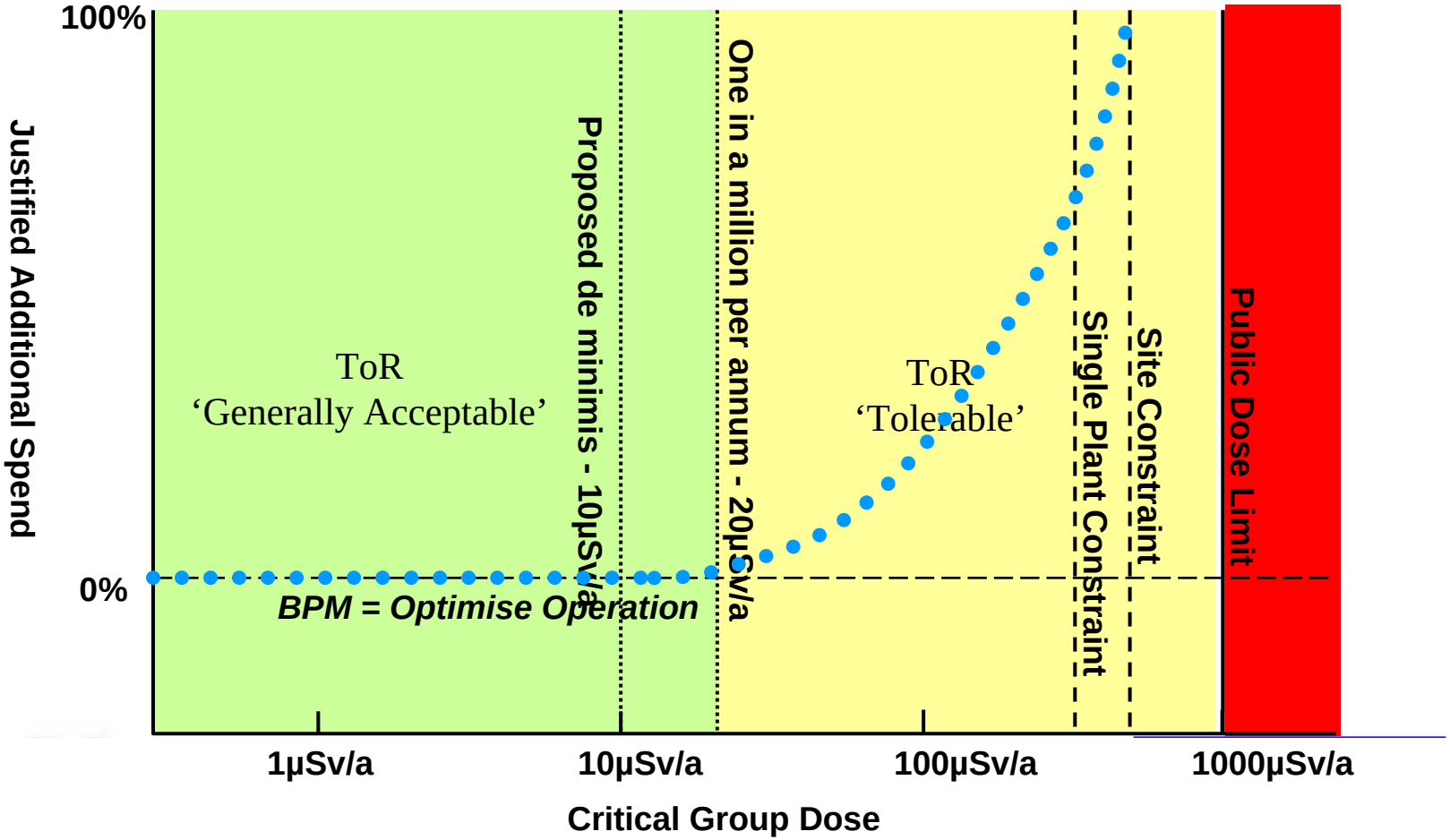


i.e. the limit of risk tolerance for the individual set at 100 times the frequency of risks from large consequence events – logical??

Critical Group Dose reduction versus cost – Expected?

- The form of the ‘willingness to spend on reductions’ versus ‘critical group dose’ has not been established
- It might be expected that the driver would be a maximum at the upper end of ‘Tolerability’ – equating to the UK public dose limit of 1000μSv/a, and the 500 μSv/a site dose constraint
- As the dose approached ‘Broadly Acceptable’, the spend would be expected to drop to near zero – and indeed there have been several policy pronouncements about dose levels at the ‘one in a million’ risk level being ‘of below regulatory concern’
- This should give rise to the situation illustrated……..

Critical Group Dose reduction versus cost – Expected?



