Allocation 101
(Allocation System Uncertainty)

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Value Realisation

- What is it & what does it mean

❑ In simple terms:

- How much (and what) we have produced?
- How much it's worth?
- Who gets paid for it?

❑ Financial "Top Line"

Value Realisation

- How do we do it?

❑ Measurement

- Quantity measurement
  - Mass (tonnes, kg)
  - Volume (Sm3, kSm3, bbls)
- Quality measurement
  - Oil sampling & distillation analysis (boiling point fractions)
  - Gas composition (N_2, CO_2, C_1, C_2…)
  - Impurities (H2S, sulphur, wax)

❑ Allocation

- What happens after measurement…

Value Realisation

- Measurement uncertainty

=

Measurement uncertainty

? ? Sm^3 ? ?

? ? kg ? ?

=

Revenue uncertainty

? ? $$$? ?

? ? £££ ? ?

Measurement vs Allocation

- What's the significance?

- ❑ Measurement uncertainty receives a high focus (rightly so)
- ❑ However, what do we actually get paid on?
- ❑ What value are we realising?
  - Measured value? 
  - Allocated value? 

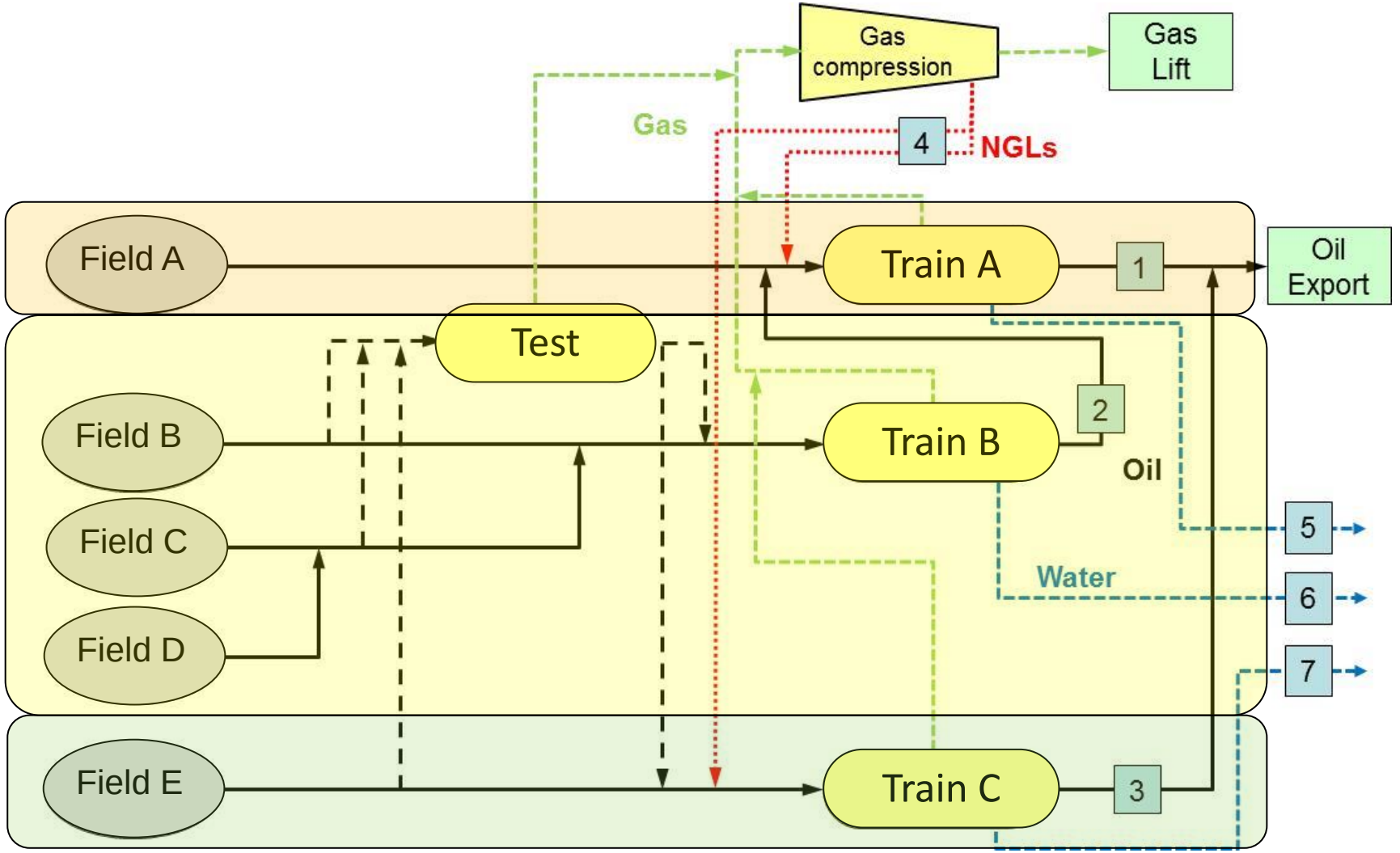
Value Realisation

- How do we **really** do it?

- ❑ Additional inputs into allocation system
  - ○ Estimates (i.e. well tests)
  - ○ Parameters (i.e. process model factors)
- ❑ Allocation methods
  - ○ Data “manipulation”
  - ○ Process models
  - ○ Mis-measurements
  - ○ Commercial agreement terms

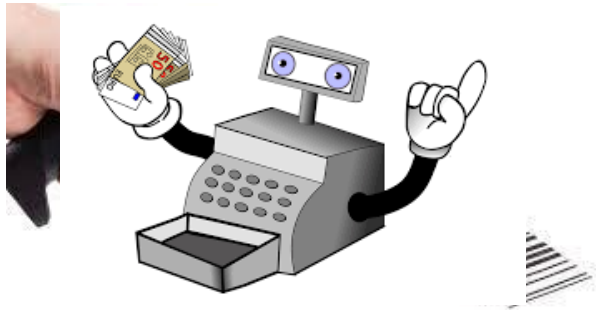
Example allocation system

- How do we **realise value here**?



Measurement system is a cash register…

- But is it really?



ENERGYSYS

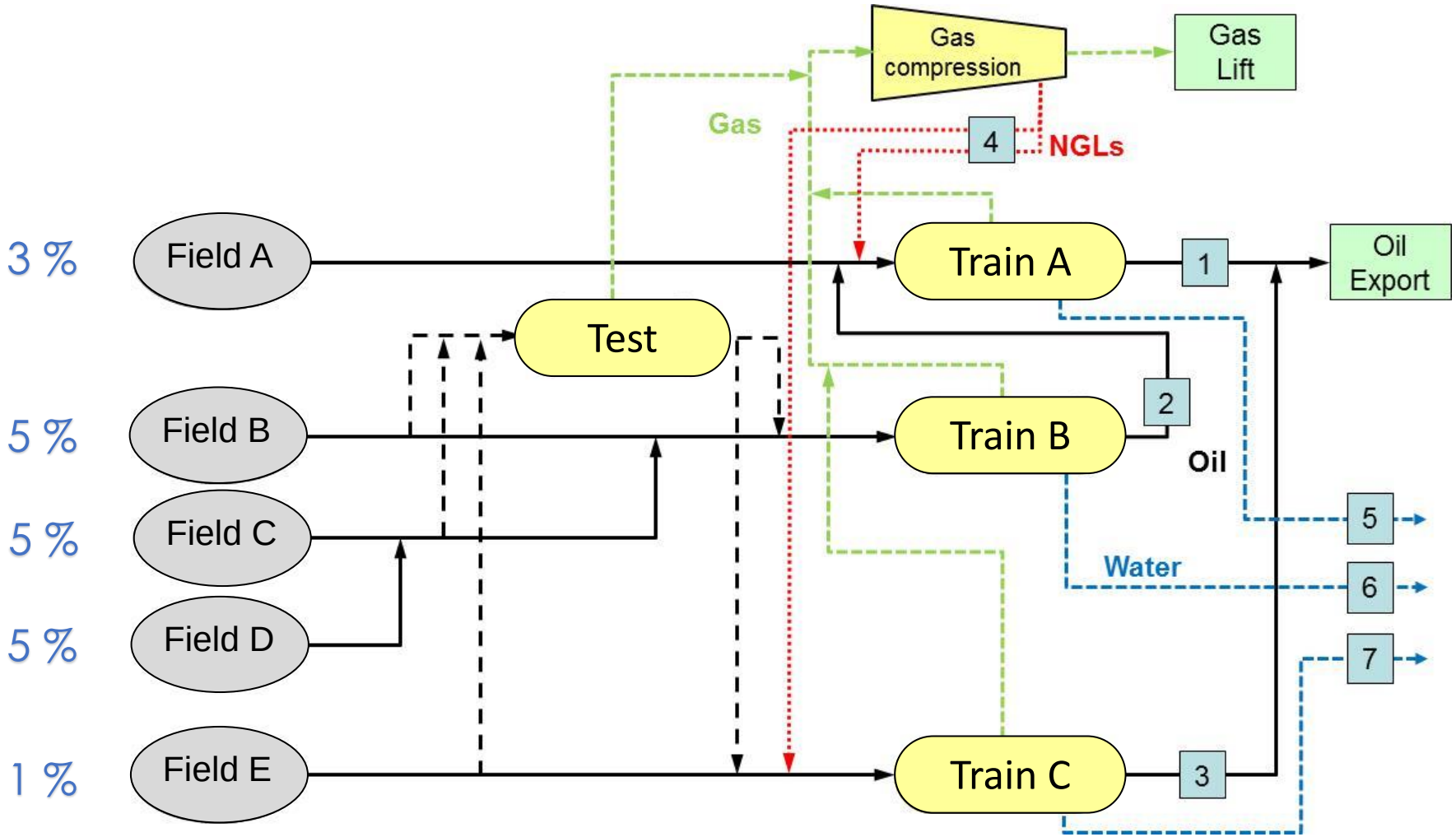
Value Realisation

- Where is the real uncertainty?

- ❑ Uncertainty in the allocated values?
  - ○ Requires a detailed model of the allocation system
  - ○ Detailed understanding of inputs and uncertainties
- ❑ Must account for:
  - ○ Allocation method (adjustments, reconciliations, etc.)
  - ○ Correlations (measurements, assumptions, etc.)

Example allocation system

- Allocated uncertainty will vary



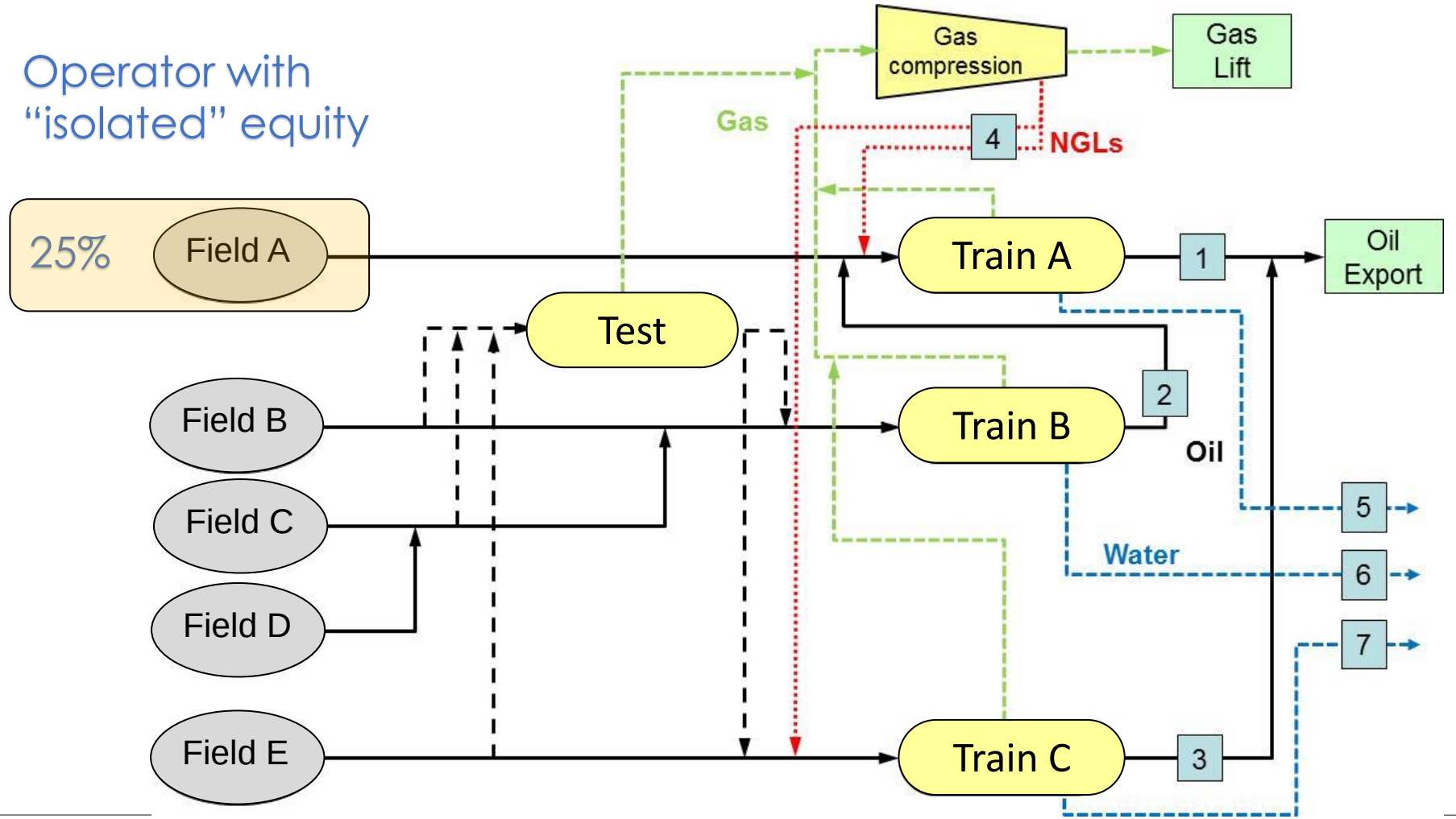
Revenue uncertainty

- OK that's field level, but what about Owners (equity)

- ❑ Uncertainty in the allocated revenue?
  - ○ Allocation to fields… what about equity?
  - ○ Allocation to owners/partners across all fields in system
- ❑ How do we account for this?

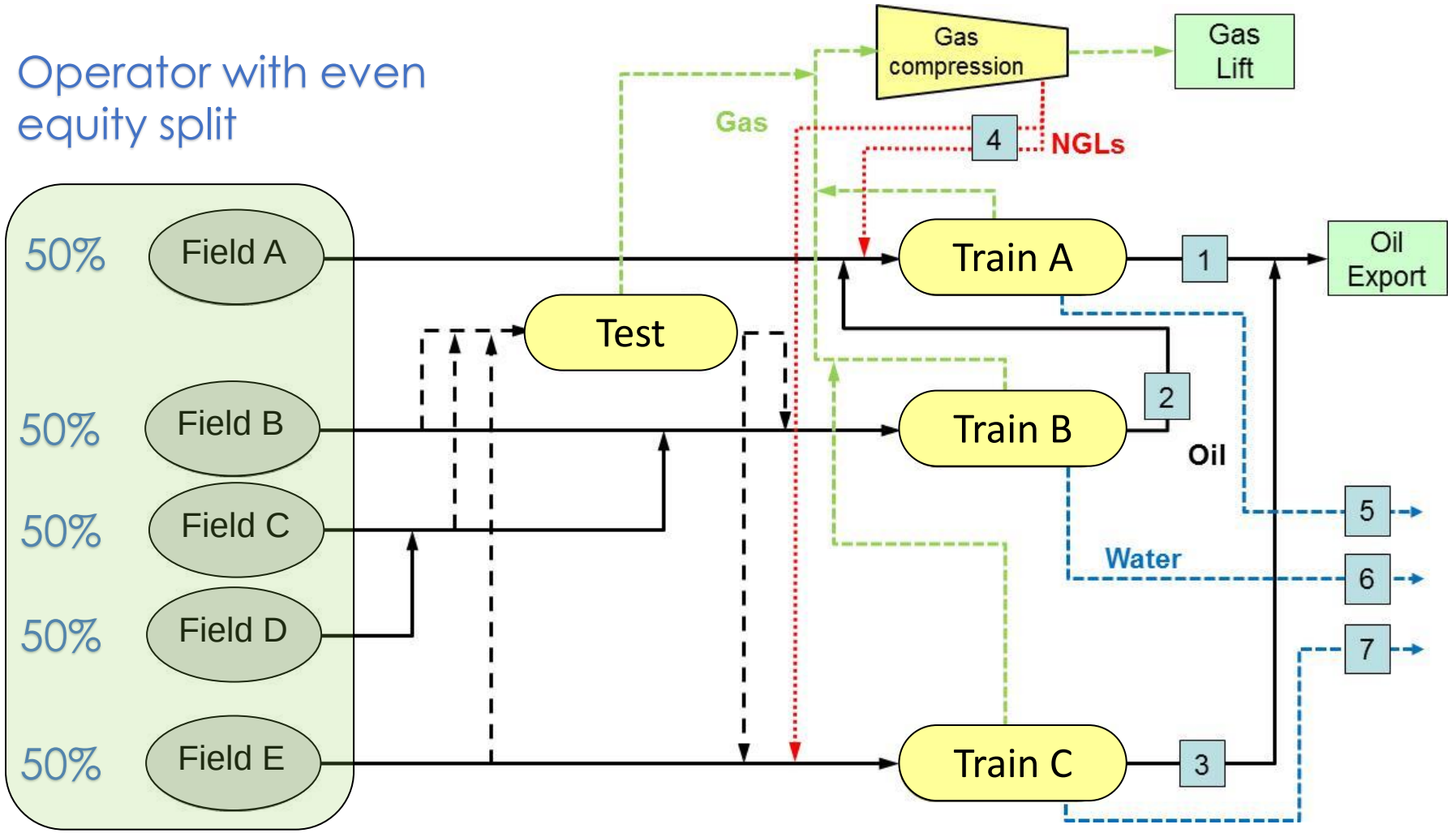
Example allocation system

- Allocated uncertainty for “owner” in single field



Example allocation system

- Allocated uncertainty for “owner” in multiple fields



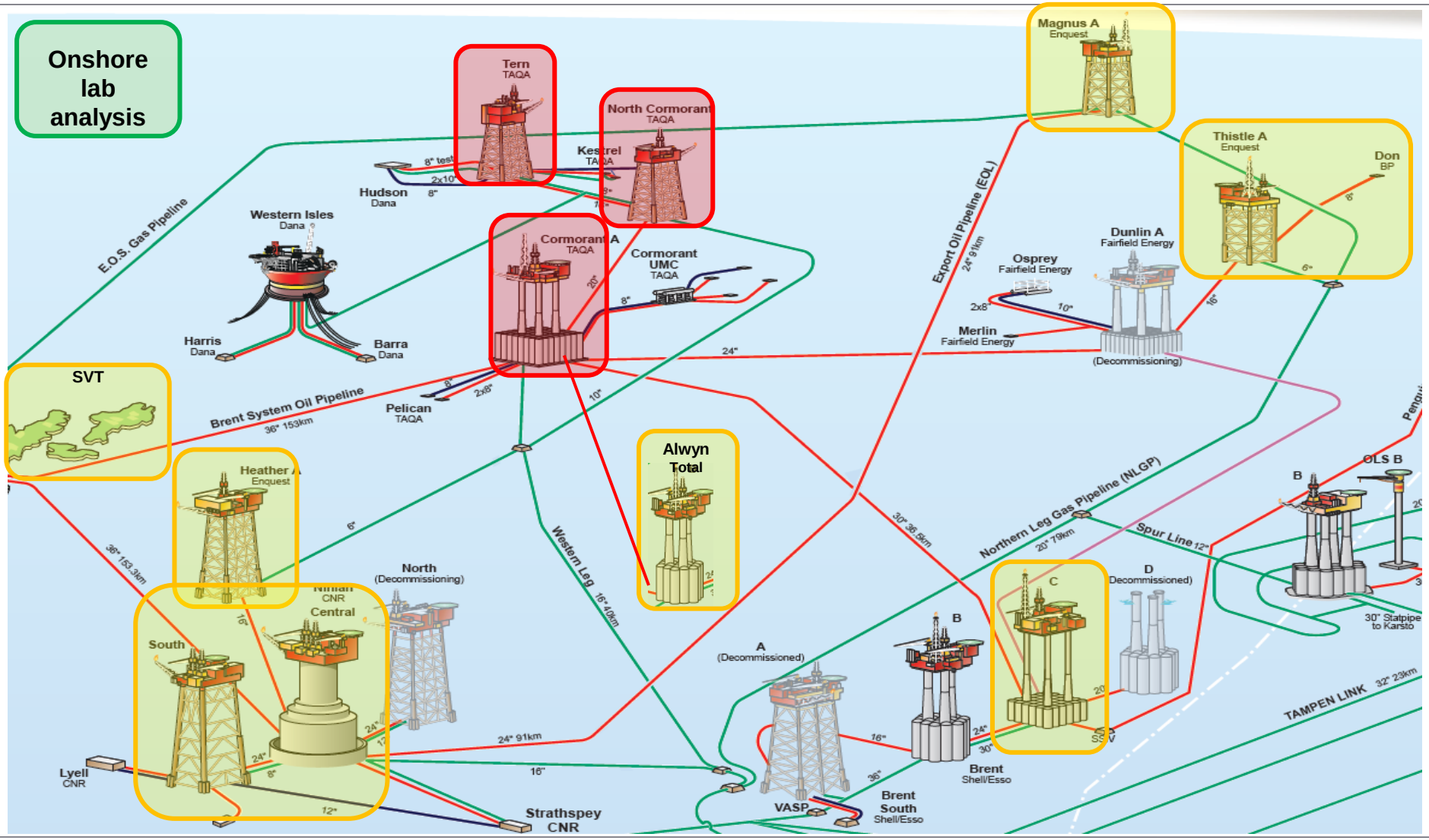
Revenue uncertainty

- How many levels?

