



Office for
Nuclear Regulation

Perspective from the Regulator: Numbers - Deterministic and Probabilistic

Overview

- ONR's expectations for PSA
- Summary of PSA Safety Assessment Principles
- What the numbers mean to ONR
- PSA Points to Ponder
- Conclusions



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ONR Expectations for PSA

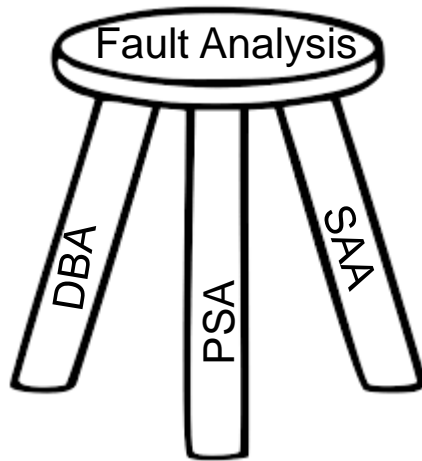


ONR's Expectations for PSA

- PSA is a fundamental and integral part of the safety case
- LC 23 requires an adequate safety case
- ONR's expectation
 - Three legs to fault analysis
 - Adequacy of PSA
 - ALARP



The Three Legs of Fault Analysis



Design Basis Analysis

- conservative
- adequacy of design measured against deterministic rules

Severe Accident Analysis

- IE is highly unlikely, so:
 - usually best estimate
 - Focus should be on mitigation rather than elimination of analysis