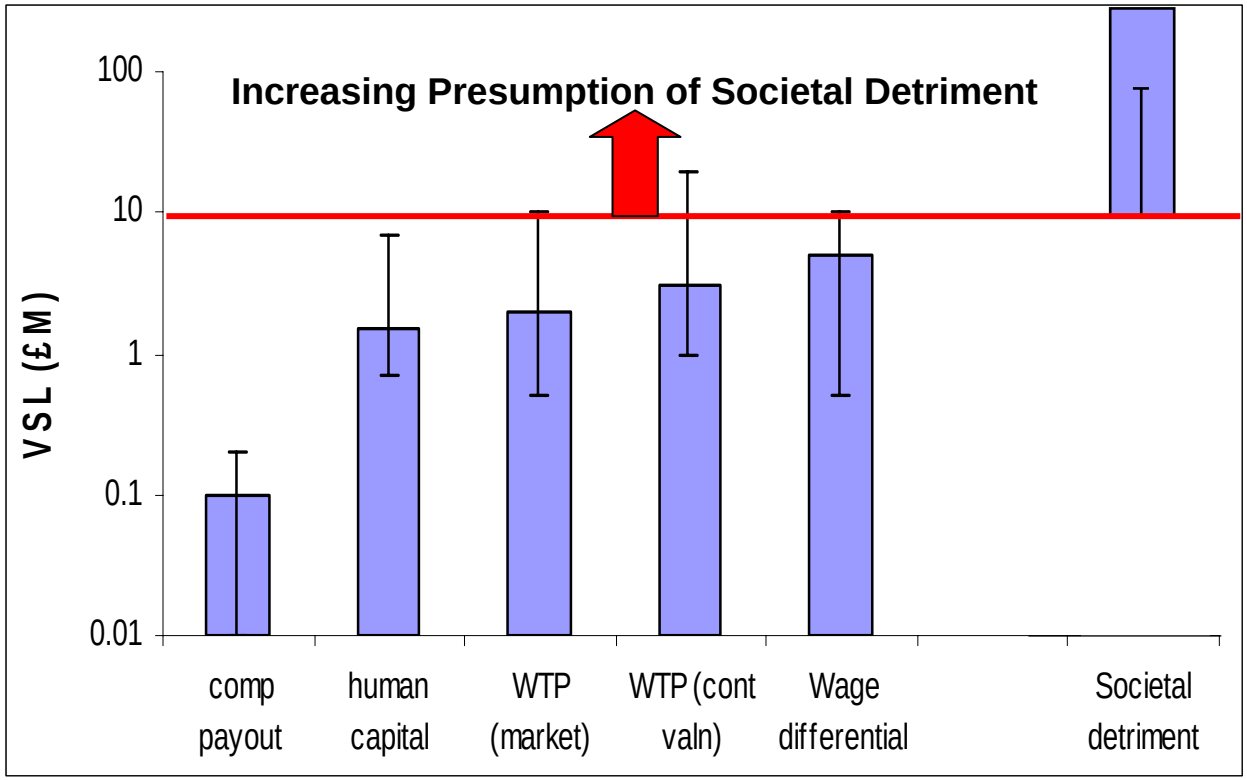
Critical Group Dose reduction versus cost – Expected?

That slide is 7 years old – I was naïve in those days!!

Nuclear Risk and Regulation

- ToR regulates by limiting the peak risk to individuals
- This does not consider the welfare of the population i.e. are there a few, a few hundred or a few million at or near peak risk?
- Overall detriment measured as number of fatalities or other effects – need to balance the reduction of risk to the few against the overall welfare of the many
- This is ethically challenging as it involves valuing statistical lives – but in the current context is a nettle that needs to be grasped
- BECAUSE – if you are spending large amounts of money on a few people at risk, the overall welfare of the population may be reduced