- ❑ Why stop at “one-system” exposure?
- ❑ Do we ever calculate overall “Operator exposure”?

Example pipeline system exposure

- Allocated uncertainty for “owner” in multiple fields



Revenue uncertainty

- Overall Operator exposure

- ❑ As an Operator what is our overall exposure?
- ❑ Where are the main risk factors?
- ❑ Are they operated by us or external?

Revenue uncertainty

- How many levels?

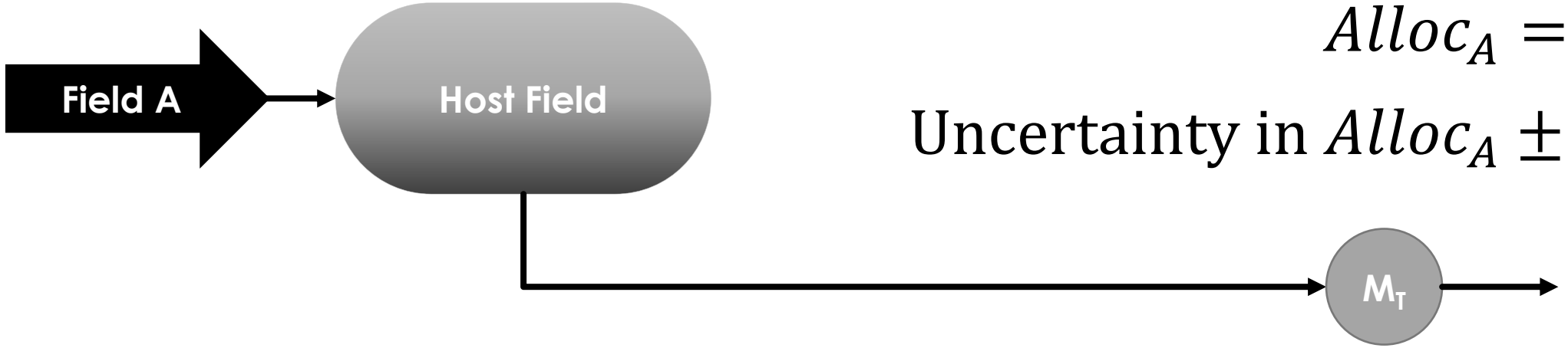
- ❑ Requires a complete bottom to top exposure analysis.
  - ○ Does anyone ever think about this to that level?
  - ○ Could we even do this?
  - ○ Is it worth it?
- ❑ Same principle applies to all Operators (not just TAQA)

How to calculate allocation uncertainty

- Having looked at the high-level principles….
- How do we go about this?

- Over to Phil…

Simple Process



$$Alloc_A = M_T$$

Uncertainty in $Alloc_A$ $\pm 1\%$

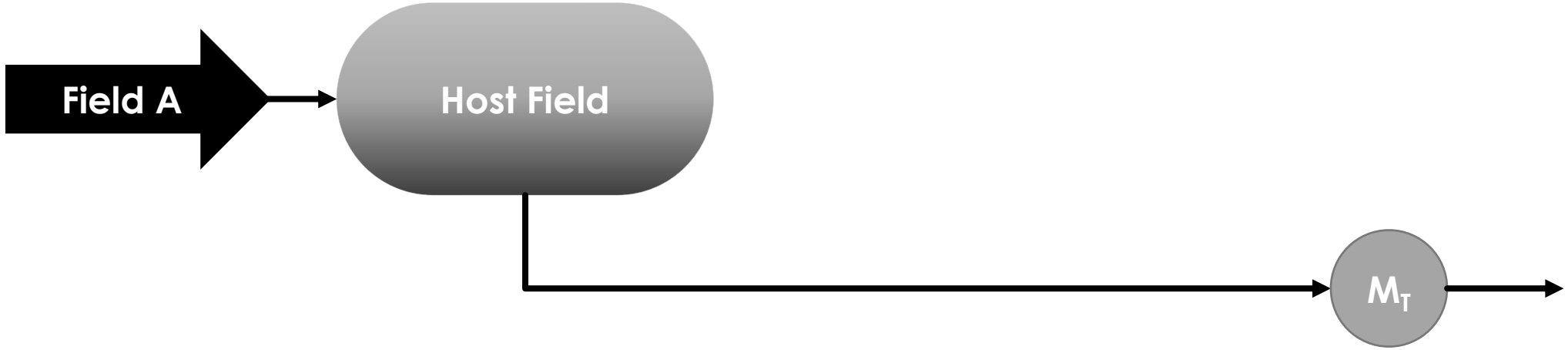
M_T =1,000 te/d

Uncertainty in M_T $\pm 1\%$

± 10 te/d

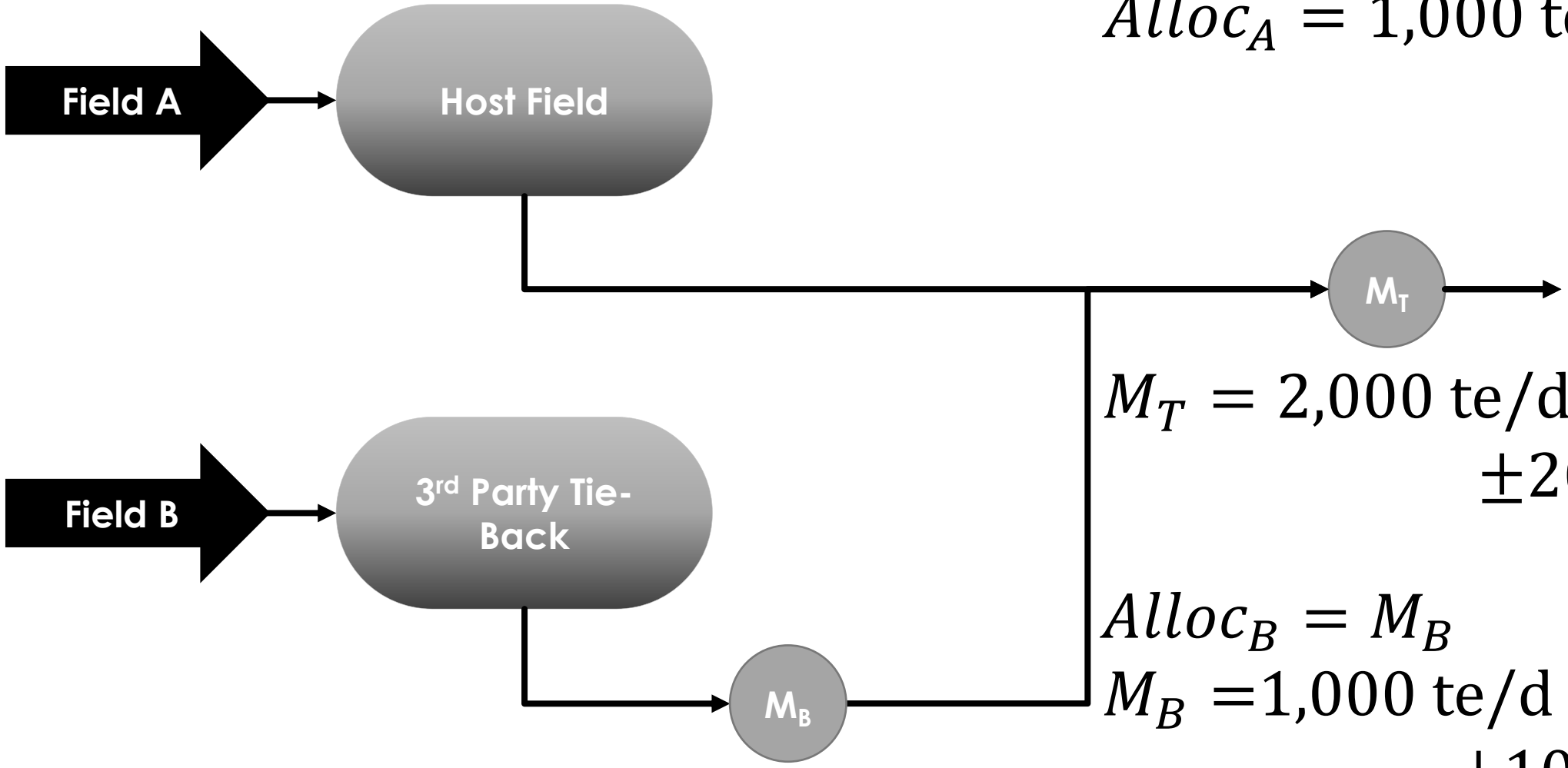
Uncertainty expressed at the 95% confidence level !

Simple Process New Field



Simple Process New Field

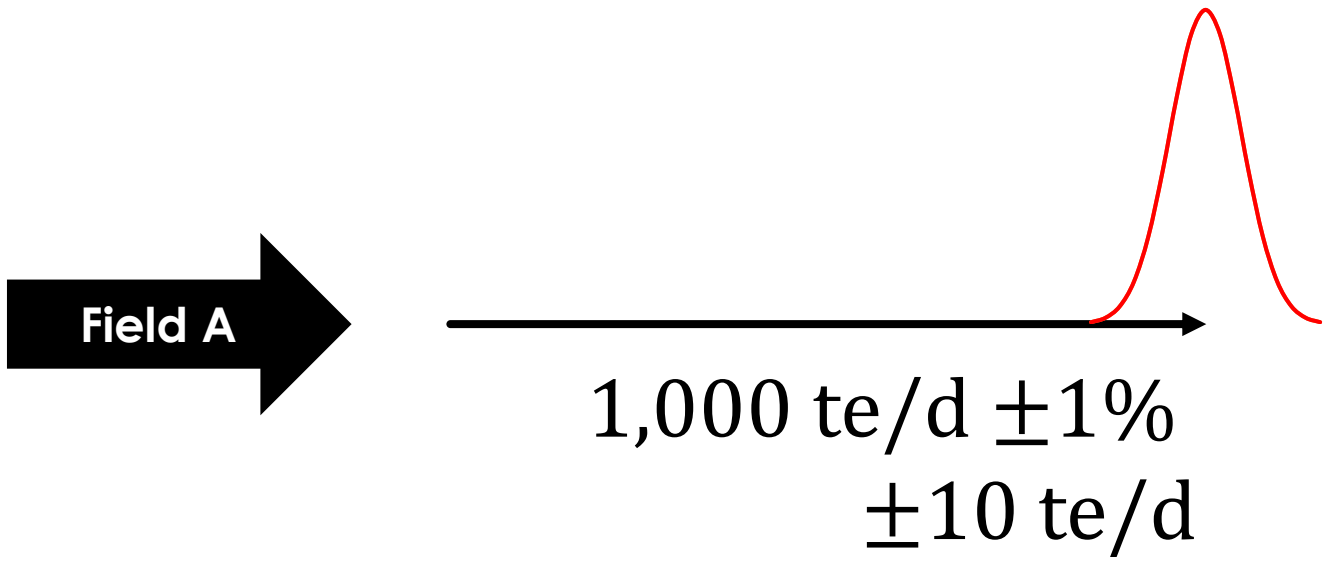
$$Alloc_A = M_T - M_B$$
$$Alloc_A = 1{,}000 \text{ te/d } \pm 2.2\%$$
$$\pm 22 \text{ te/d}$$

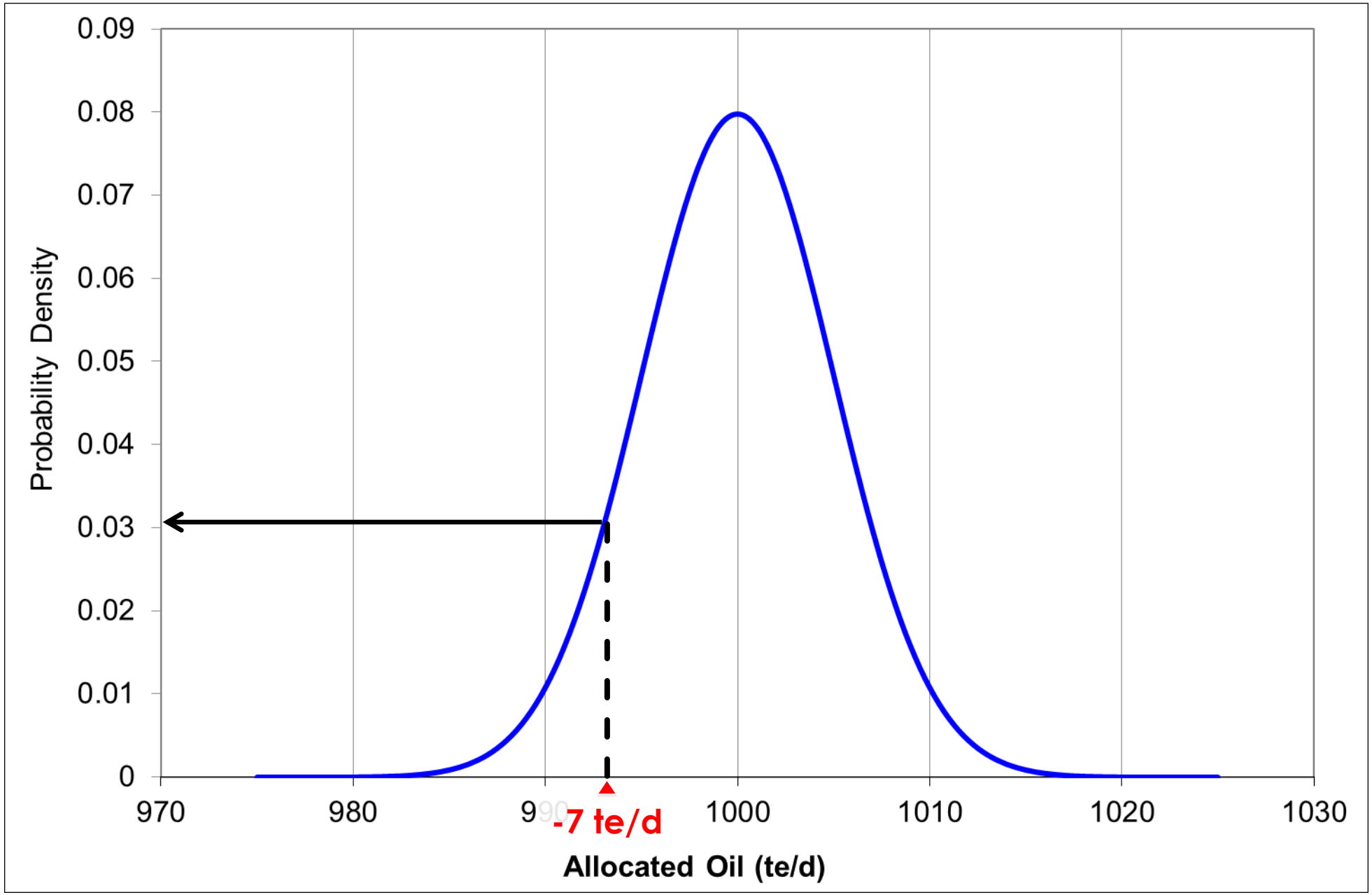


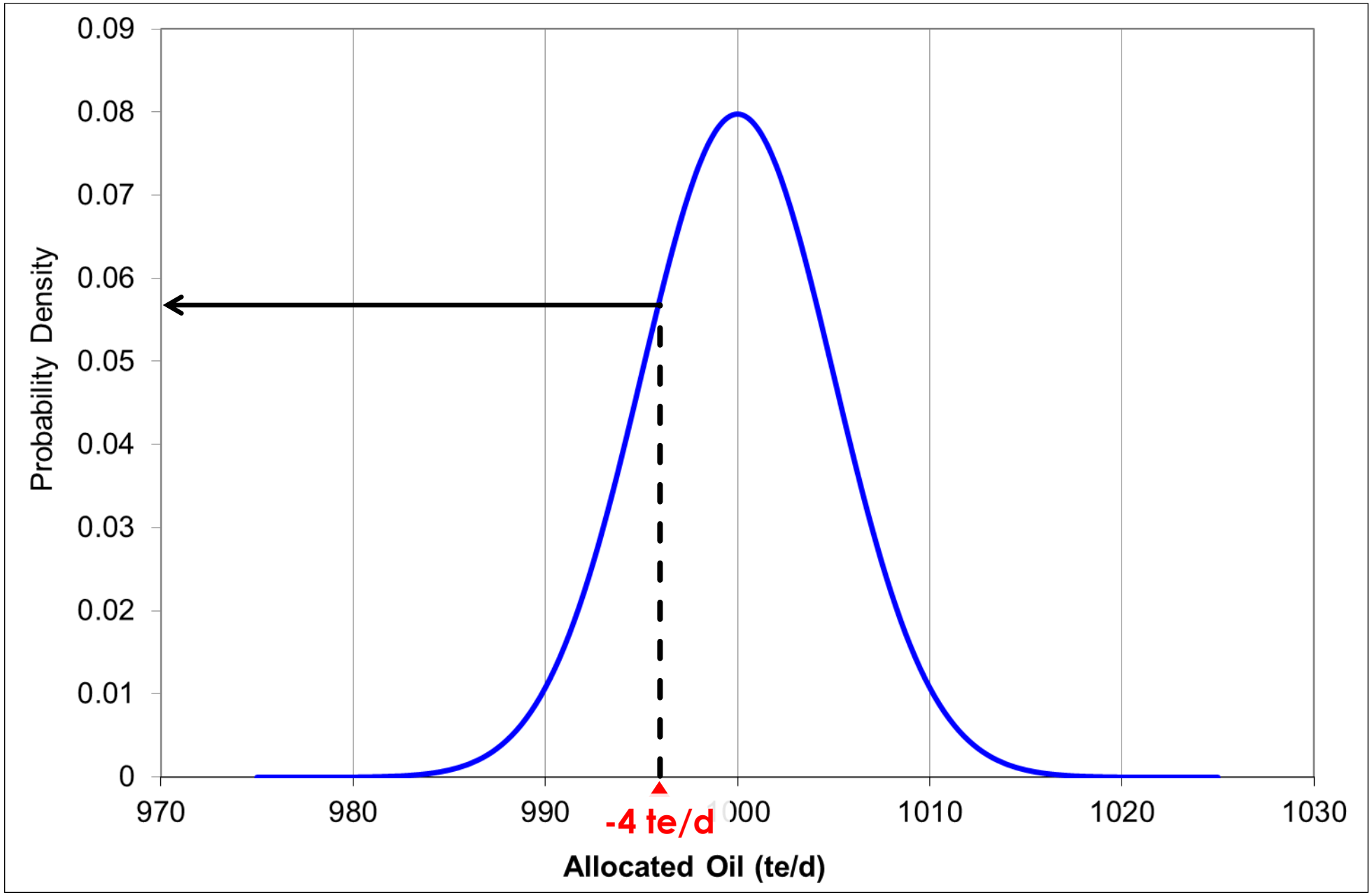
$$M_T = 2{,}000 \text{ te/d } \pm 1\%$$
$$\pm 20 \text{ te/d}$$