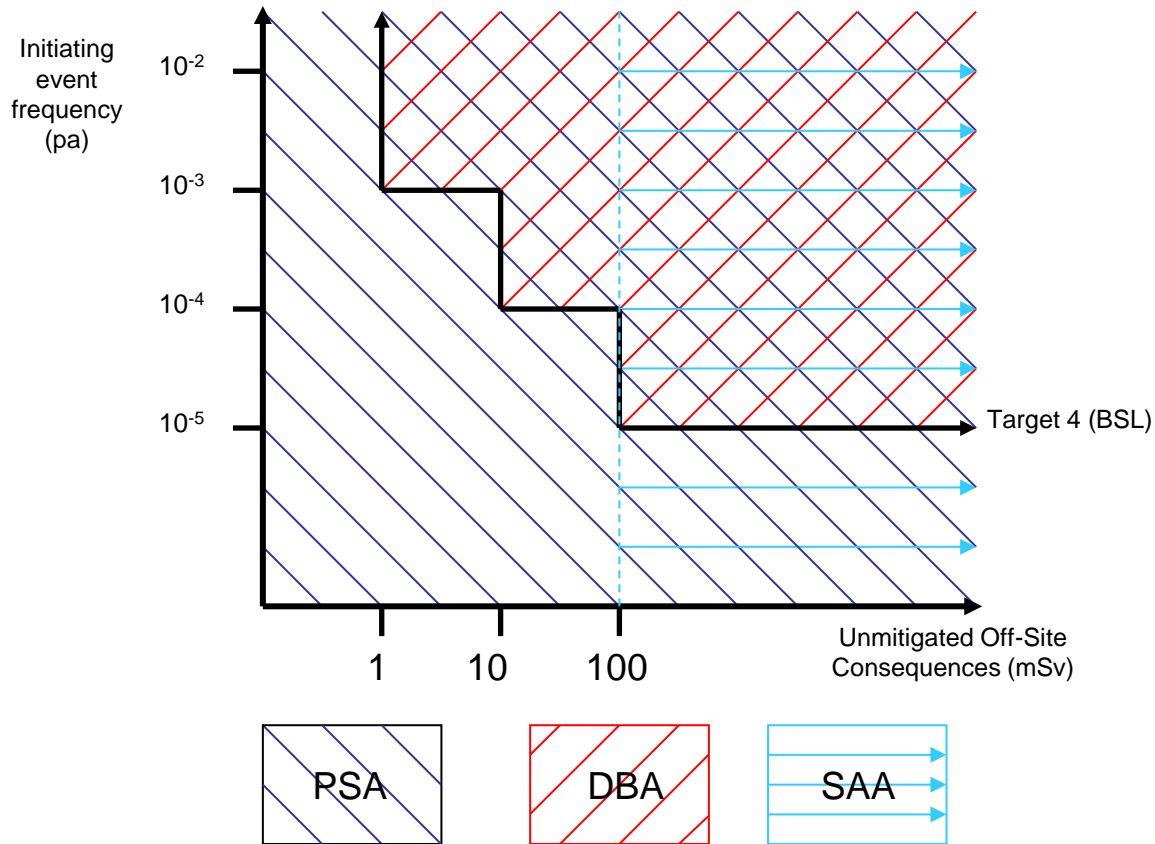
**Is it
ALARP?**

PSA

- best estimate
- measure of plant risk

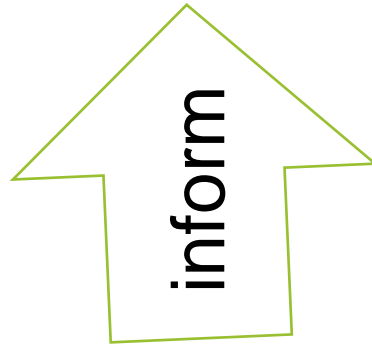


The Three Legs of Fault Analysis



How ONR Judges Adequacy of PSA

- ONR SAPs FA.10 to FA.14
- ONR Technical Assessment Guide (TAG) 30 for PSA



International standards,
guidance and practice

WENRA RLs

NUREG

IAEA TECDOCs

ALARP and PSA

ALARP
arguments



should

be used for
performing
inadequate
analysis



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The Numbers

What the numbers mean to ONR

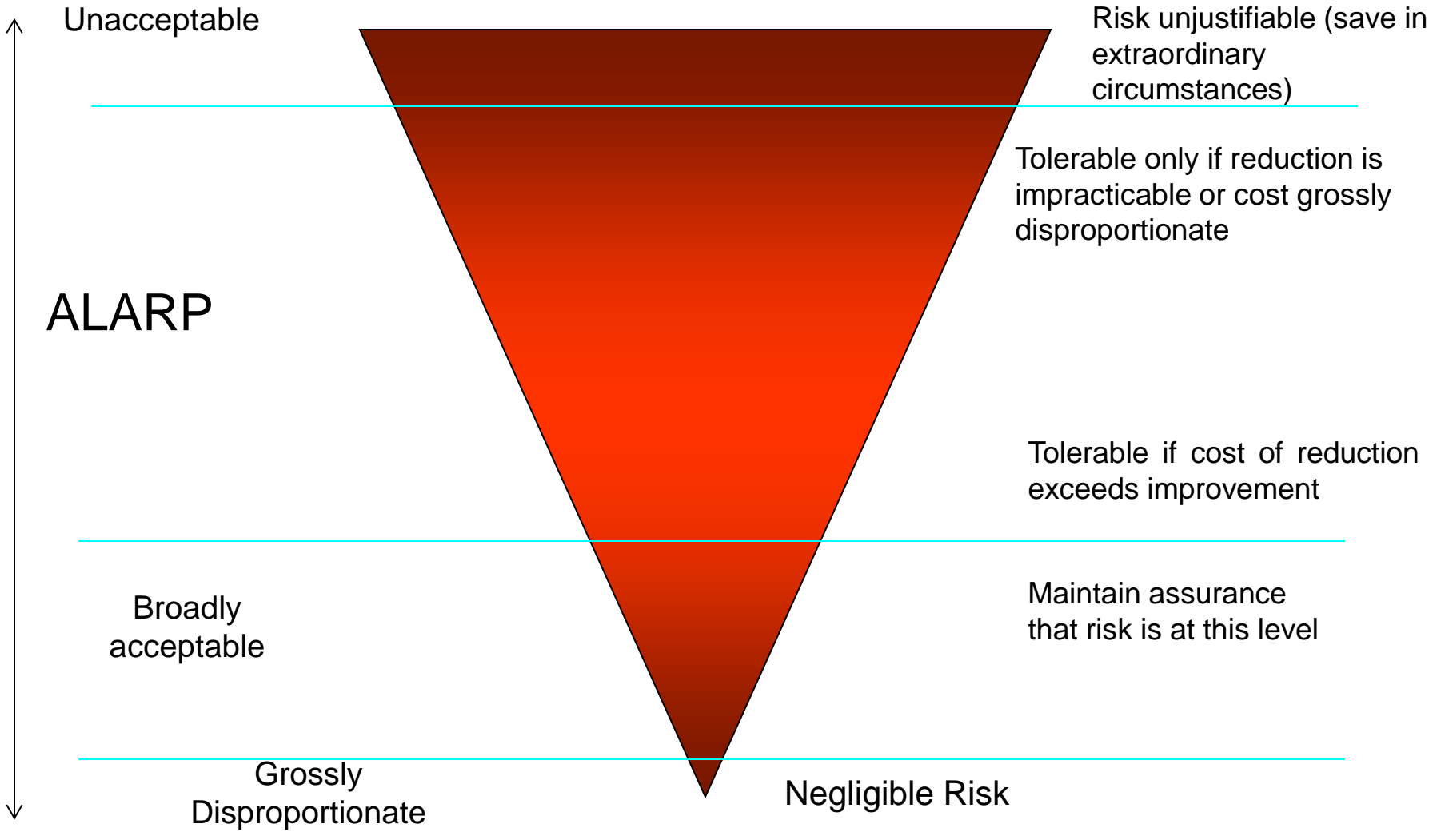


Overview

- PSA is not just a bunch of numbers!
 - It helps to demonstrate that:
 - balanced design
 - no particular class of accident or feature of the facility makes a disproportionate contribution to the overall risk
 - risk associated with the design/operation is ALARP
 - the acceptability of the overall risk of the facility can be judged
- Numbers should be the final part of PSA
 - logic is the main element of PSA
 - PSA tells the story of the architecture of safety claims
 - it links the complex underlying engineered systems and human safety claims



1992 ToR triangle (Carrot)





R2P2 and ToR: Numerical Risk Levels

Suggested maximum tolerable risk to workers in any industry	_____	1 in 10 ³
Suggested maximum tolerable risk to any member of the public from any large-scale industrial hazard	_____	1 in 10 ⁴
	Range of risk to average radiation worker (~1990s)	