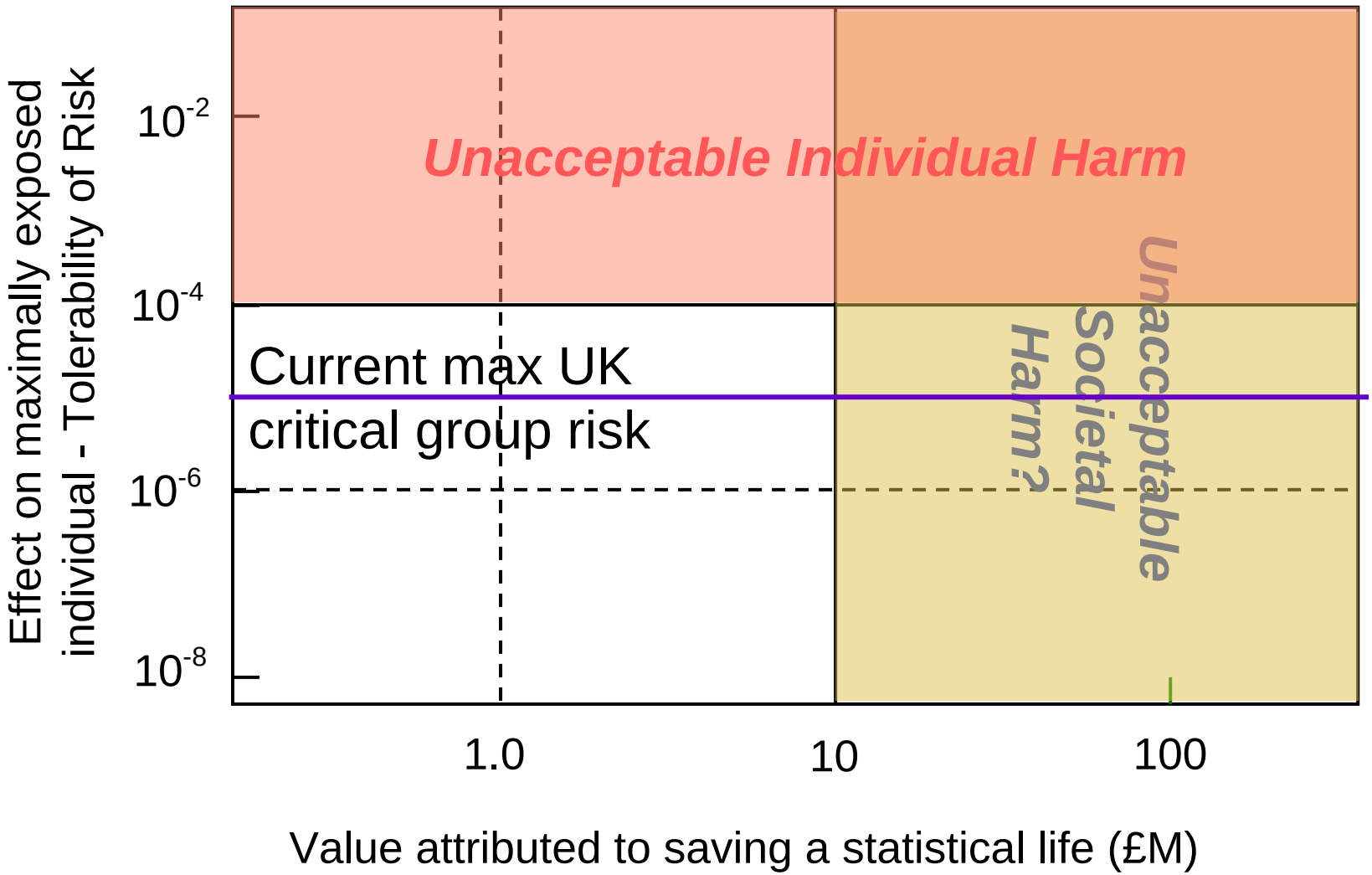
Values of Statistical Life



Nuclear Risk and Regulation

- **UK Government Policy gives Values of Spend for Saving a Statistical Life (VSSSL) of around £1m for such purposes as traffic schemes**
- **Treasury guidance mentions that some risks with high aversion may attract higher VSSSL values than this – but discourages anything over a factor of 2**
- **In the nuclear arena analysis of schemes has shown VSSLs of tens or even hundreds of millions of pounds**
- **An NRPB figure of £20K (1993) per man Sievert (about equivalent to the £1M VSSSL) is used when convenient (i.e. when it gives the 'right' answer) but otherwise ignored**
- **The process can be illustrated……**