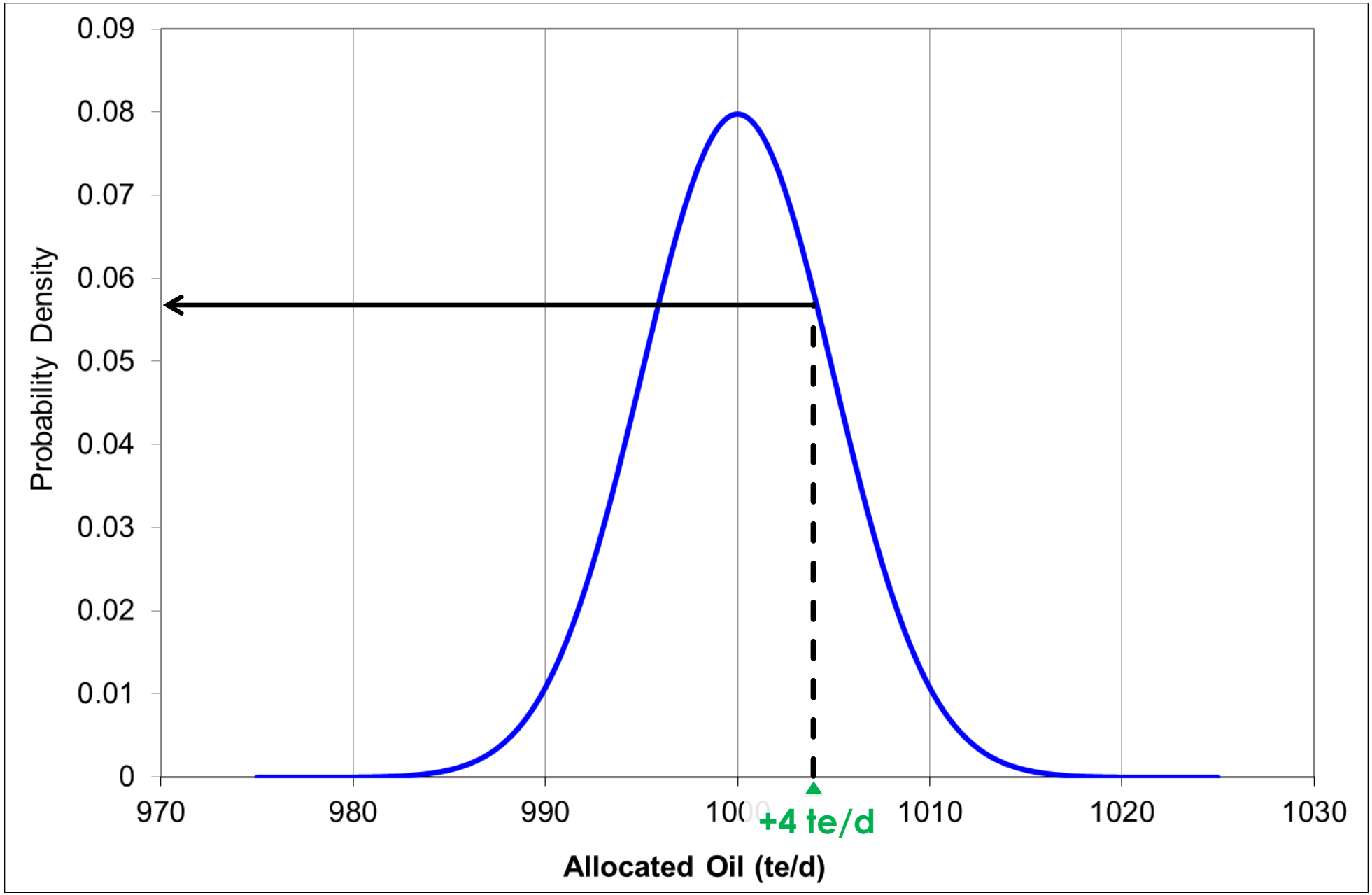
$$Alloc_B = M_B$$
$$M_B = 1{,}000 \text{ te/d } \pm 1\%$$
$$\pm 10 \text{ te/d}$$

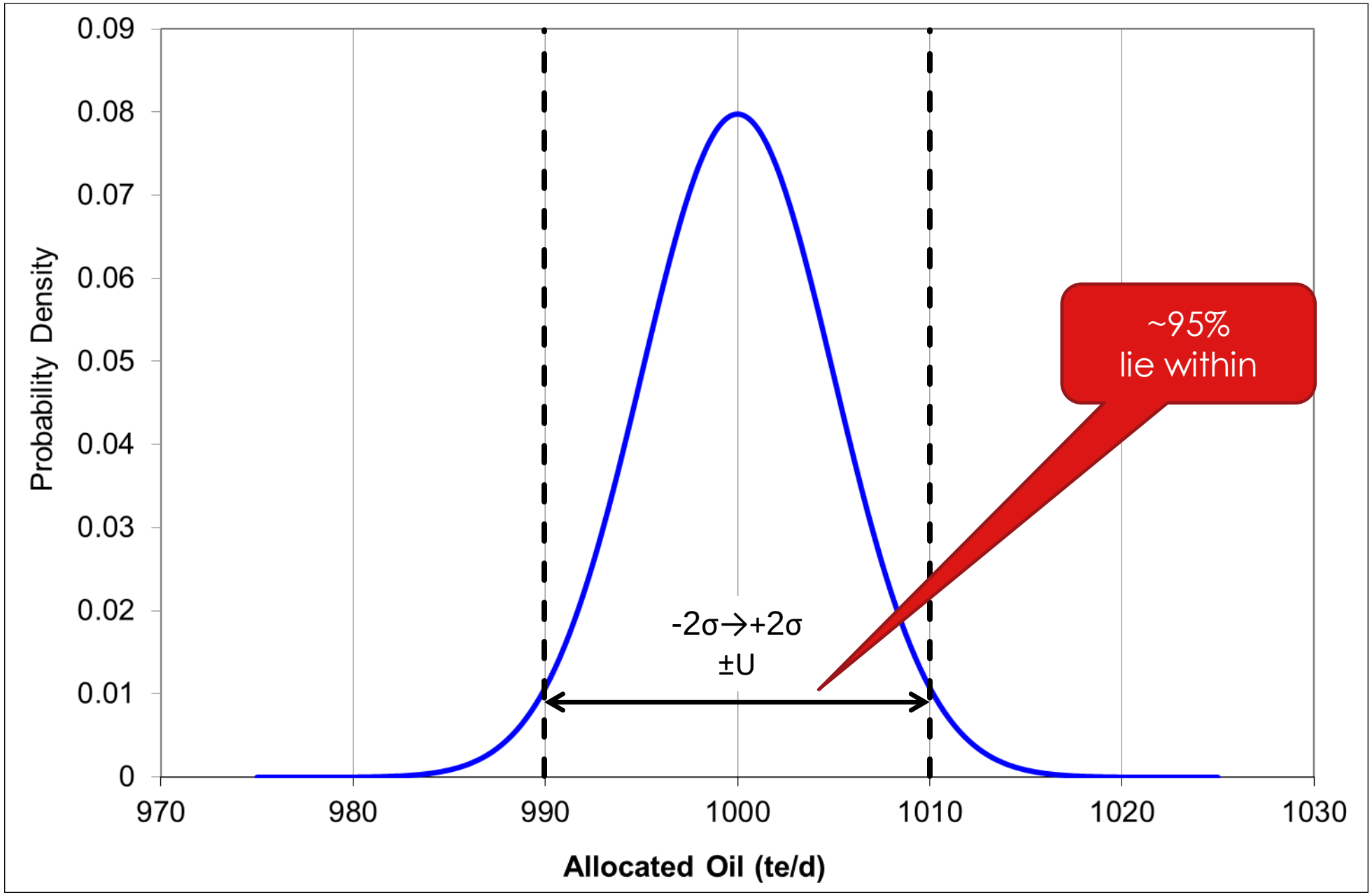
Simple Process New Field

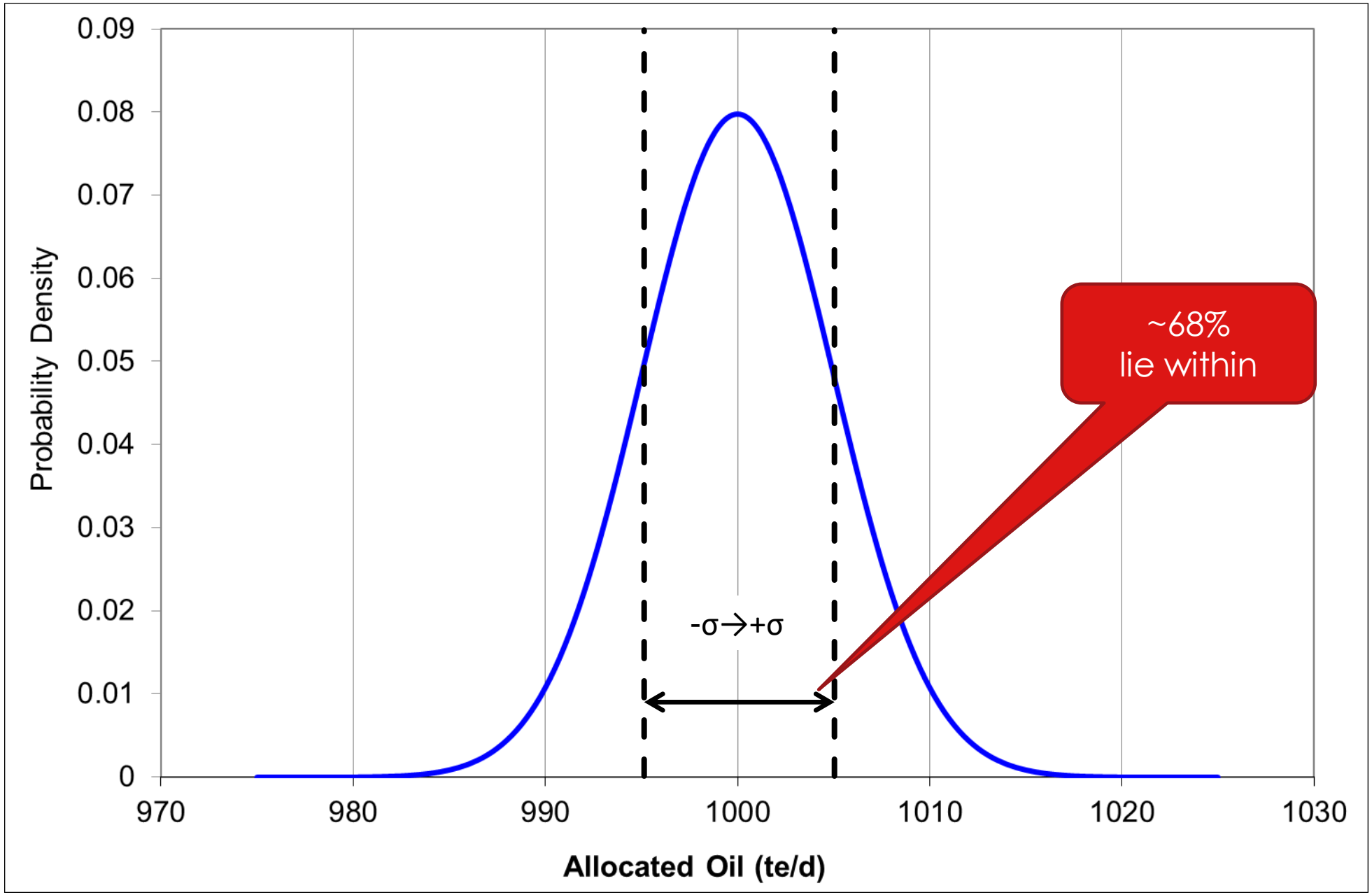


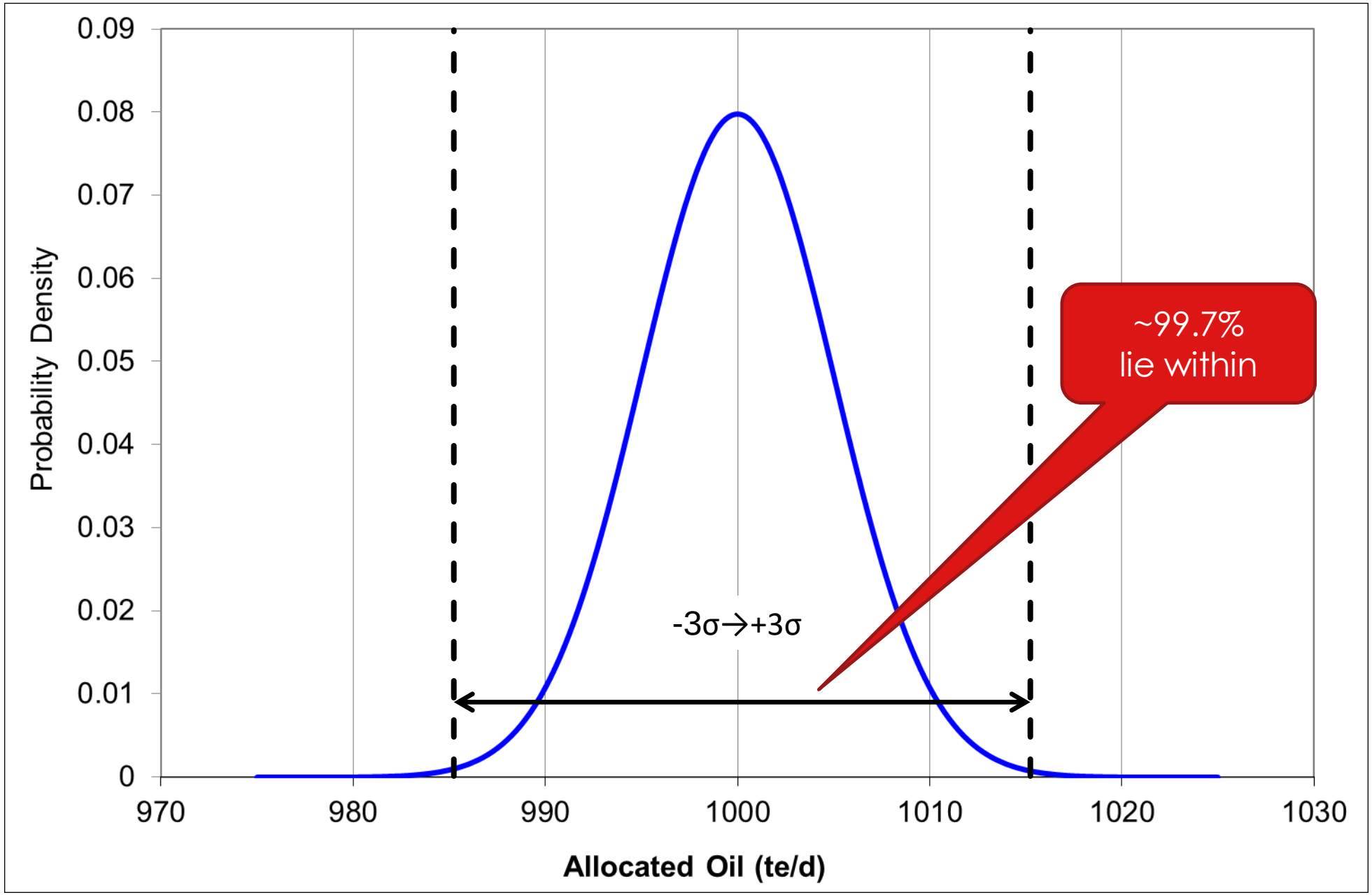

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
970
980
990
1000
1010
1020
1030
-7 te/d
Allocated Oil (te/d)

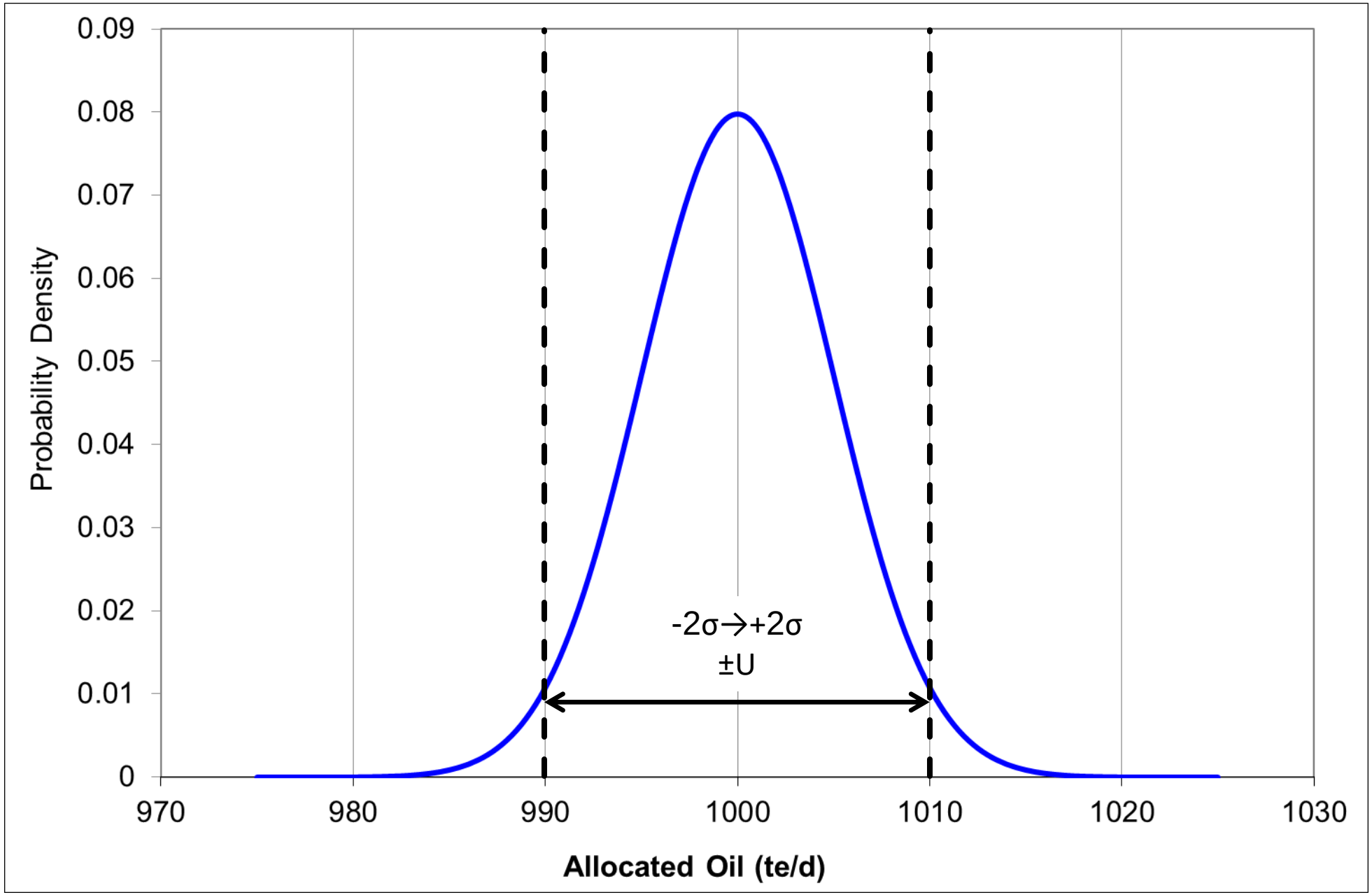

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
970
980
990
-4 te/d
1010
1020
1030
Allocated Oil (te/d)

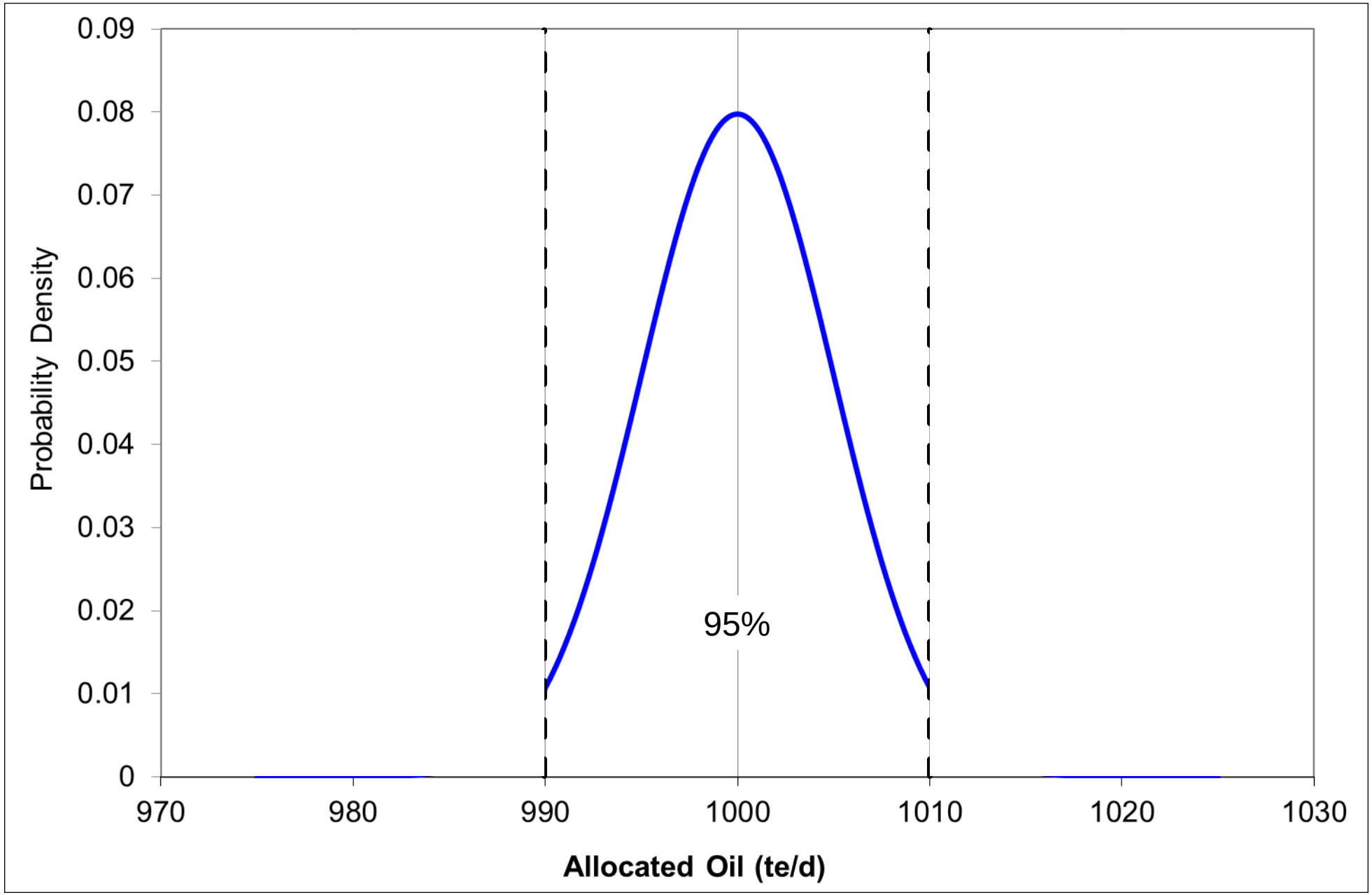

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
970
980
990
1000
1010
1020
1030
+4 te/d
Allocated Oil (te/d)