	_____	1 in 10 ⁵
	_____	1 in 10 ⁶
Range of risk to members of the public living near nuclear installations from normal operation	Range of risk to members of the public living near nuclear installations from any kind of nuclear accident	
_____		1 in 10 ⁷
Range of risk to the average member of the UK public from normal operation plus possible nuclear accidents		



Criteria for the tolerability of risk

Unacceptable
region

- High gross disproportion
Long term plan needed

Tolerable
Region

- Normal regulatory
business

Broadly
acceptable

- Expectation for new facilities
- Policy is not to focus here

ONR Policy



PSA and Tolerability of Risk

- Frequently Misunderstood by Licensees:
 - ALARP is **NOT** simply a matter of numbers
 - ALARP is rarely even numerical!
 - Numbers can inform the ALARP decision but should “guide rather than decide”
- PSA Myth
 - “Risk is broadly acceptable, and therefore ALARP” = do nothing



The Key Focus of PSA for Licensees

- Structured and systematic thinking process
- Qualitative Insights
 - Cut-sets
- Quantitative insights
 - Dominant sequences
 - Importance
 - Sensitivity
 - Balance of risk
 - Level of risk (last and least important!)



The Key Focus of PSA for Licensees

- Appropriate fidelity
- Comprehensive – models all modes of operation and all areas of risk (such as internal external hazards, shutdown operation, etc.)
- Best-estimate representation of risk
- Numbers have a role...