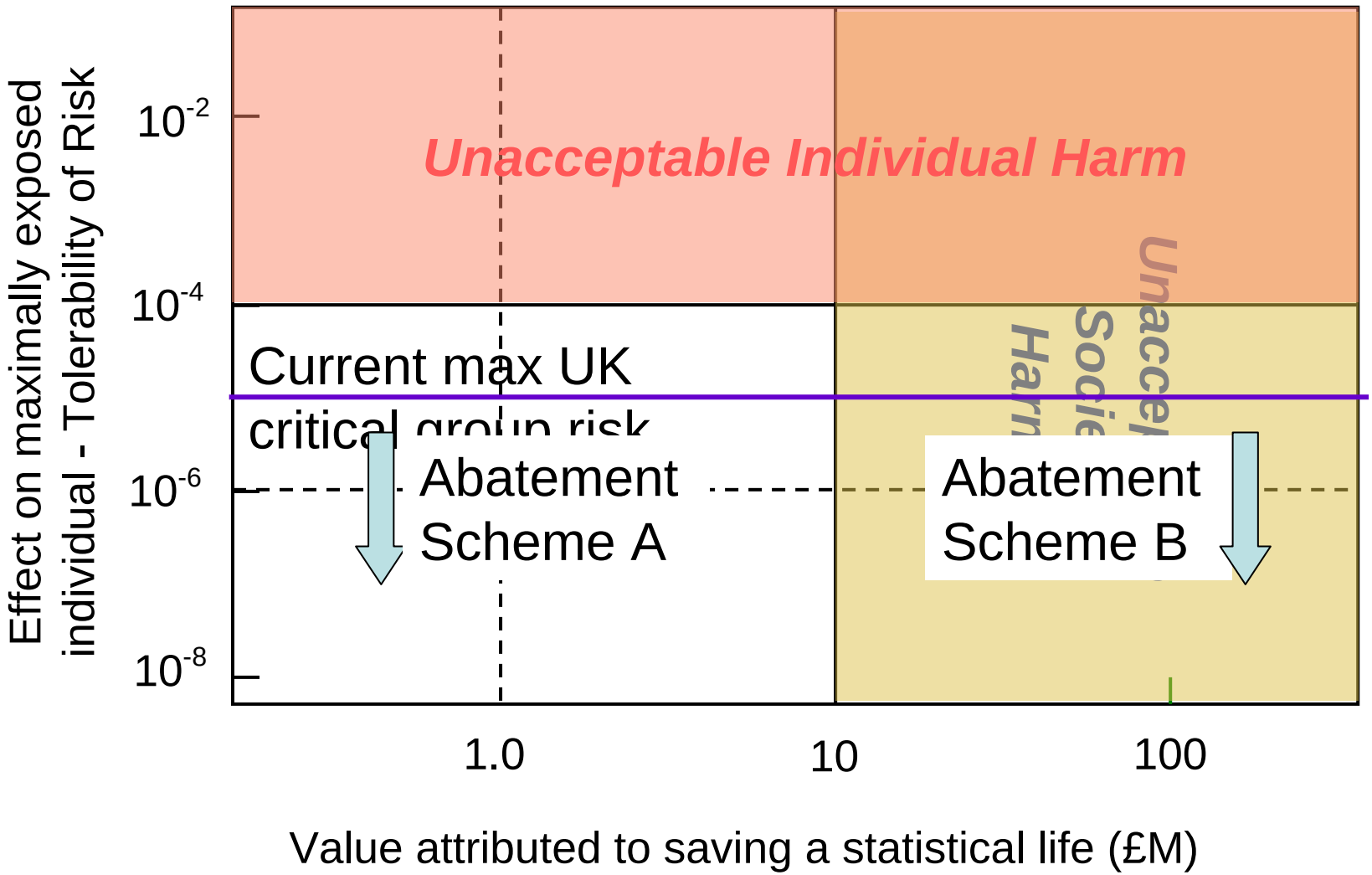
Balancing Individual and Societal Good



Nuclear Risk and Regulation

- It would be expected that when individual risks were all in the Tolerable region and the vast majority well within the Broadly Acceptable region, then the main regulatory driver would be the reduction of societal detriment – collective dose
- This could be tested by comparing the attitude to two discharge reduction schemes….

Balancing Individual and Societal Good



Balancing Individual and Societal Good

- If you were balancing these two factors, Scheme A looks justified by both criteria
- Whereas Scheme B is reducing a ‘tolerable’ risk to a few people while practically certainly causing overall societal harm
- The ‘Scheme B’ situation is commonplace in the UK nuclear industry and the overall picture is that ALARA /ALARP’ critical group dose reductions are being driven virtually without regard for the cost
- This disproportionality is even less defensible when the nature of the risks is examined

Risks Characteristics

- **Nearly all the other risks of fatality quoted in R2P2 are 'statistical' – i.e. for every million people exposed to a one-in a thousand risk, on average 1,000 people per year will die, and be identified as dying from the risk**
- **Being struck by lightning, road traffic risks and the like are illustrations – you run the risk, you are unlucky, you die from a lighting strike/traffic accident etc. The realisation of the risk is immediately identifiable.**
- **Risks from radioactive discharges are very different – in that they are *theoretical* – based on Linear No Threshold modelling assumptions – and are a very small predicted part of the overall mortality from radiation, which is itself is a small proportion of overall deaths from cancer**

Risks Characteristics

- **Nuclear Industry discharges are *modelled* to cause small numbers of *theoretical* deaths**
- **These models show that very little of the risk is delivered at the 1 in 100,000 level of the maximum UK critical group – in fact nearly all the dose is delivered at a risk level of between 1 in 10 billion and 1 in 1000 billion per annum**
- **We contend that with this risk spread, it makes little sense to have a single value for VSSSL – we surely value**