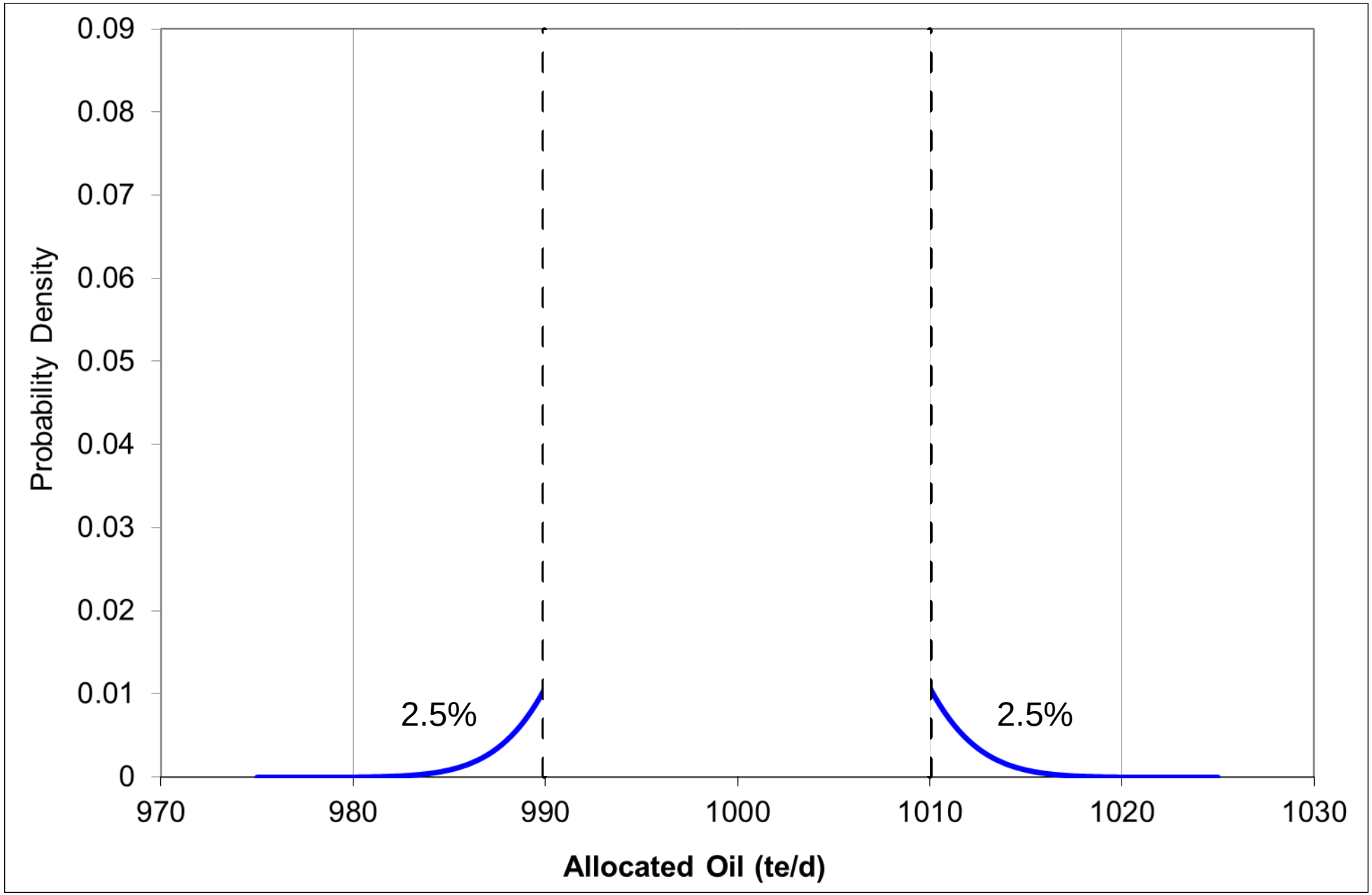

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
970
980
990
1000
1010
1020
1030
Allocated Oil (te/d)
-2σ→+2σ
±U
~95%
lie within

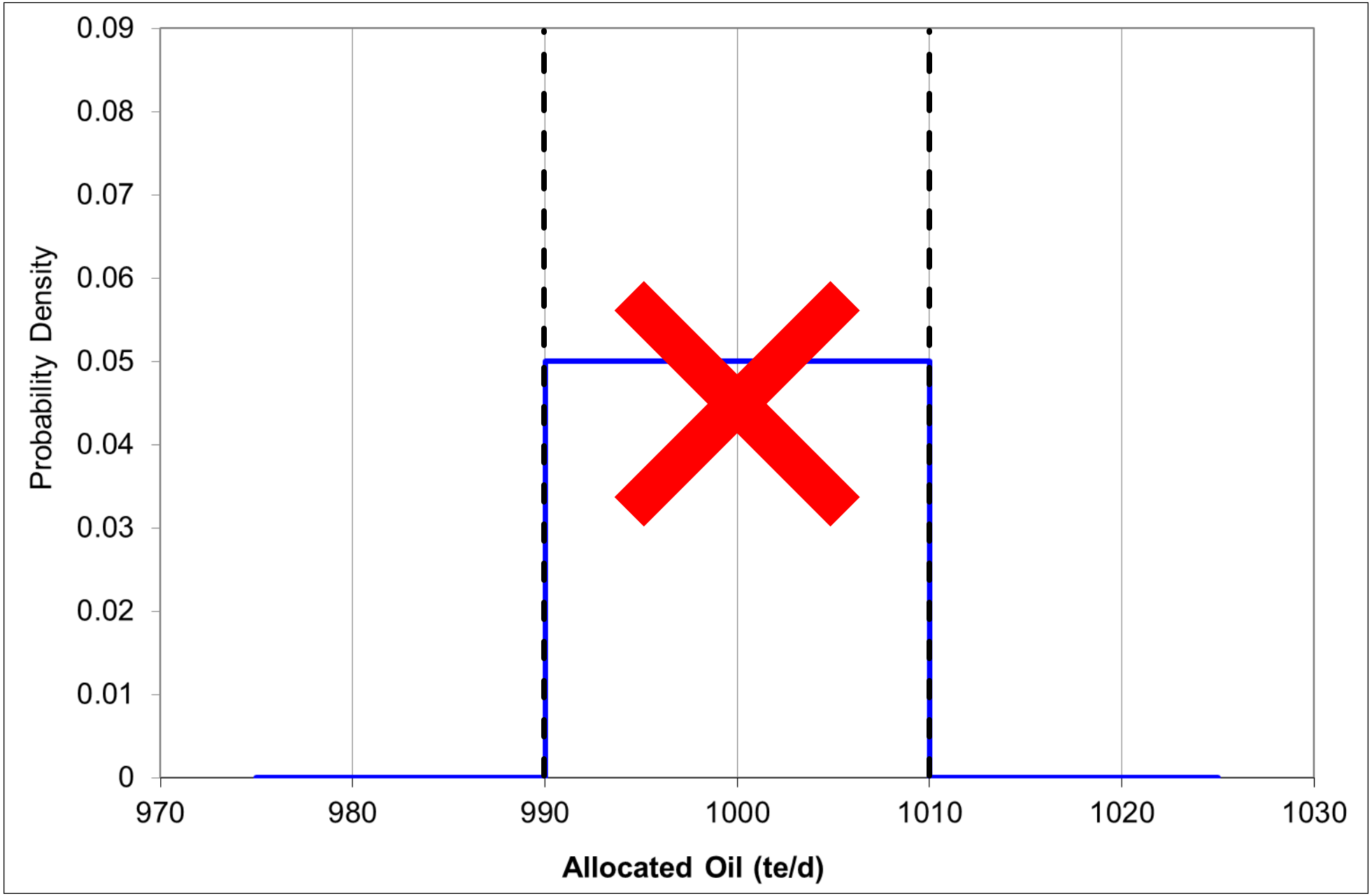

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
970
980
990
1000
1010
1020
1030
Allocated Oil (te/d)
-σ→+σ
~68%
lie within

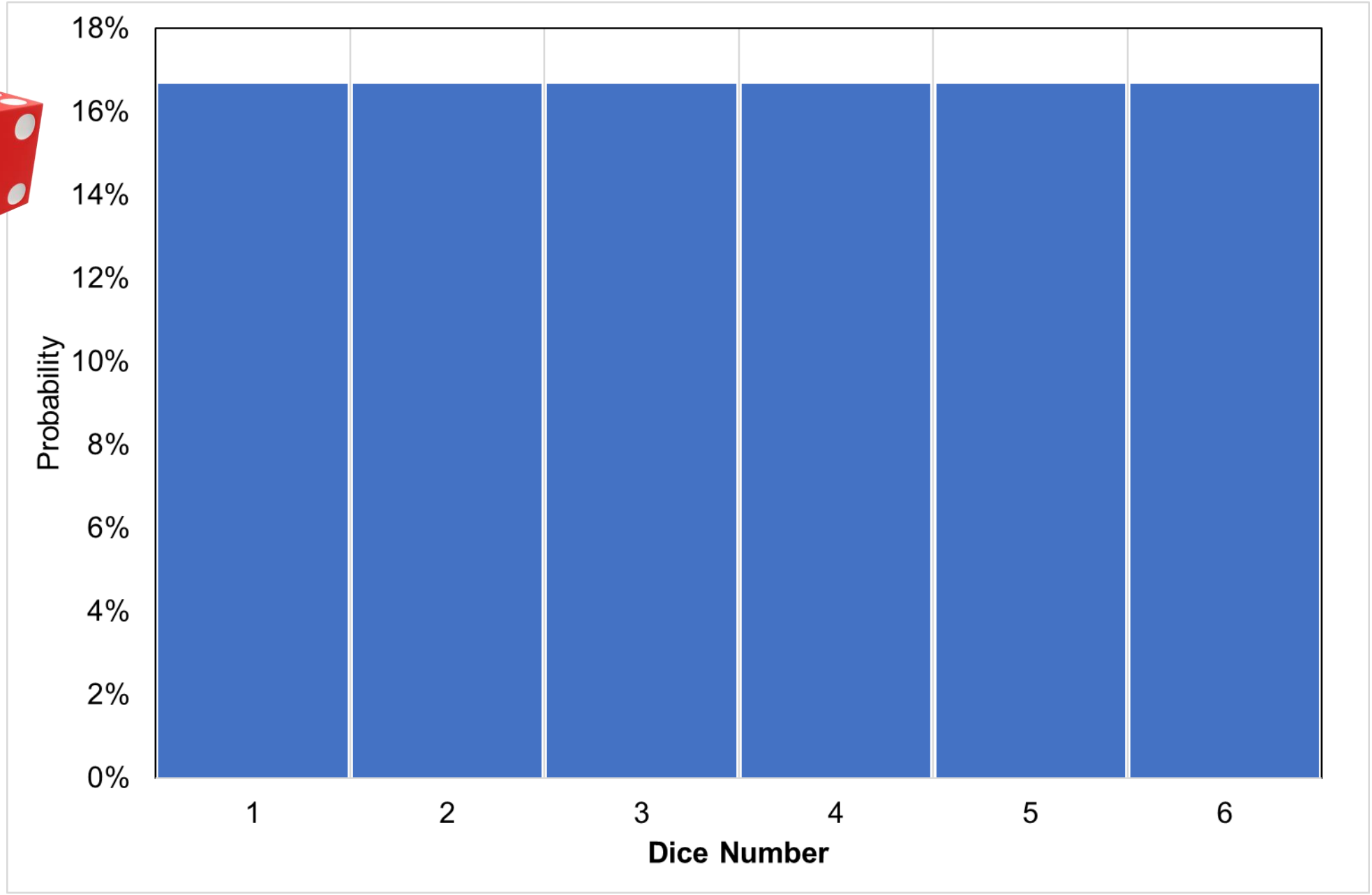

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
970
980
990
1000
1010
1020
1030
Allocated Oil (te/d)
-3σ→+3σ
~99.7%
lie within

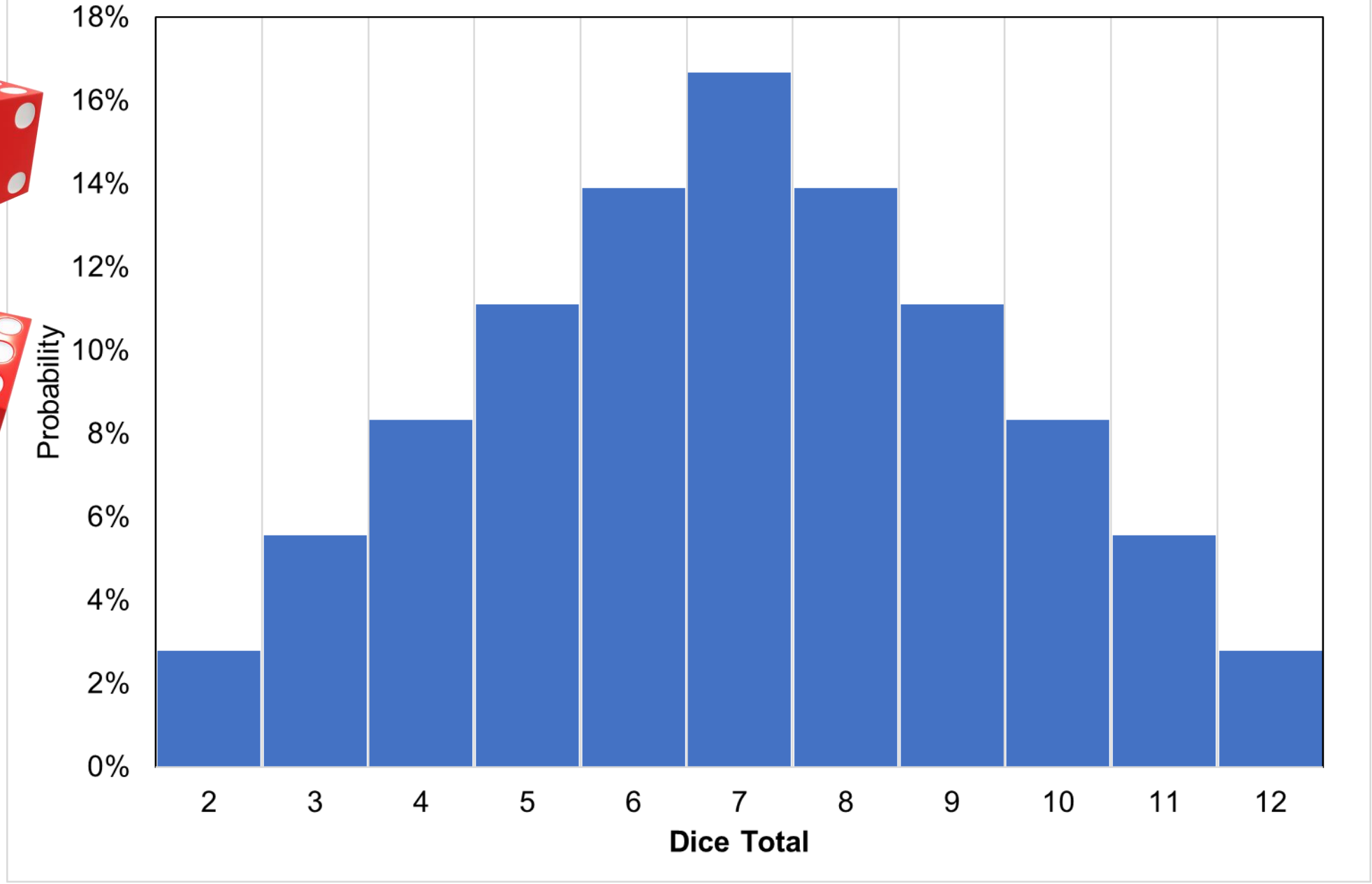

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
970
980
990
1000
1010
1020
1030
Allocated Oil (te/d)
-2σ→+2σ
±U

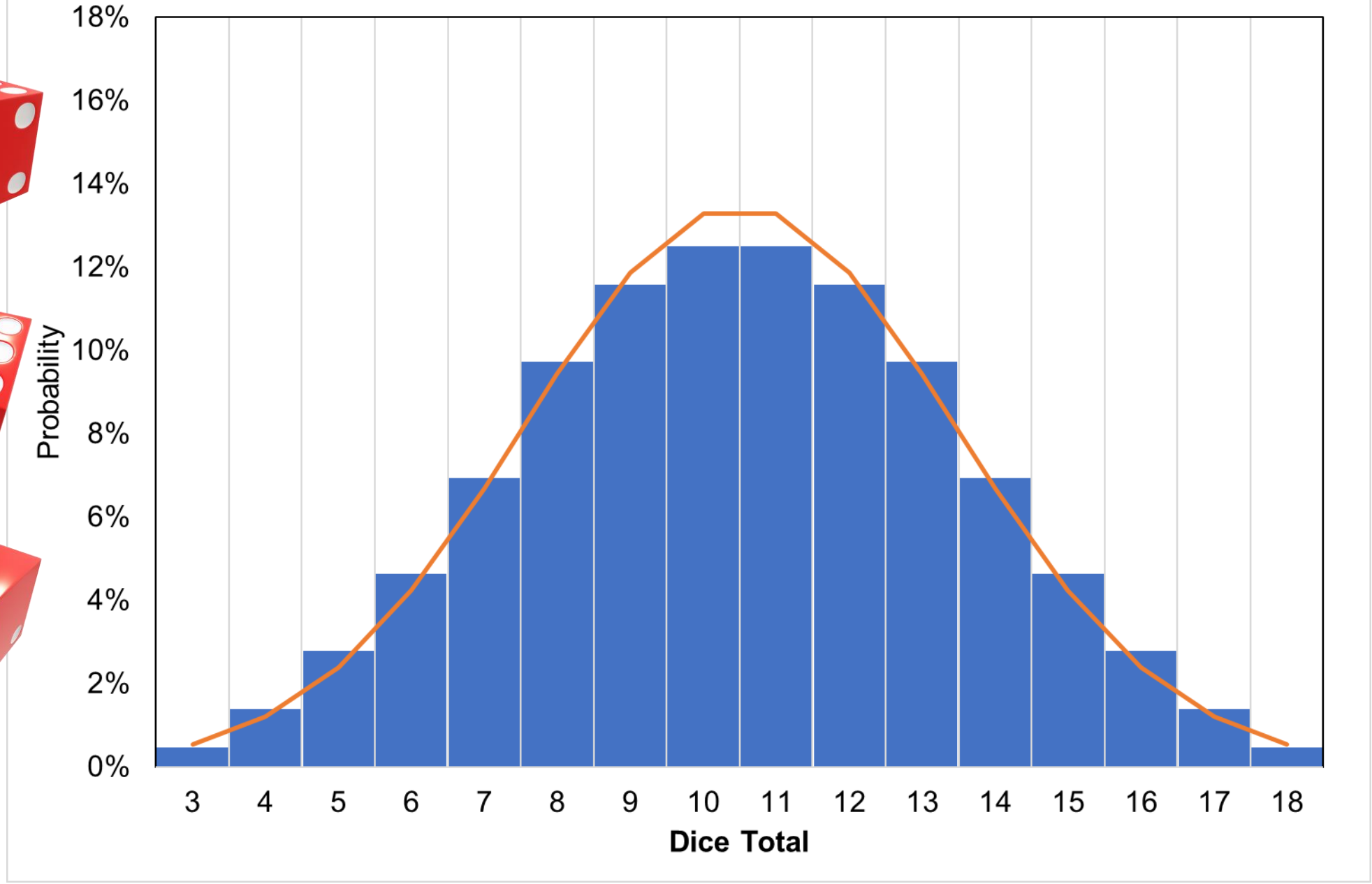

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
95%
970
980
990
1000
1010
1020
1030
Allocated Oil (te/d)


0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
2.5%
2.5%
970
980
990
1000
1010
1020
1030
Allocated Oil (te/d)