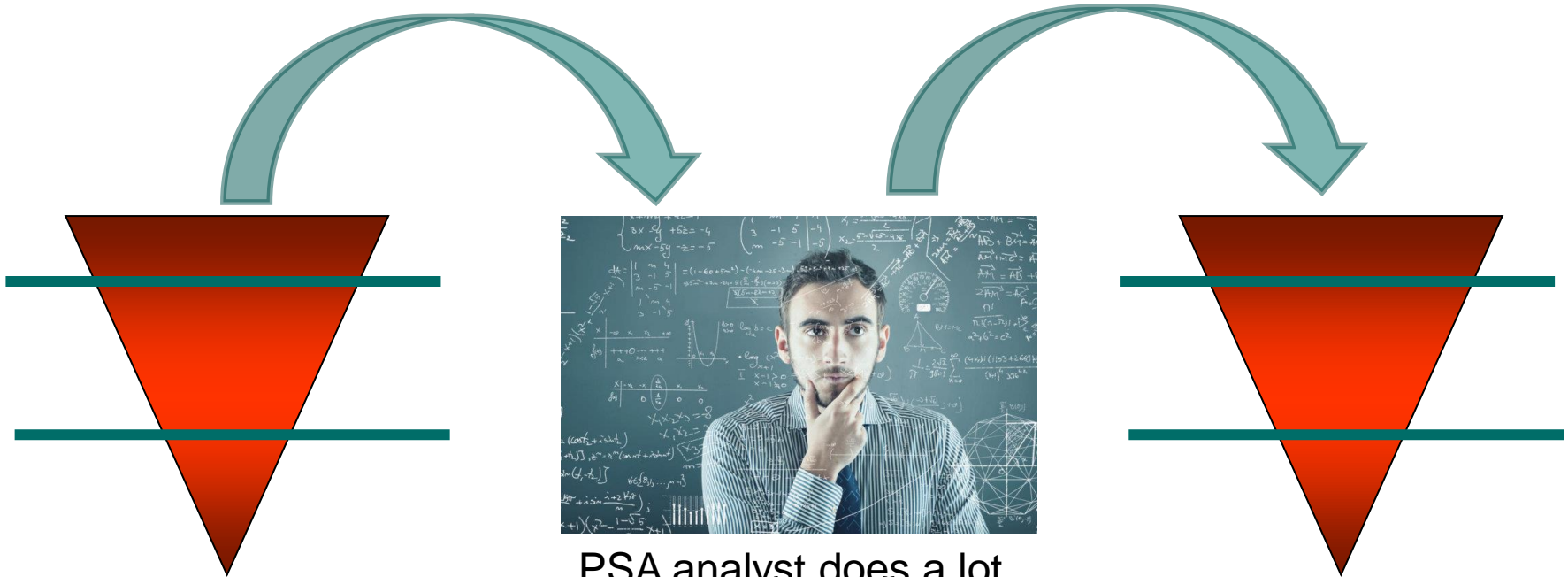


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PSA Points to Ponder



PSA Risk vs. Real Risk



PSA analyst does a lot
of work...

Licensee conclusion: “PSA
risk unchanged, therefore
the risk is ALARP” Is it?



PSA Risk vs. Real Risk

- Consider changes to PSA insights
- Remove conservatisms from base case first
- What more could be done?
- Why are you not doing it?

ONR is interested in whether there are any reasonably practicable enhancements to manage the change in “real” risk



CCFs

- ONR expects that PSA models be best-estimate. It is also expected that CCFs are generally modelled at the component level in fault trees.
- There can be a different expectation in deterministic analysis. ONR would expect that DBA CCFs lower than $1E-05$ should be exceptional and would require a very high level of justification.
- There can be differences in expectations for probabilistic and deterministic modelling of CCFs.
- Any claims on CCF in a PSA still need to be credible and adequately justified.
- Sensitivity studies using deterministic ‘cutoffs’ should be carried out in the PSA to demonstrate the design is not challenged by more onerous assumptions.



Use of PSA in Justification of Changes to Safety Cases

- ONR expects PSA to be used as part of justifications of changes to safety cases – SAP FA.14
- However, documentation and approaches should be very clear as PSA can be misused or the results overemphasised, for example:
 - It would not be appropriate for PSA to be the only leg of the justification
 - Splitting out different pieces of a PSA for uses they were never intended for may lead to unintended consequences to those not familiar with PSA (e.g. using PSA failure rates from a station database based on generic information overseas to justify kit change design criteria)

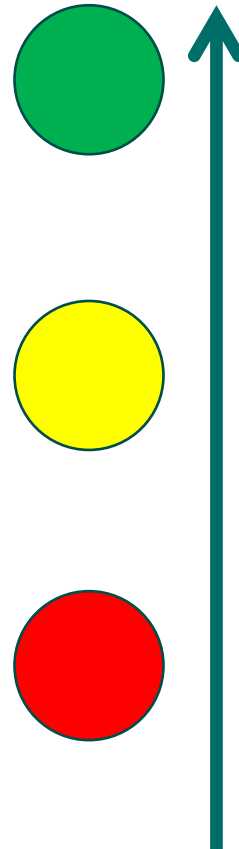


PSA Data

Facility specific data

Generic data (if facility data is not available, and if the generic data is appropriate to the design and of high quality) – use mathematical combination technique such as Bayesian method

Engineering Judgement (if no facility data or generic data) – keep track of sensitivity and error of these data.
Warning: ad-hoc judgements not following a robust and systematic process will generally attract inspector scrutiny



Increasing
legitimacy
and quality of
overall PSA
assessment



Conclusion



- PSA is a fundamental and integral part of the safety case
- PSA needs to be comprehensive and representative of the plant
- NOT just a bunch of numbers
- Best-estimate
- Treatment of CCFs can be different between deterministic and probabilistic modelling
- Fundamentally, the safety argument should be associated with real risk

Questions?