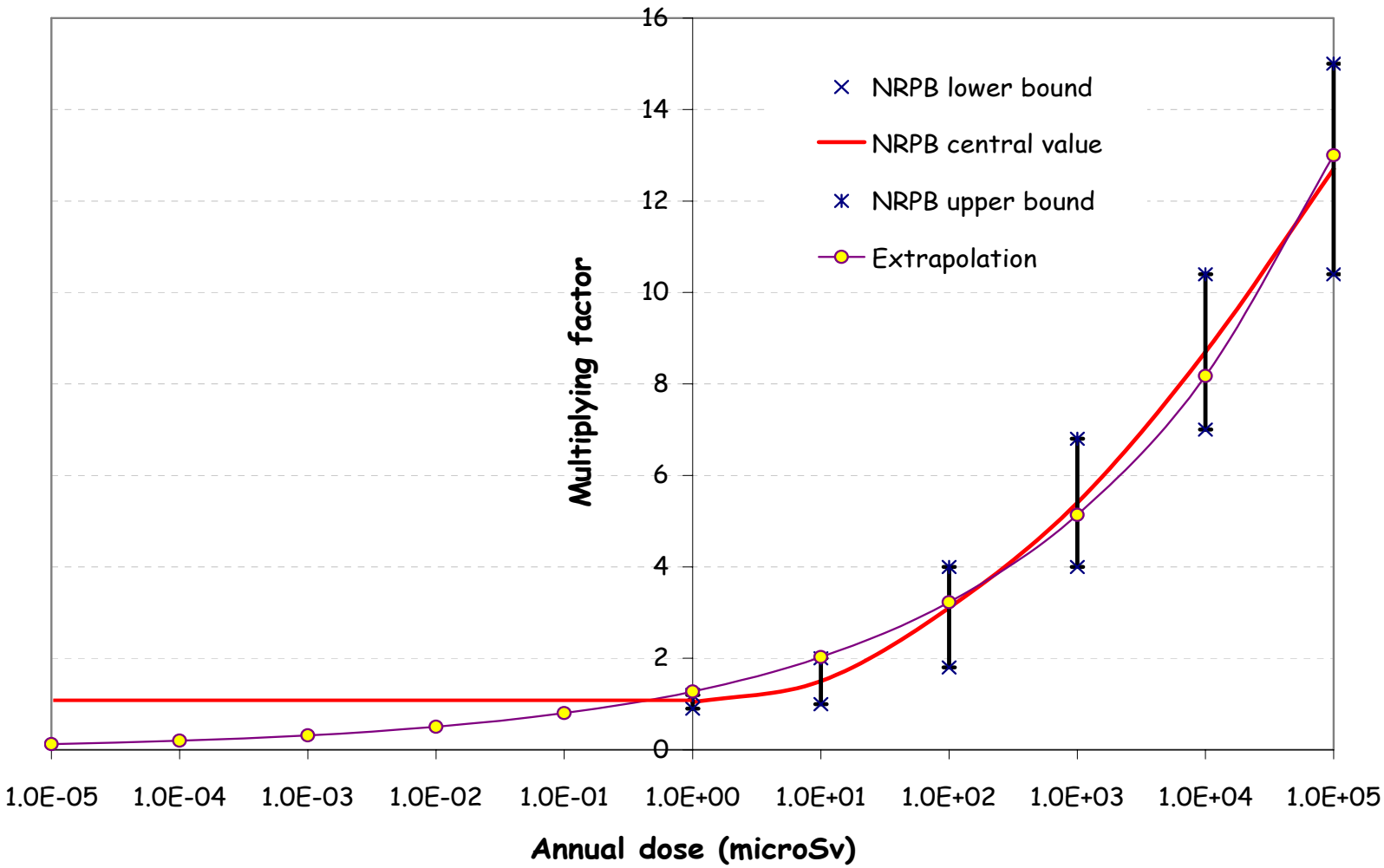
1/100,000 x 100,000 = 1

more highly than we value

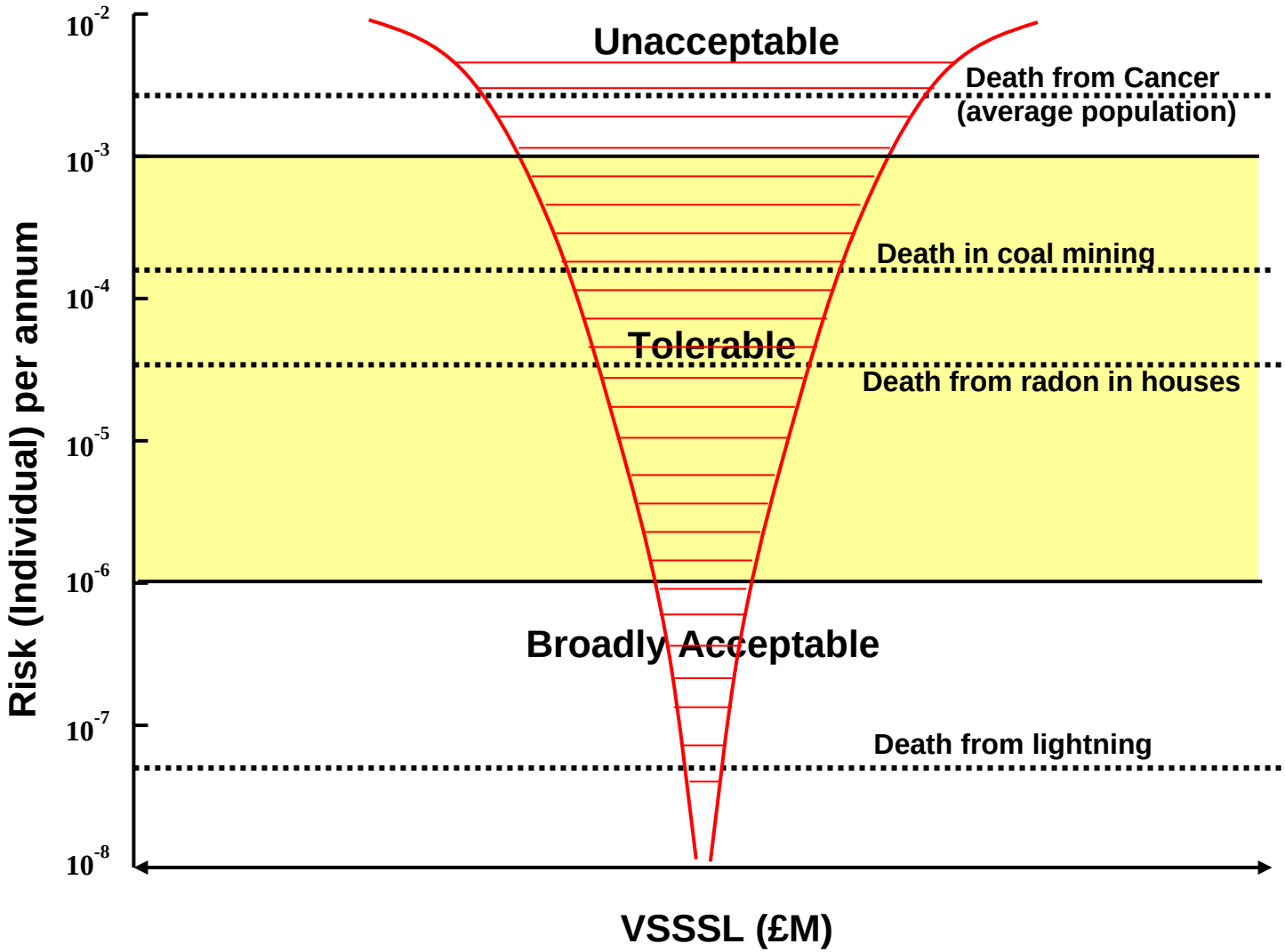
1/100,000,000,000 x 100,000,000,000 = 1??

- **Such a scheme has been suggested and looks like this…**

Methodology – Dose Valuation



Methodology – Dose Valuation



Risk Estimation

- When the risks encountered are near the high end of the acceptable levels for individuals, it is important that these most exposed individuals do not cross the ‘safe/unsafe’ boundary – the study of ‘exotic’ behaviour is somewhat justified?
- Where the risks encountered are all well within the tolerable region, surely the imperative is to establish realistic estimates of the most exposed doses for ‘normal’ people – secure in the knowledge that ‘exotics’ will not approach an unsafe state?
- Two examples will illustrate the extent to which disproportionality is achieved

Risk Estimation – Geological Disposal

- Buried deep in UK disposal safety cases is the concept of the Potentially Exposed Group – who spend their entire lives as subsistence farmers taking all their water from a spring which has percolated through the repository
- These people are targetted to meet the ‘one in a million’ safety standard
- If the group is, say, 50 strong and the dose fails the ‘standard’ by a factor of 100, then the detriment is about 0.006 fatalities per annum
- This is in several hundred thousand years time – when the dose will be dwarfed by any number of natural sources – like much of Cornwall!

Risk Estimation – Geological Disposal

- The other risk considered is that geotechnical engineers core through the repository and do not recognise the corings as being ‘unnatural’ and with increased radiation levels
- This ‘can core to 800 metres, can’t measure radioactivity’ must itself be a fairly unlikely concept and this ‘unlikelihood’ should itself surely be factored into the risk – but it isn’t.