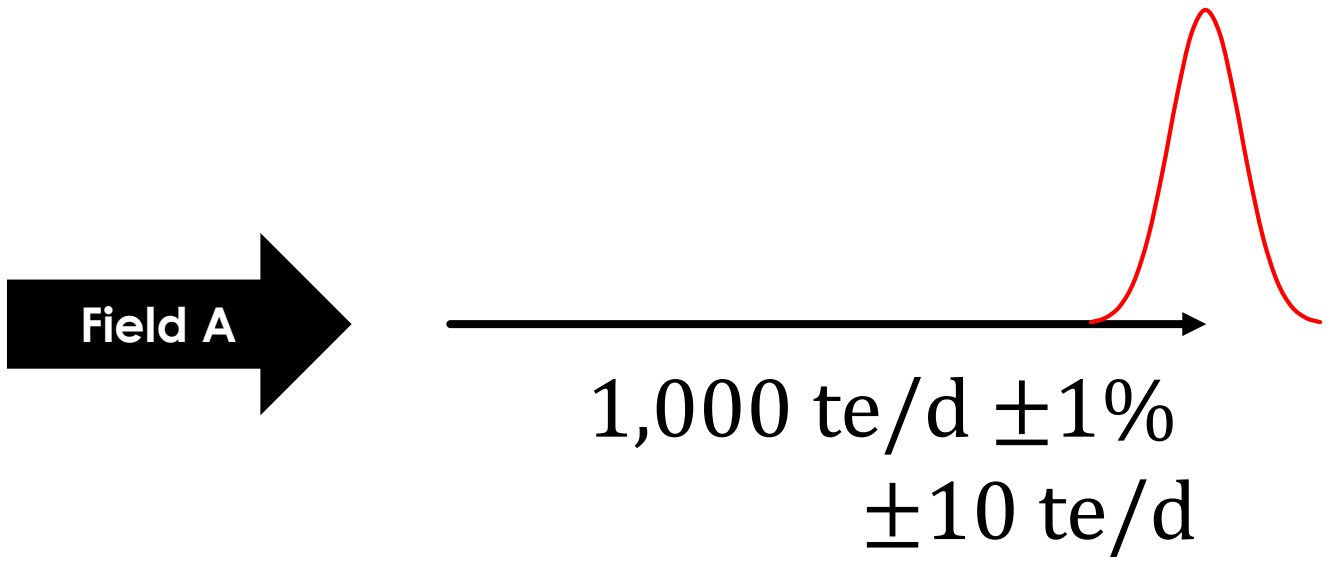

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
970
980
990
1000
1010
1020
1030
Allocated Oil (te/d)


18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Probability
1
2
3
4
5
6
Dice Number

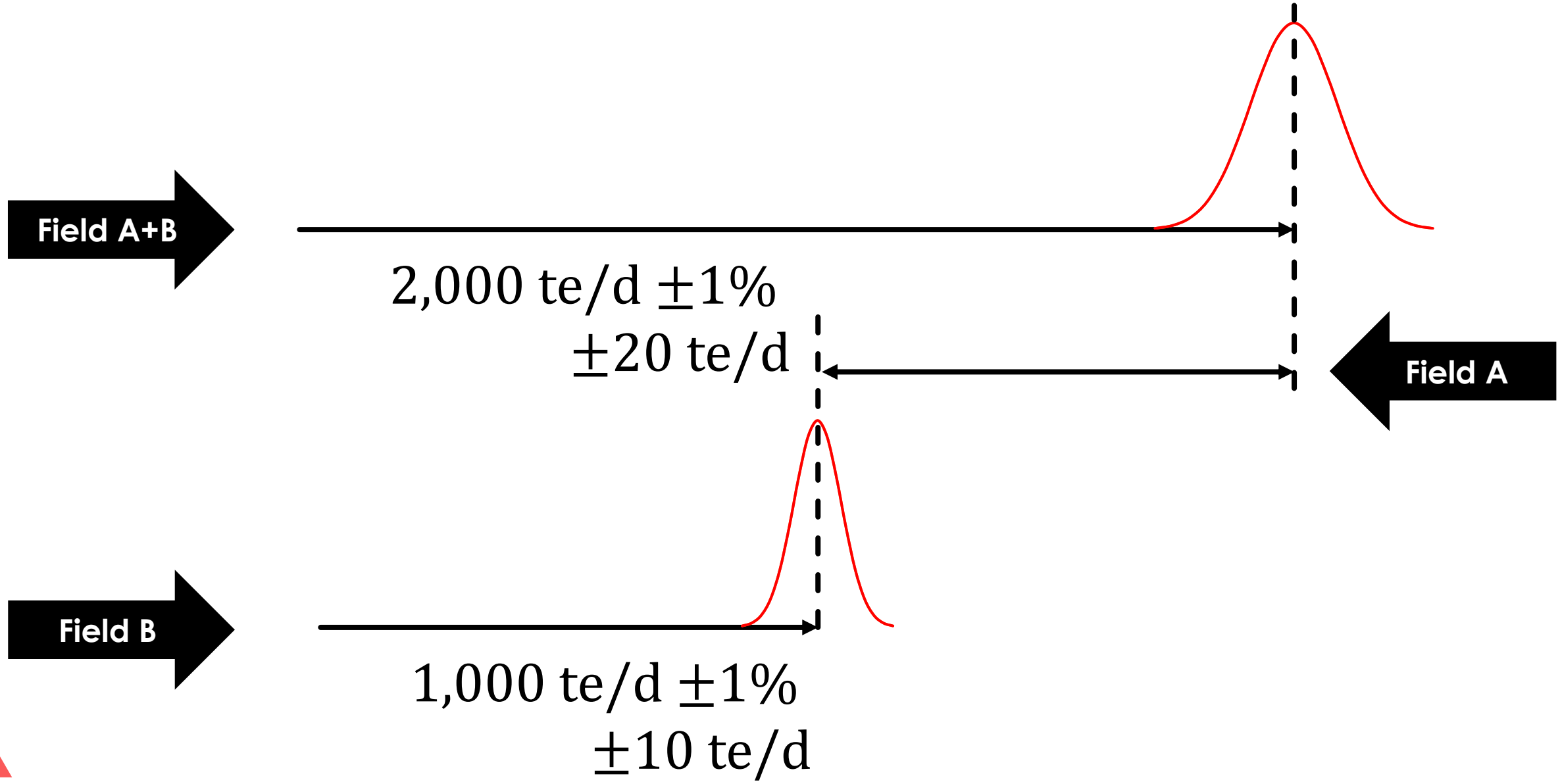

18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Probability
2
3
4
5
6
7
8
9
10
11
12
Dice Total


18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Probability
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Dice Total

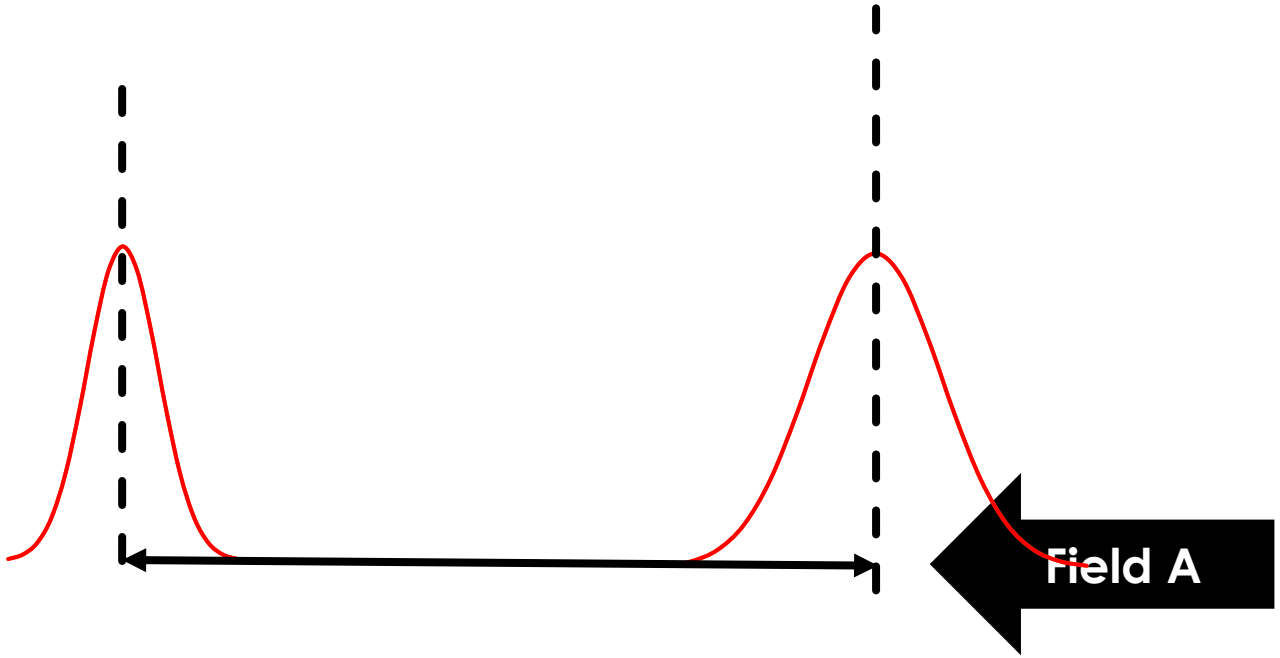
Simple Process New Field



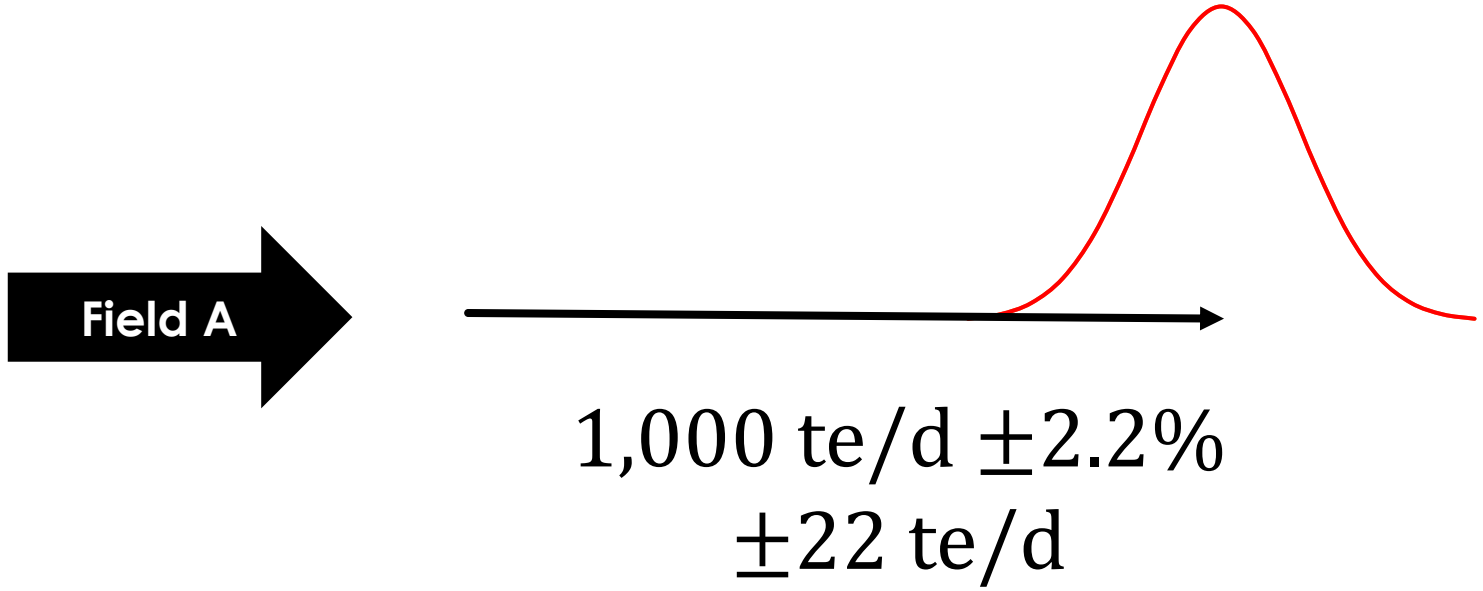
Simple Process New Field

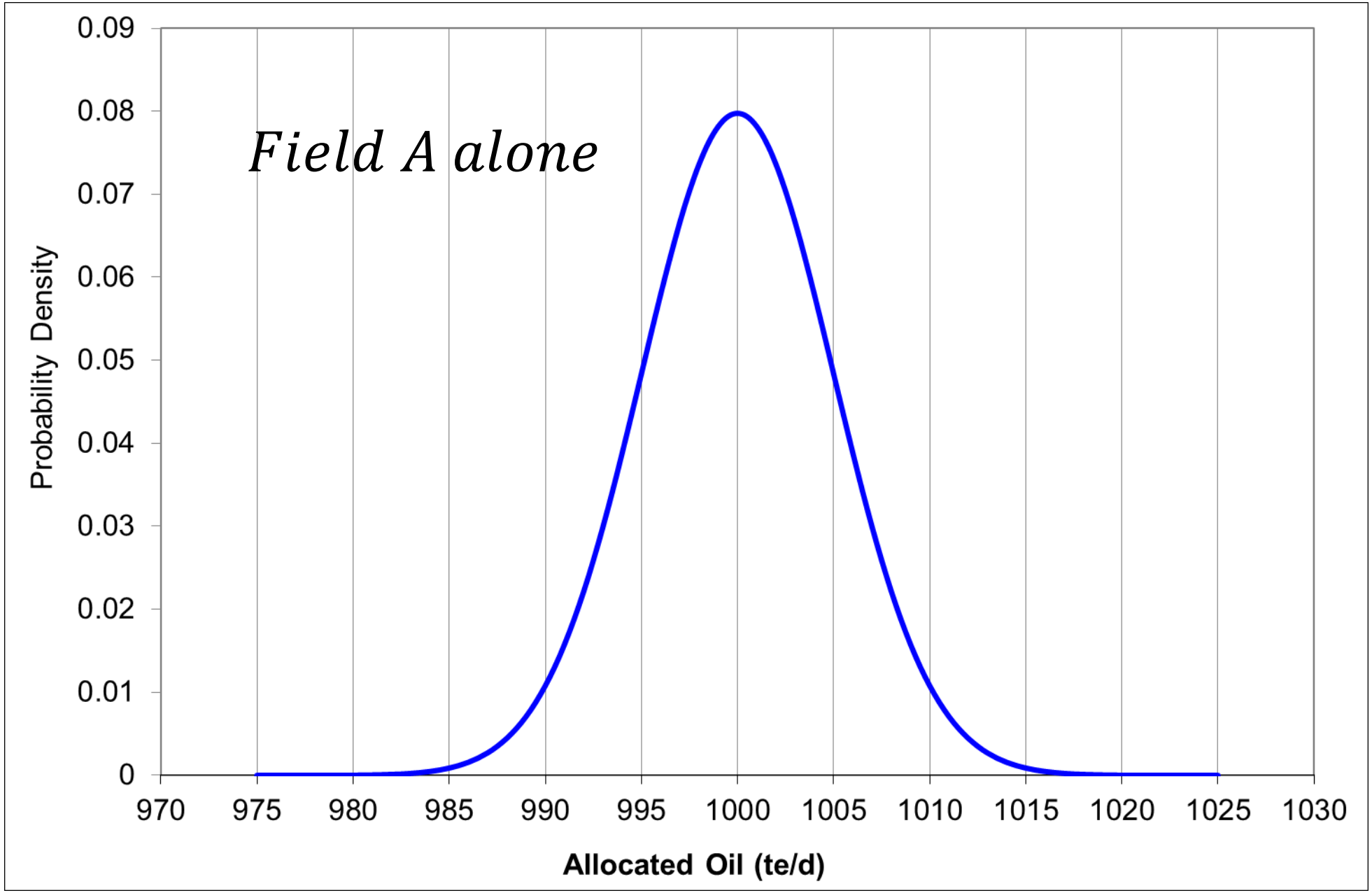


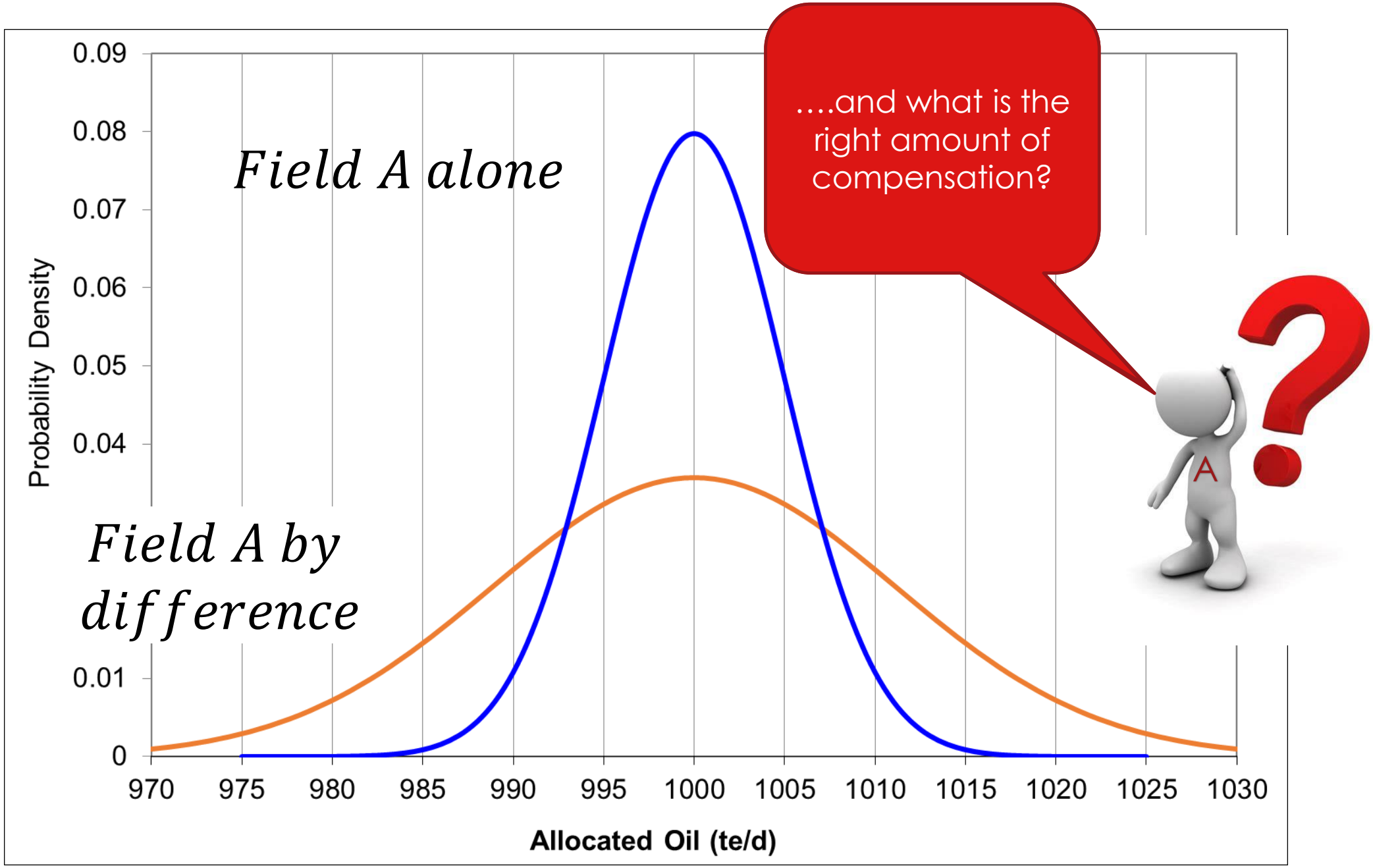
Simple Process New Field

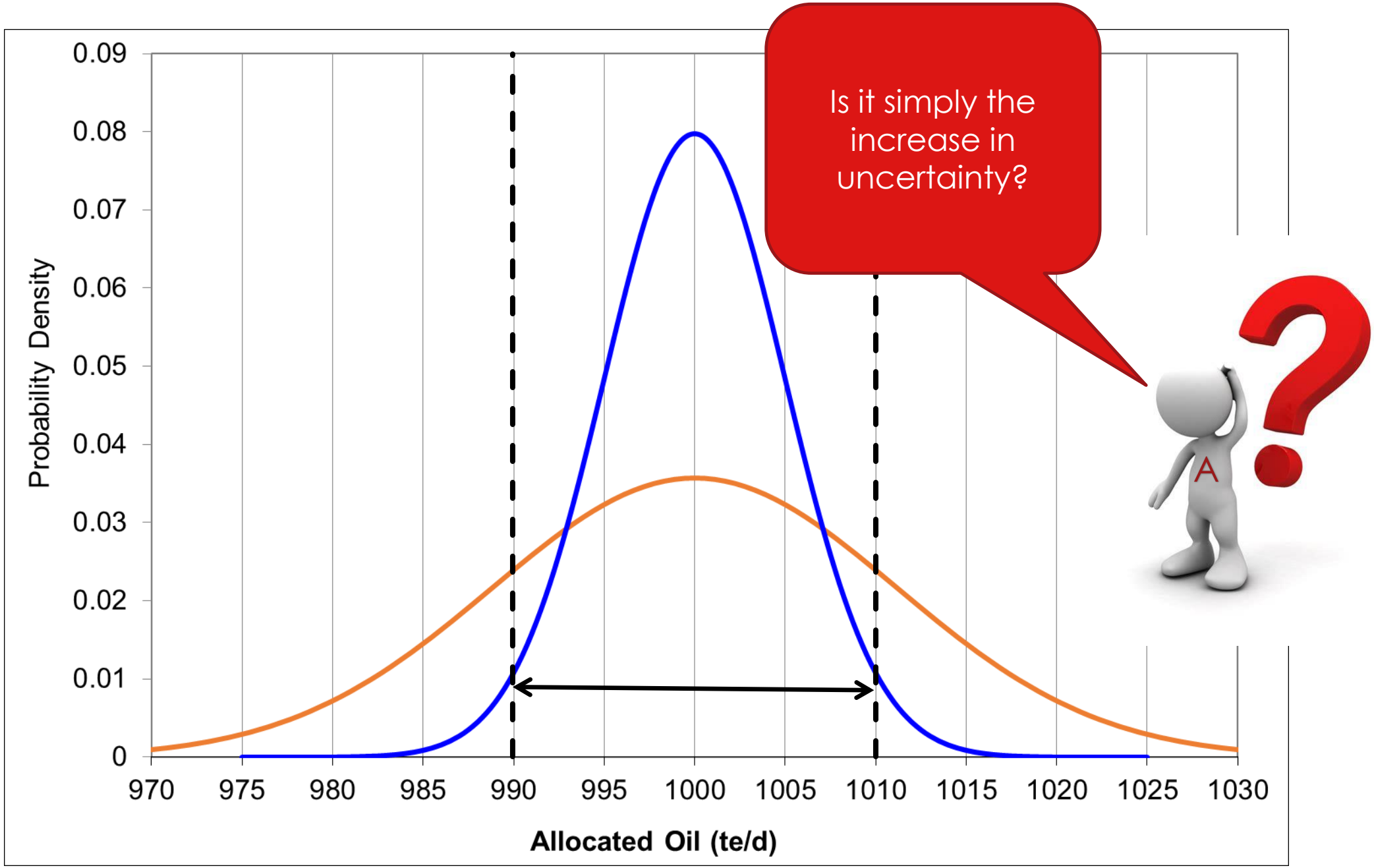


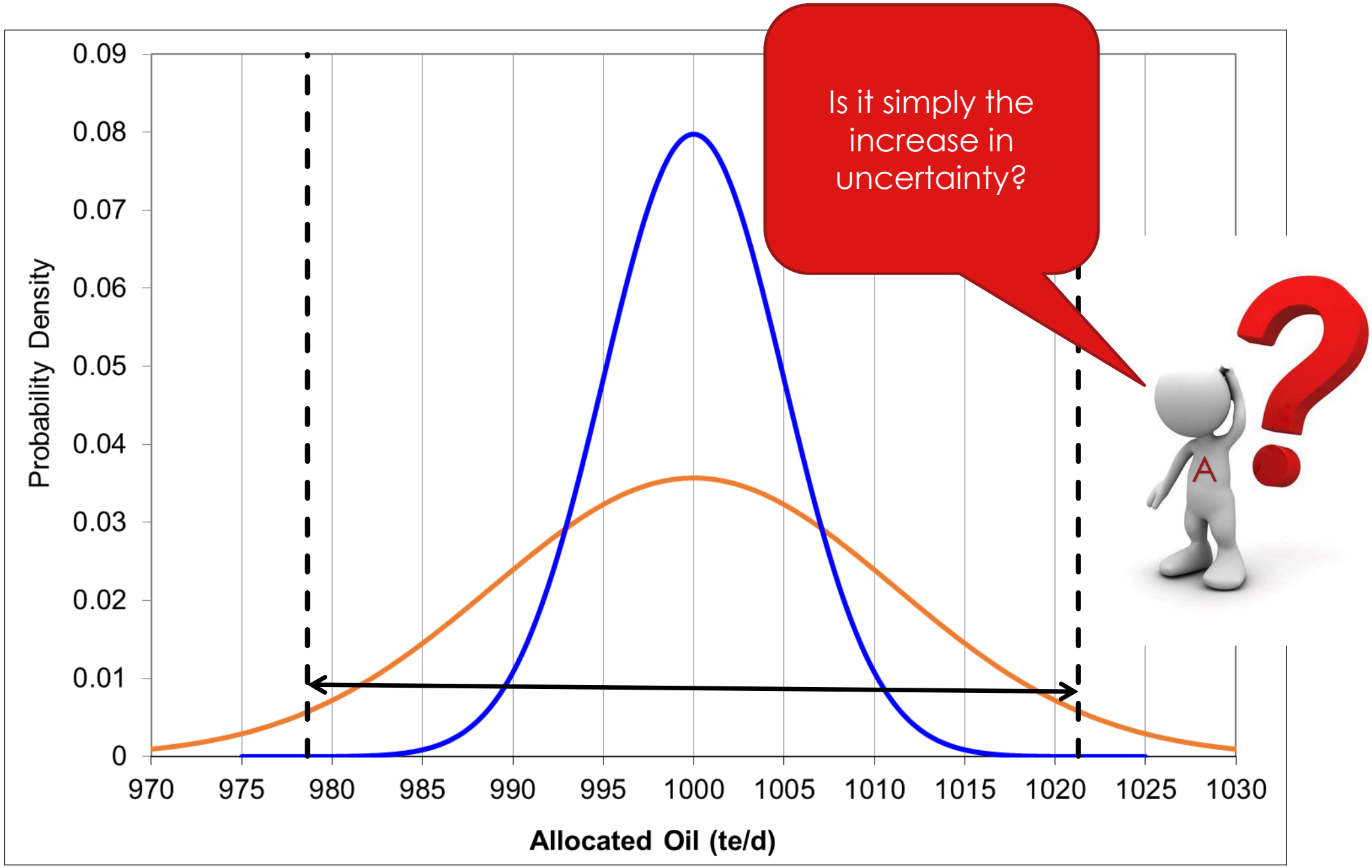
Simple Process New Field




Field A alone
Probability Density
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
970
975
980
985
990
995
1000
1005
1010
1015
1020
1025
1030
Allocated Oil (te/d)


0.09
0.08
0.07
0.06
0.05
0.04
0.01
0
Probability Density
970
975
980
985
990
995
1000
1005
1010
1015
1020
1025
1030
Allocated Oil (te/d)
Field A alone
Field A by difference
….and what is the right amount of compensation?
A


Is it simply the increase in uncertainty?
Probability Density
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
970
975
980
985
990
995
1000
1005
1010
1015
1020
1025
1030
Allocated Oil (te/d)


Is it simply the increase in uncertainty?
Probability Density
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
970
975
980
985
990
995
1000
1005
1010
1015
1020
1025
1030
Allocated Oil (te/d)

Basis

1. Uncertainty described by the Normal or Gaussian distribution
2. Utility
   a) Loss averse
   b) Indifferent to gains

Offered a Gamble

Expected Value

50% chance

100% chance

50% chance

Expected value = 0.5*0 +0.5*2 = 1 €

Utility

50% chance

1000000 €
100% chance

50% chance

Expected value = 0.5*0 +0.5*2000000 = 1000000 €

Utility

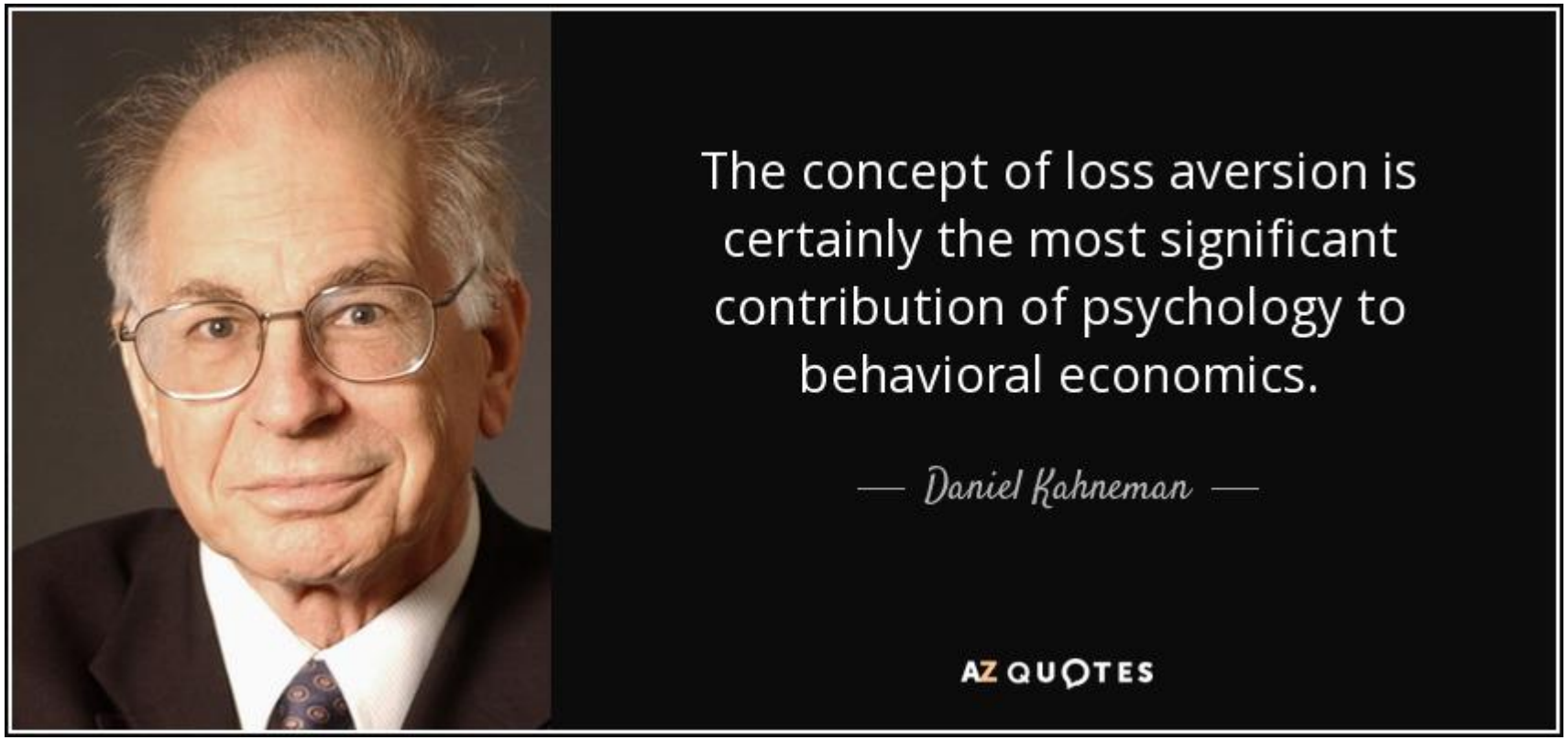
50% chance

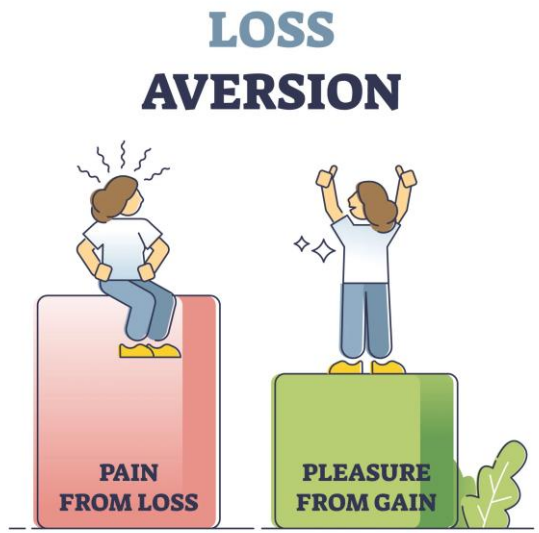
900000 €
100% chance

50% chance

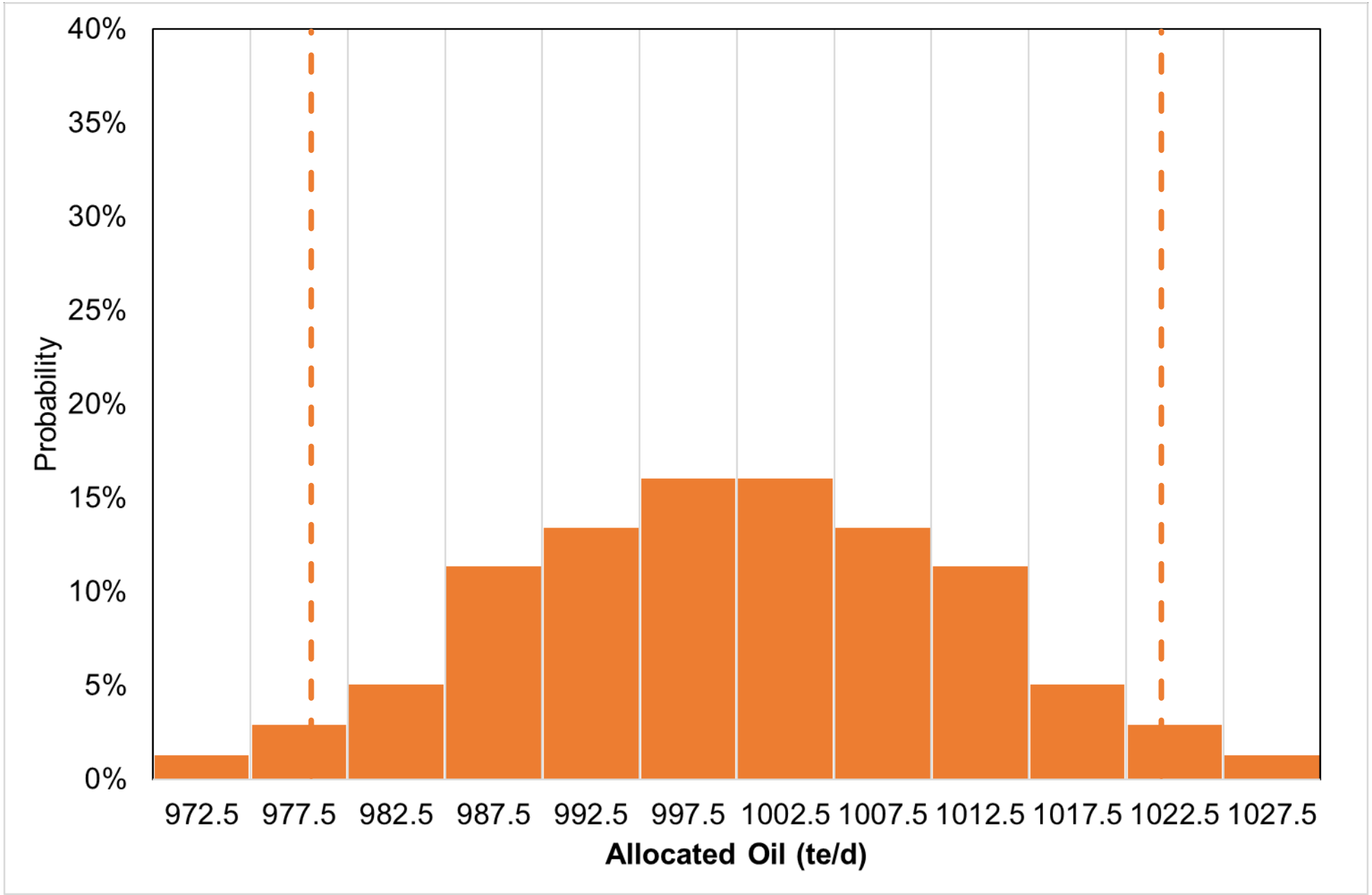
Expected value = 0.5*0 +0.5*2000000 = 1000000 €