Risk Estimation – Critical Groups

Correspondence (or otherwise) with observation

These examples indicate that in a situation a factor of 100 away from any ‘safe/unsafe’ boundary, there are very large conservatisms being introduced at the critical group stage with NO acknowledgement of this in the messages reaching stakeholders

In summary

We are protecting maximally exposed individuals at well below any safe/unsafe boundary as if they were on that boundary – and in the process spending many times Government guidelines for reducing overall public detriment

We are aiming to dispose of waste to standards which aim to prevent dose differences (in thousands of years time) which occur naturally from one locality to another in many parts of the UK

In summary

We are applying standards to groups of peoplke using assumptions and habit surveys relating to then safe/unsafe boundary, but surely inappropriate for levels a factor of 100 below an already conservative limit

The result is over-expenditure of millions of pounds which could have been spent on schemes providing demonstrable health or environmental benefit for the UK

The Process

- Some of the world's best scientific minds are seeking for continuous improvement in the safety of waste management and disposal
- They often lose sight of the adequate in the excited pursuit of the perfect – introducing ever more sophisticated techniques and materials
- A feedback loop is created with regulatory regimes seeking improvements largely unfettered by cost and proportionality
- The nuclear fuel cycle is made artificially expensive, myths of 'spiralling expenditure' are supported, political objections can be bolstered
- The process looks like this……..