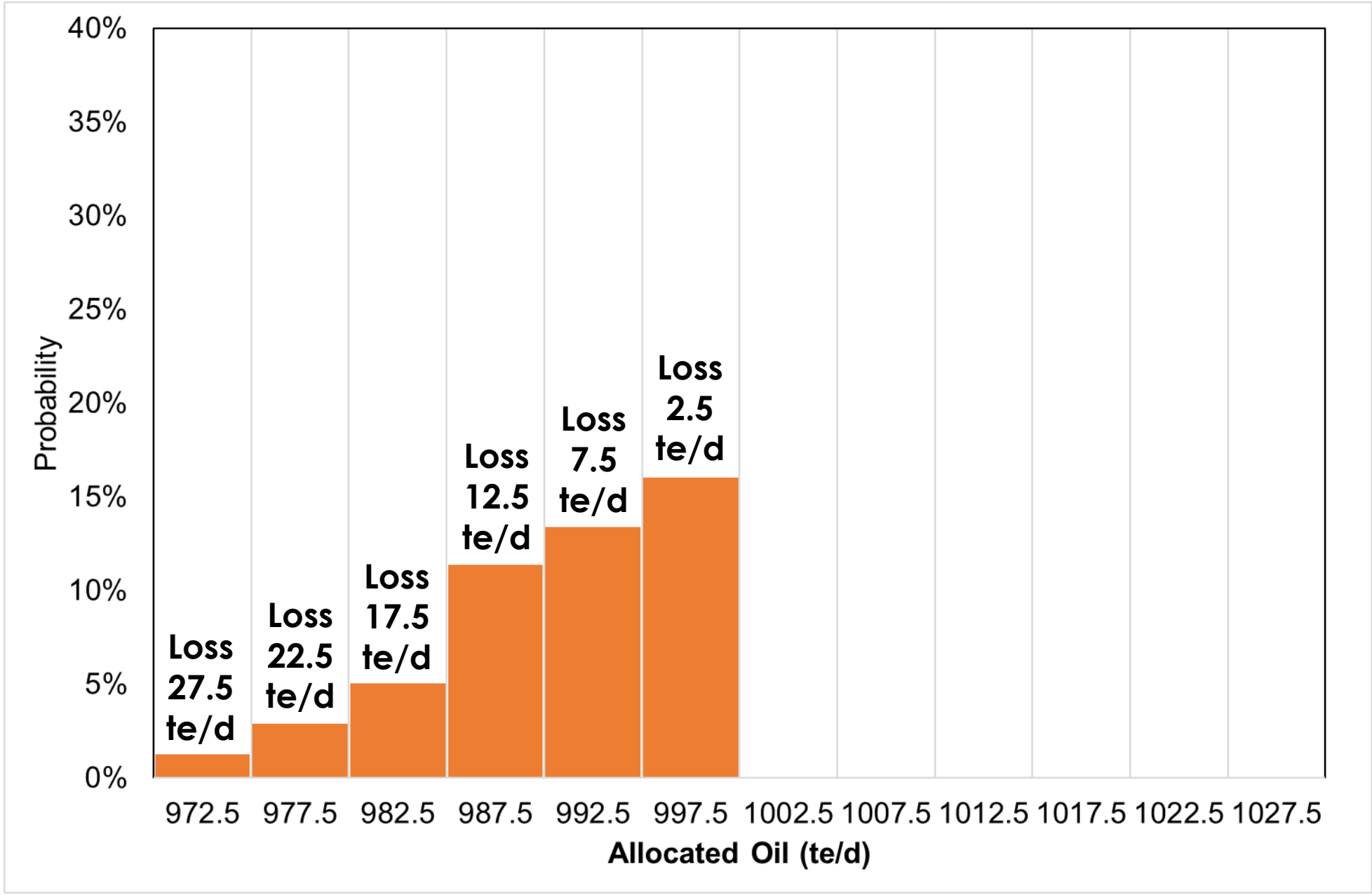
Prospect Theory - Loss Aversion

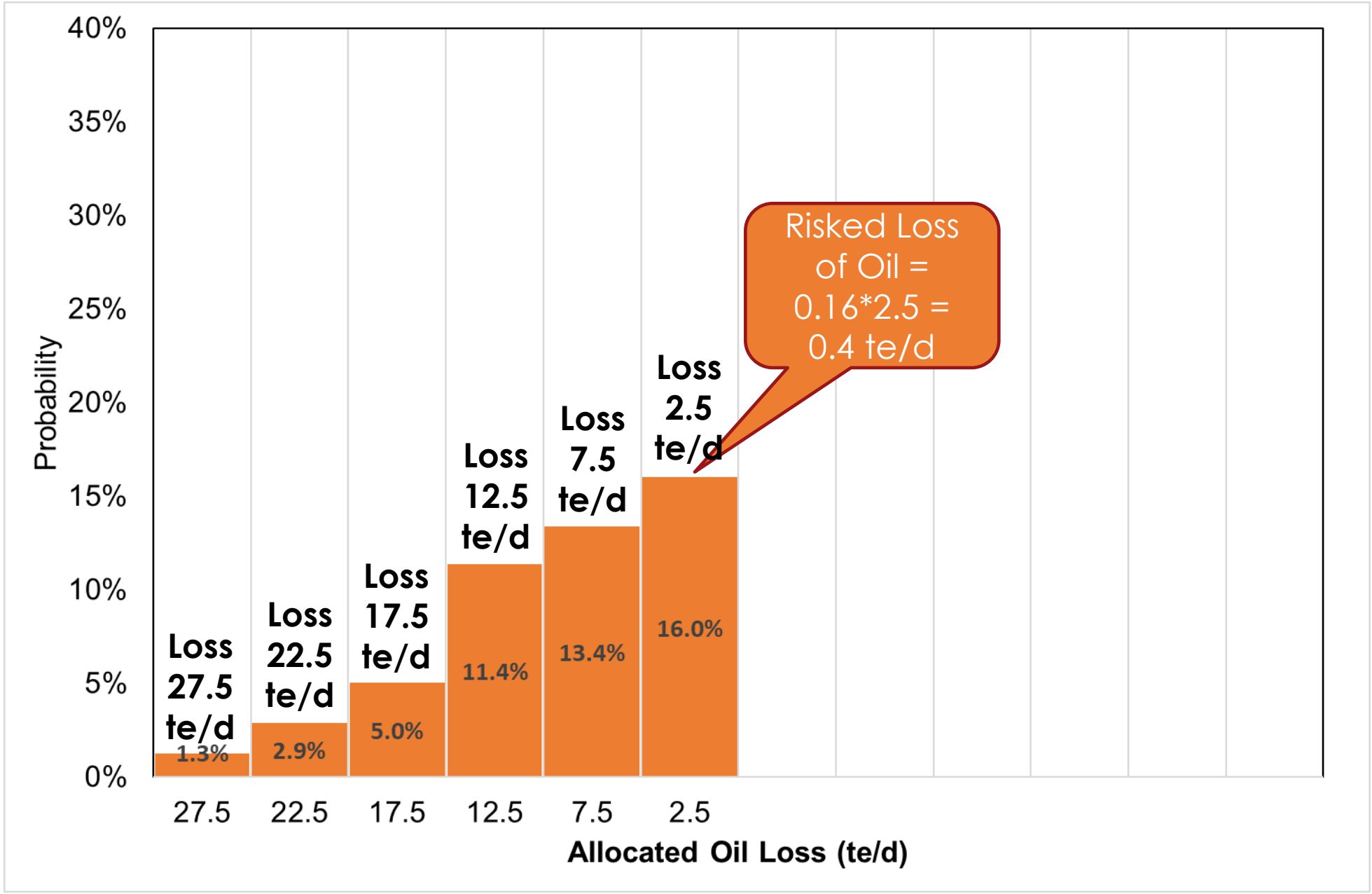


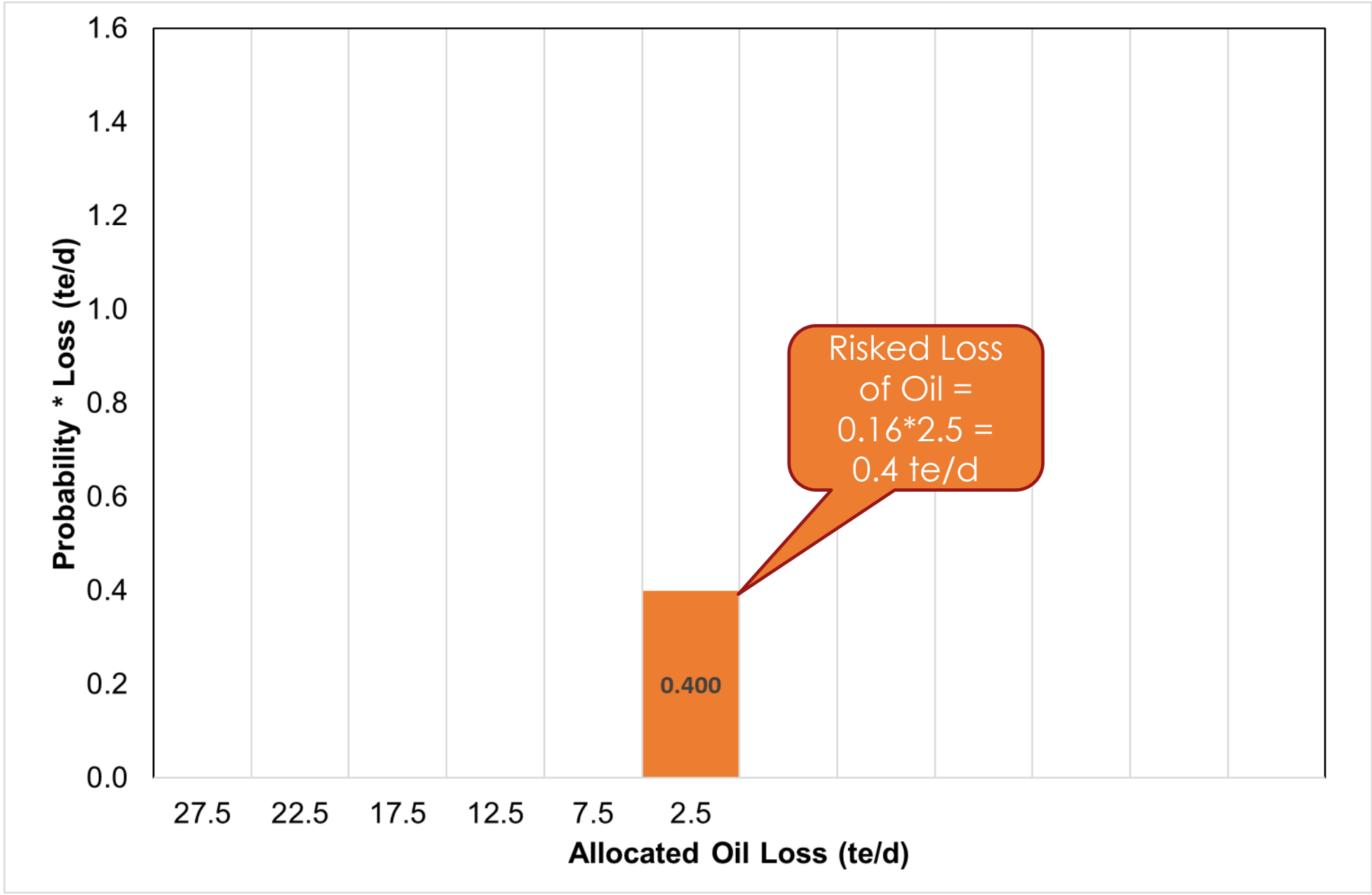


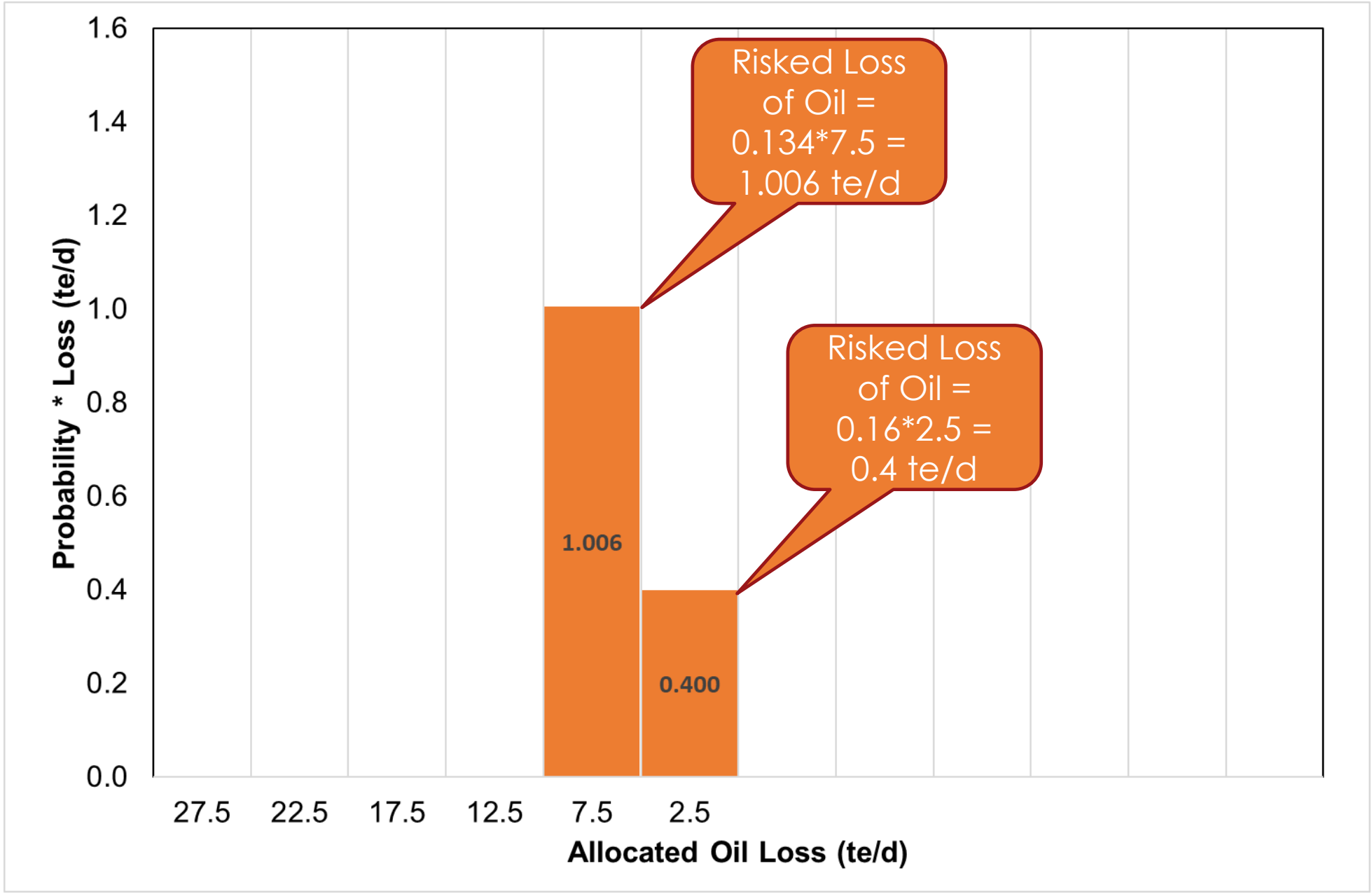
Pain of loss ~ twice joy of gain

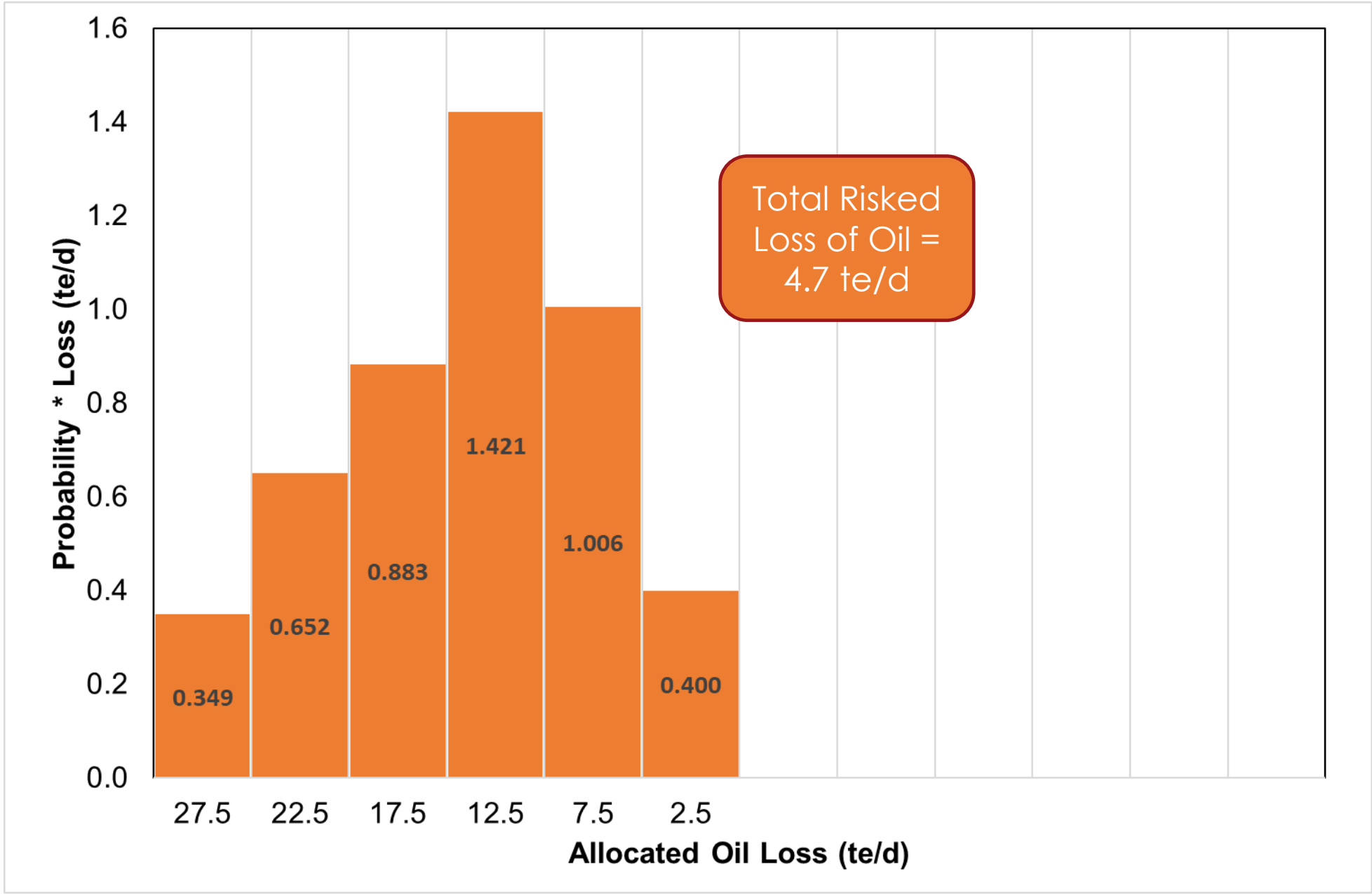

40%
35%
30%
25%
20%
15%
10%
5%
0%
Probability
972.5
977.5
982.5
987.5
992.5
997.5
1002.5
1007.5
1012.5
1017.5
1022.5
1027.5
Allocated Oil (te/d)

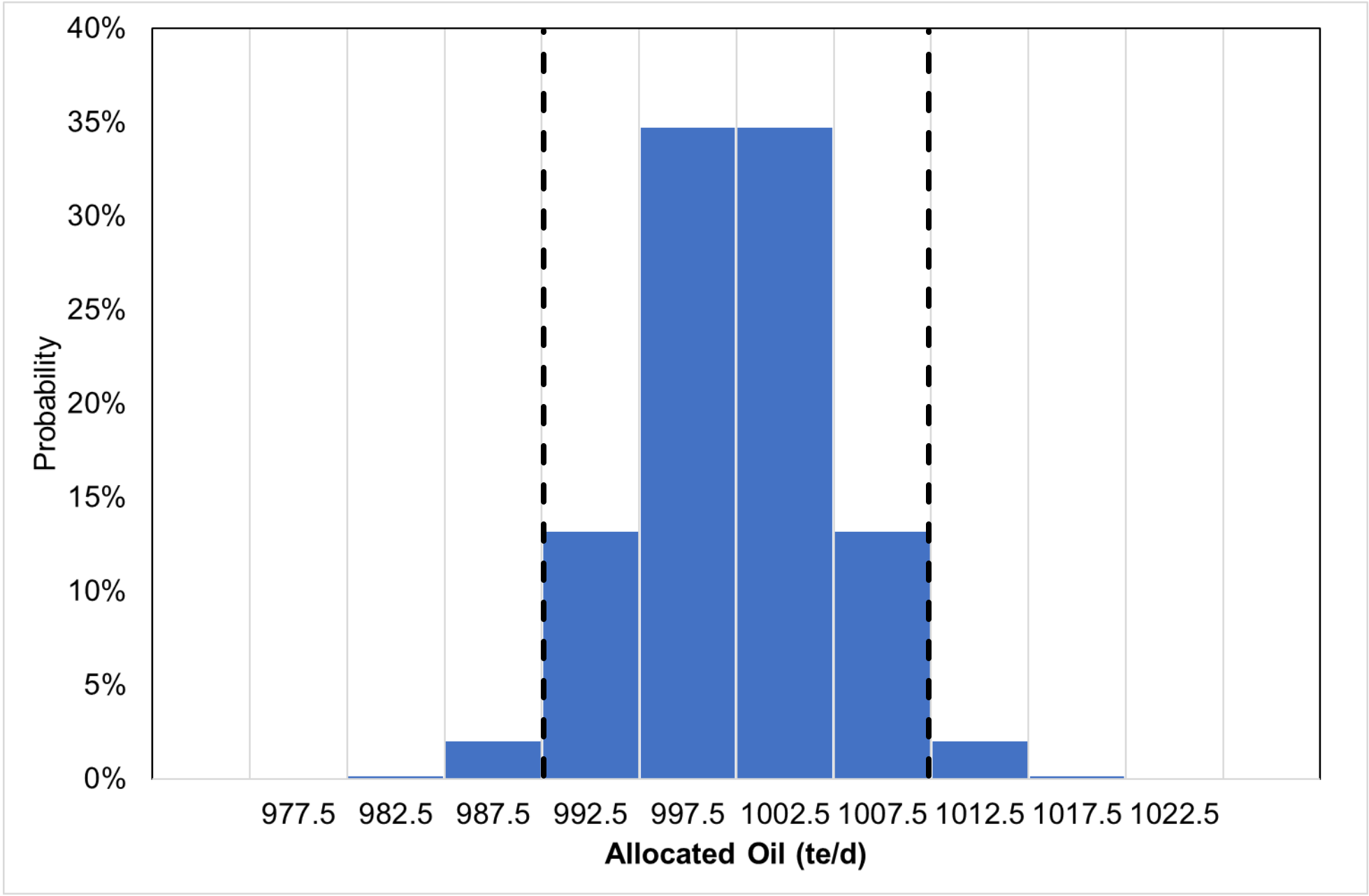

40%
35%
30%
25%
20%
15%
10%
5%
0%
Probability
Loss 27.5 te/d
Loss 22.5 te/d
Loss 17.5 te/d
Loss 12.5 te/d
Loss 7.5 te/d
Loss 2.5 te/d
972.5
977.5
982.5
987.5
992.5
997.5
1002.5
1007.5
1012.5
1017.5
1022.5
1027.5
Allocated Oil (te/d)

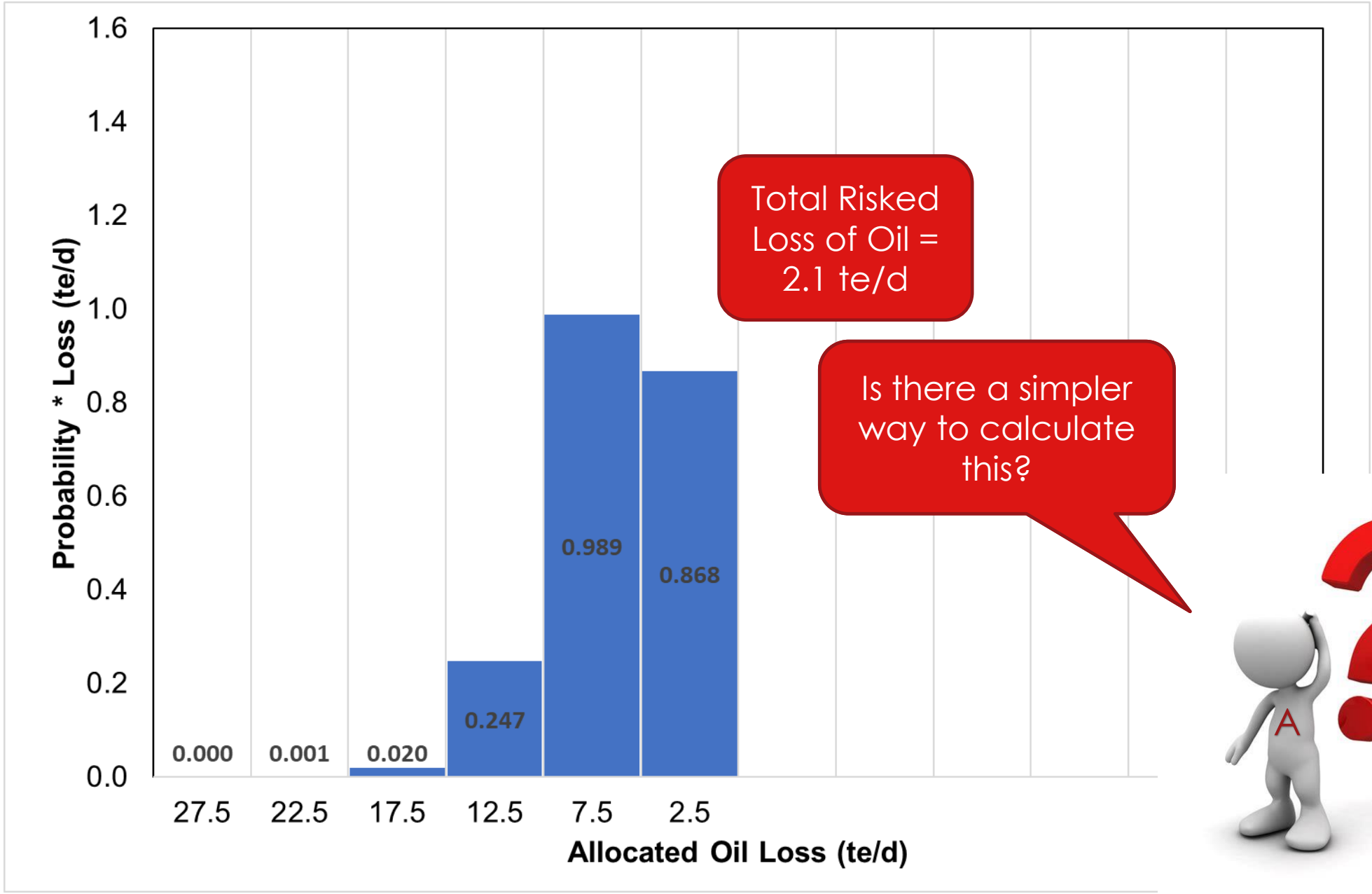

40%
35%
30%
25%
20%
15%
10%
5%
0%
Probability
Loss 27.5 te/d
Loss 22.5 te/d
Loss 17.5 te/d
Loss 12.5 te/d
Loss 7.5 te/d
Loss 2.5 te/d
1.3%
2.9%
5.0%
11.4%
13.4%
16.0%
Risked Loss of Oil = 0.16*2.5 = 0.4 te/d
27.5
22.5
17.5
12.5
7.5
2.5
Allocated Oil Loss (te/d)