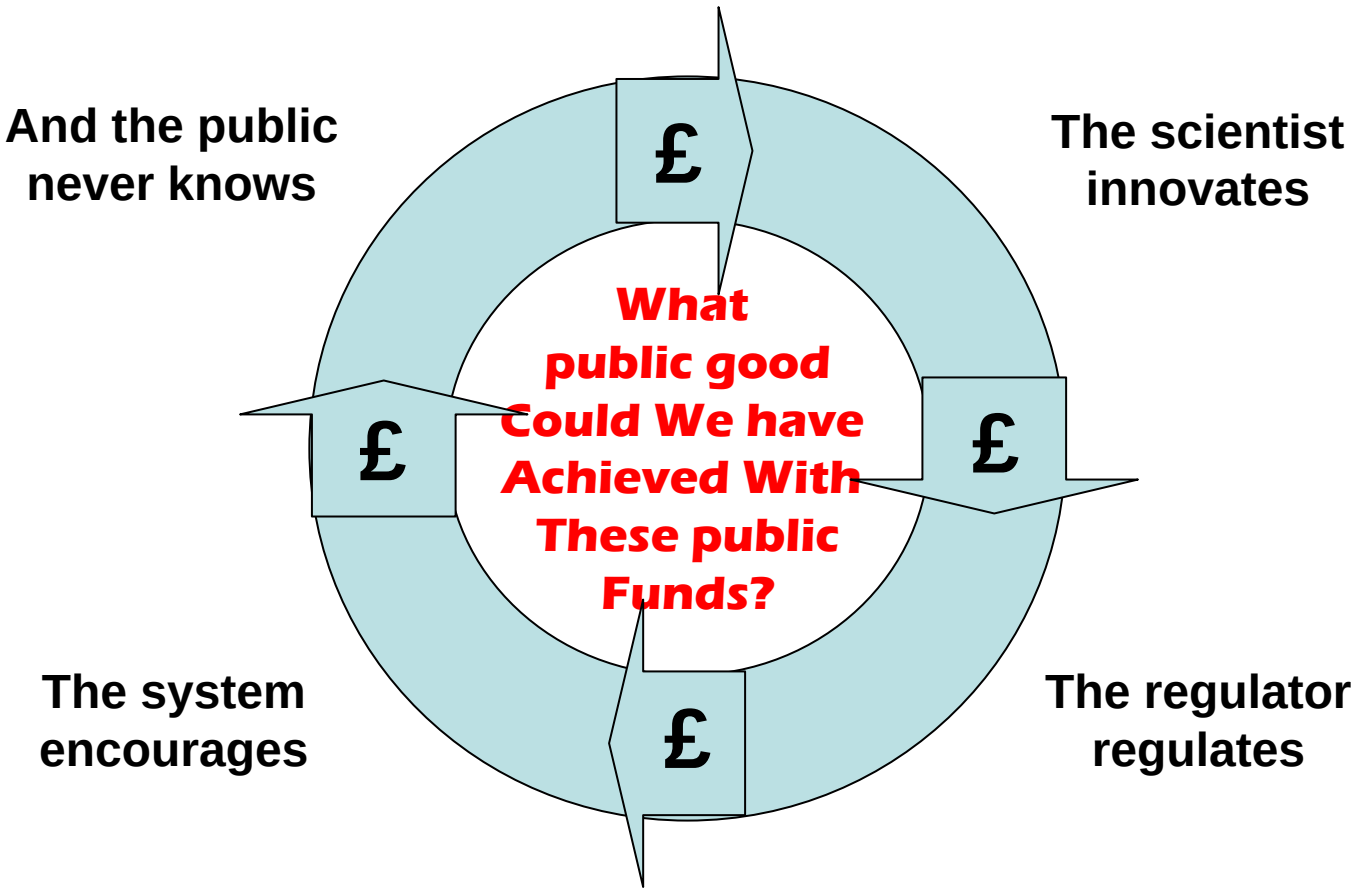
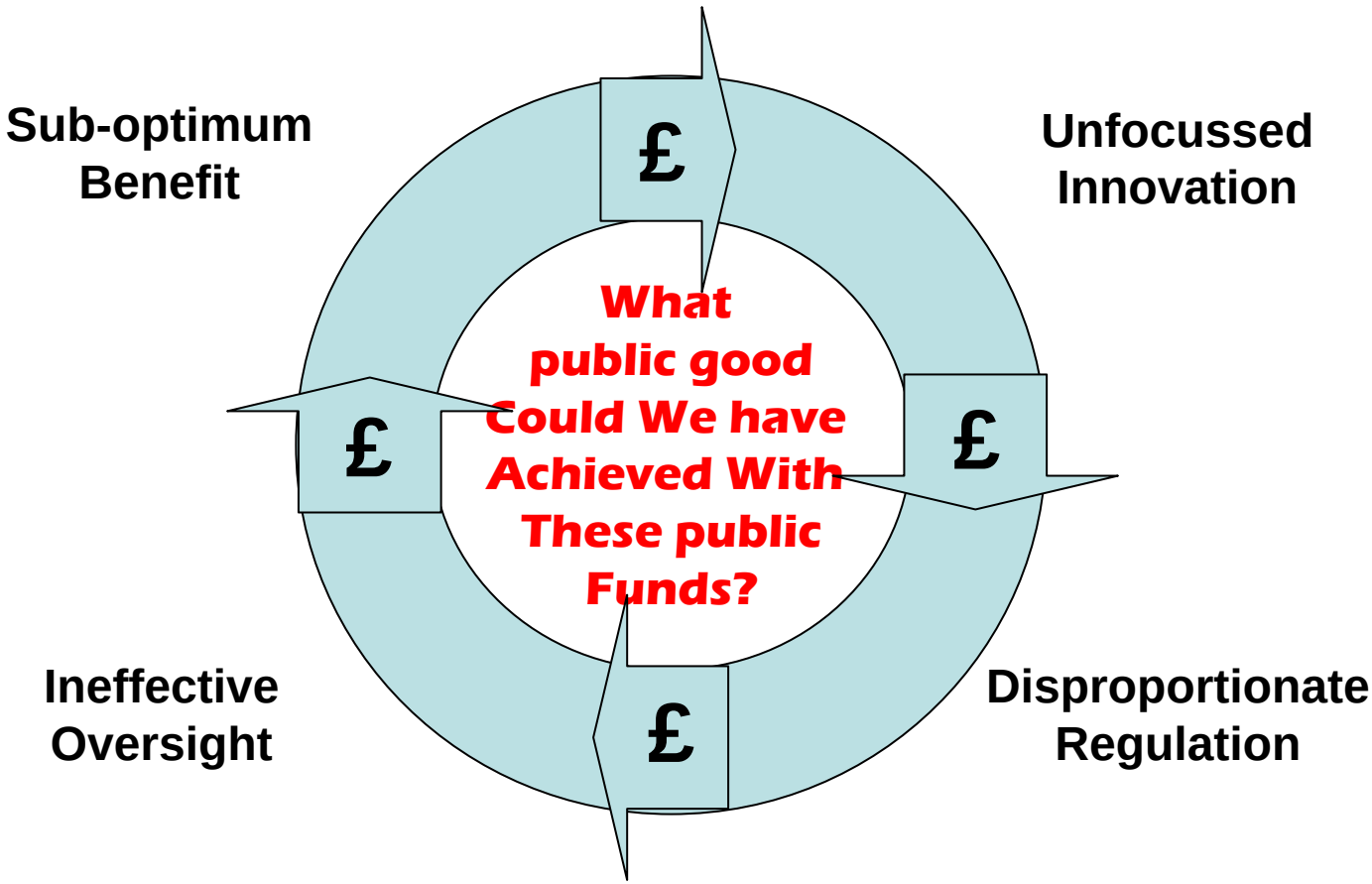

And the public never knows
The scientist innovates
£
£
£
£
What public good Could We have Achieved With These public Funds?
The system encourages
The regulator regulates

Fig 3 part 1


Sub-optimum Benefit
Unfocussed Innovation
£
£
£
£
What public good Could We have Achieved With These public Funds?
Ineffective Oversight
Disproportionate Regulation

The Remedy

Will: for decision makers to require assurance that the broader good is being served and that the nuclear cleanup industry is not just 'spending because it can'

Methodology: that the Nuclear Decommissioning Authority continues down the path of understanding what it is spending its money on, and to challenge and justify its expenditure and progress

Communication: to enable decision makers and other stakeholders to appreciate that difficult choices have to be made and how nuclear cleanup is being achieved in a way which promotes overall good