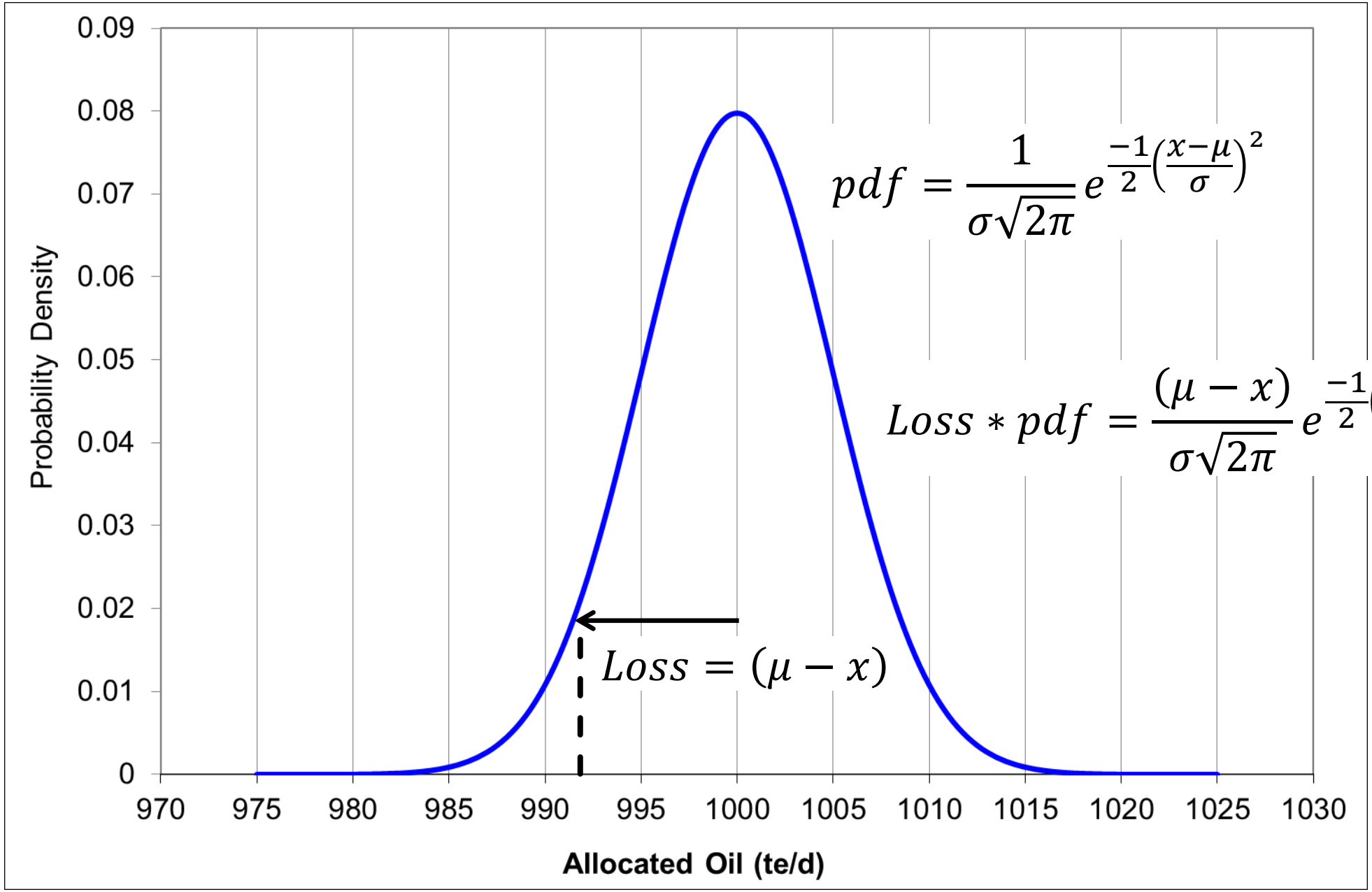

1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Probability * Loss (te/d)
Risked Loss of Oil = 0.16*2.5 = 0.4 te/d
0.400
27.5
22.5
17.5
12.5
7.5
2.5
Allocated Oil Loss (te/d)

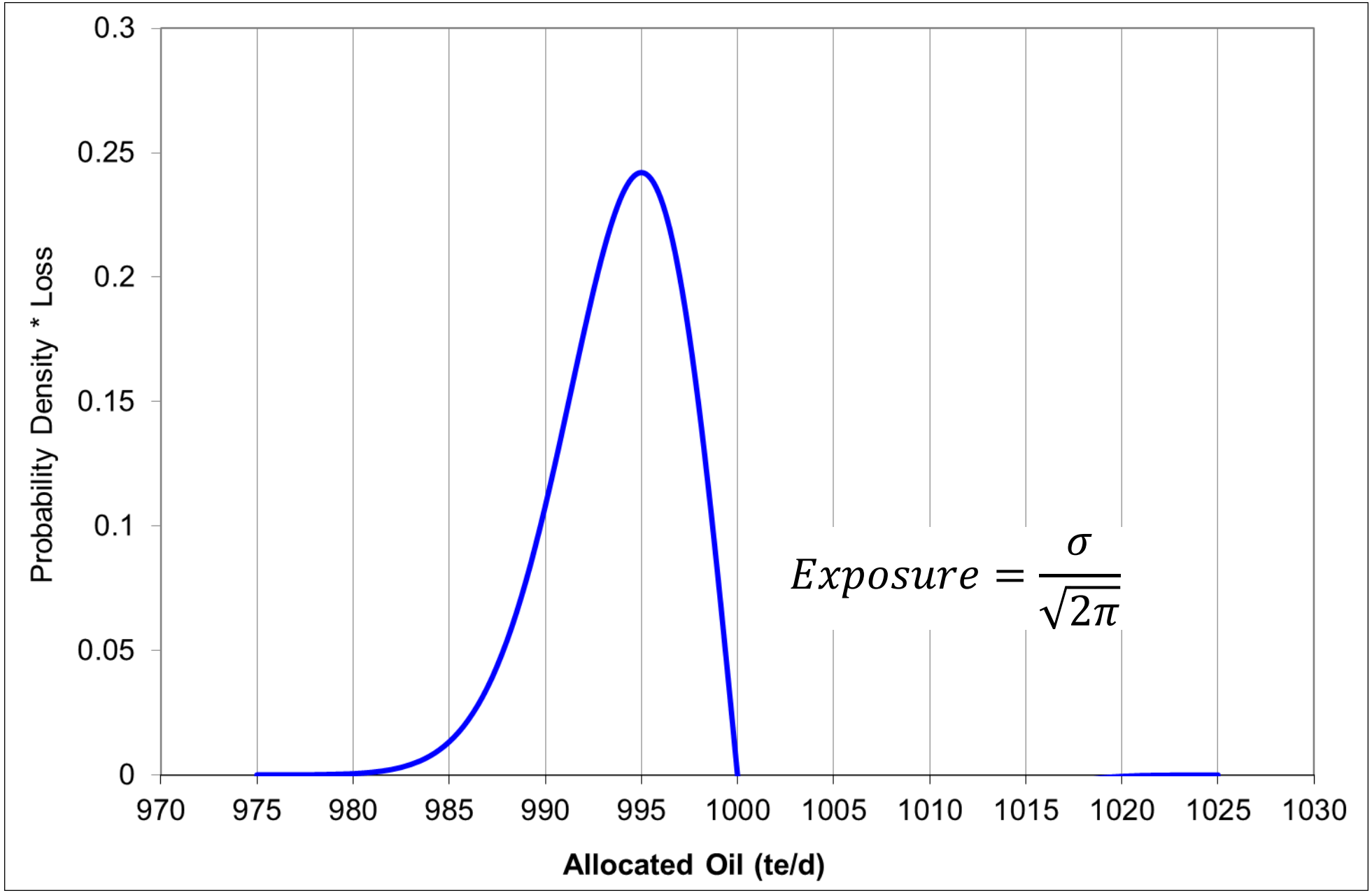

Risked Loss of Oil = 0.134*7.5 = 1.006 te/d
Risked Loss of Oil = 0.16*2.5 = 0.4 te/d
1.006
0.400
Probability * Loss (te/d)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
27.5
22.5
17.5
12.5
7.5
2.5
Allocated Oil Loss (te/d)

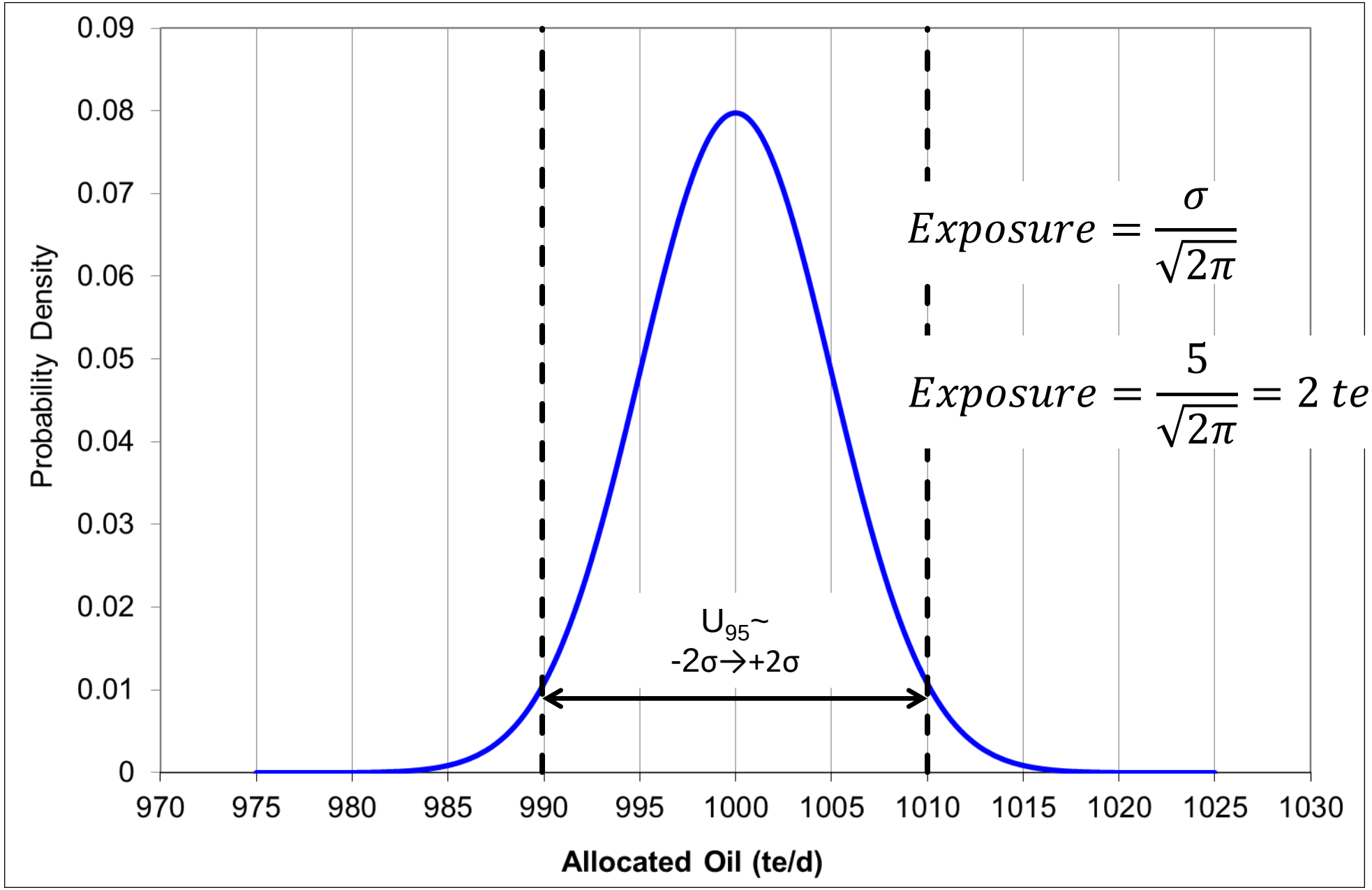

1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Probability * Loss (te/d)
0.349
0.652
0.883
1.421
1.006
0.400
27.5
22.5
17.5
12.5
7.5
2.5
Allocated Oil Loss (te/d)
Total Risked Loss of Oil = 4.7 te/d

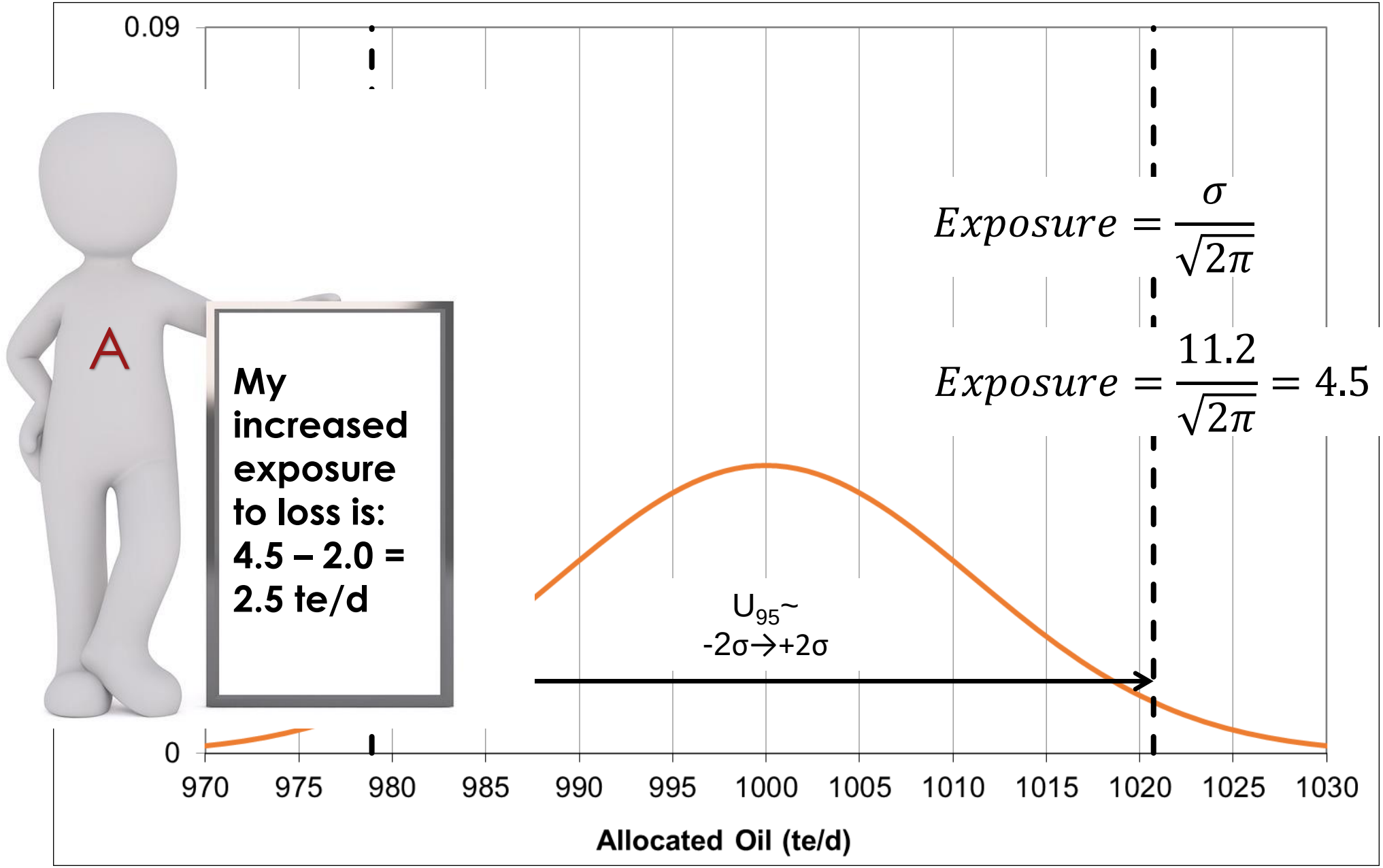

40%
35%
30%
25%
20%
15%
10%
5%
0%
Probability
977.5
982.5
987.5
992.5
997.5
1002.5
1007.5
1012.5
1017.5
1022.5
Allocated Oil (te/d)


1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Probability * Loss (te/d)
0.000
0.001
0.020
0.247
0.989
0.868
27.5
22.5
17.5
12.5
7.5
2.5
Allocated Oil Loss (te/d)
Total Risked Loss of Oil = 2.1 te/d
Is there a simpler way to calculate this?


0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
970
975
980
985
990
995
1000
1005
1010
1015
1020
1025
1030
Allocated Oil (te/d)
$pdf = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$
$Loss * pdf = \frac{(\mu - x)}{\sigma\sqrt{2\pi}} e^{\frac{-1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$
$Loss = (\mu - x)$


0.3
0.25
0.2
0.15
0.1
0.05
0
Probability Density * Loss
970
975
980
985
990
995
1000
1005
1010
1015
1020
1025
1030
Allocated Oil (te/d)
$Exposure = \frac{\sigma}{\sqrt{2\pi}}$


0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Probability Density
970
975
980
985
990
995
1000
1005
1010
1015
1020
1025
1030
Allocated Oil (te/d)
U95~
-2σ→+2σ
$Exposure = \frac{\sigma}{\sqrt{2\pi}}$
$Exposure = \frac{5}{\sqrt{2\pi}} = 2\ te/d$


0.09
A
My increased exposure to loss is: 4.5 – 2.0 = 2.5 te/d
$Exposure = \frac{\sigma}{\sqrt{2\pi}}$
$Exposure = \frac{11.2}{\sqrt{2\pi}} = 4.5\ te/d$
U_{95}~ -2σ→+2σ
0
970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030
Allocated Oil (te/d)

1. Uncertainty described by the Normal or Gaussian distribution
2. Utility
   a) Loss averse
   b) Indifferent to gains

$$Exposure\ to\ Loss = \frac{\sigma}{\sqrt{2\pi}}$$

$$Exposure\ to\ Loss = \frac{\sigma}{\sqrt{2\pi}}$$

$$Exposure\ to\ Loss = \frac{U_k}{k\sqrt{2\pi}}$$

$$Exposure\ to\ Loss = \frac{U_{95}}{1.96\sqrt{2\pi}}$$

$$Exposure\ to\ Loss \sim 0.2 * U_{95}$$

NORSOK I-106

ANNEX C
System selection criteria (informative)

All measurements have an uncertainty. In fiscal measurement there is a risk for loss of revenue as the measured value may be lower than the true value. Concept with low measurement uncertainty has lower risk for loss of revenue than concepts with higher uncertainty. Metering systems with low uncertainty normally has higher cost than systems with higher uncertainty. The higher cost will also represent a loss of revenue.

Th… a concept with low uncertainty (co… be unreasonab… …
…f a les…

NORSOK I-106

uncertainty
C_A total life cycle costs concept A
C_B total life cycle costs concept B
NPV net present value of the measured quantity
Risk factor (risk for loss / uncertainty at 95 % confidence level) = 0,2

The risk factor has been quantified in section 4 in the paper: Cost Benefit Analyses in the Design of Allocation Systems, by Phillip Stockton, presented at the North Sea Flow Measurement Workshop in 2009.

Concept B may be acceptable if the additional risk for loss is lower than the additional cost for concept A.

Concept B may be acceptable if:

$(C_A - C_B) > (U_B - U_A) * \text{risk fac} \ldots \text{NPV}$

NORSOK I-106

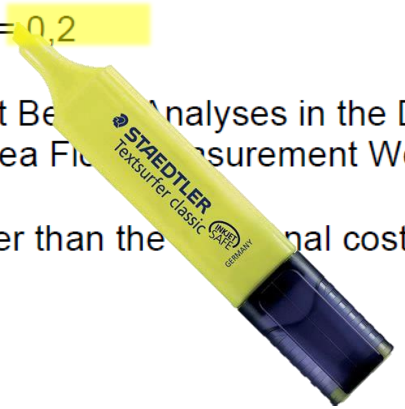
uncertainty
C_A total life cycle costs concept A
C_B total life cycle costs concept B
NPV net present value of the measured quantity
Risk factor (risk for loss / uncertainty at 95 % confidence level) = 0,2

The risk factor has been quantified in section 4 in the paper: Cost Be Analyses in the Design of Allocation Systems, by Phillip Stockton, presented at the North Sea Fi surement Workshop in 2009.

Concept B may be acceptable if the additional risk for loss is lower than the nal cost for concept A.

Concept B may be acceptable if:

$(C_A - C_B) > (U_B - U_A) * \text{risk factor} * NPV$



UK OGA (Now NSTA) Guidelines

4.1 Risk-Based Maintenance Strategies

4.1.1 The OGA expects Operators of both pipelines and individual measurement stations to be open to the adoption of a risk-based approach to maintenance.

4.1.2 In such an approach, Operator experience is used to assess the likely overall effect, in terms of financial exposure, of increased uncertainty in measurement at either the primary or the secondary element, and to balance this against the cost of its mitigation by re-calibration.

4.1.3 In considering the effect of increased measurement uncertainty, it is important use

[5] Pashnina, N & Daniel, P. "Determination of Optimal Calibration Intervals – A Risk-Based Approach." 34th International North Sea Flow Measurement Workshop, St. Andrews 2016.

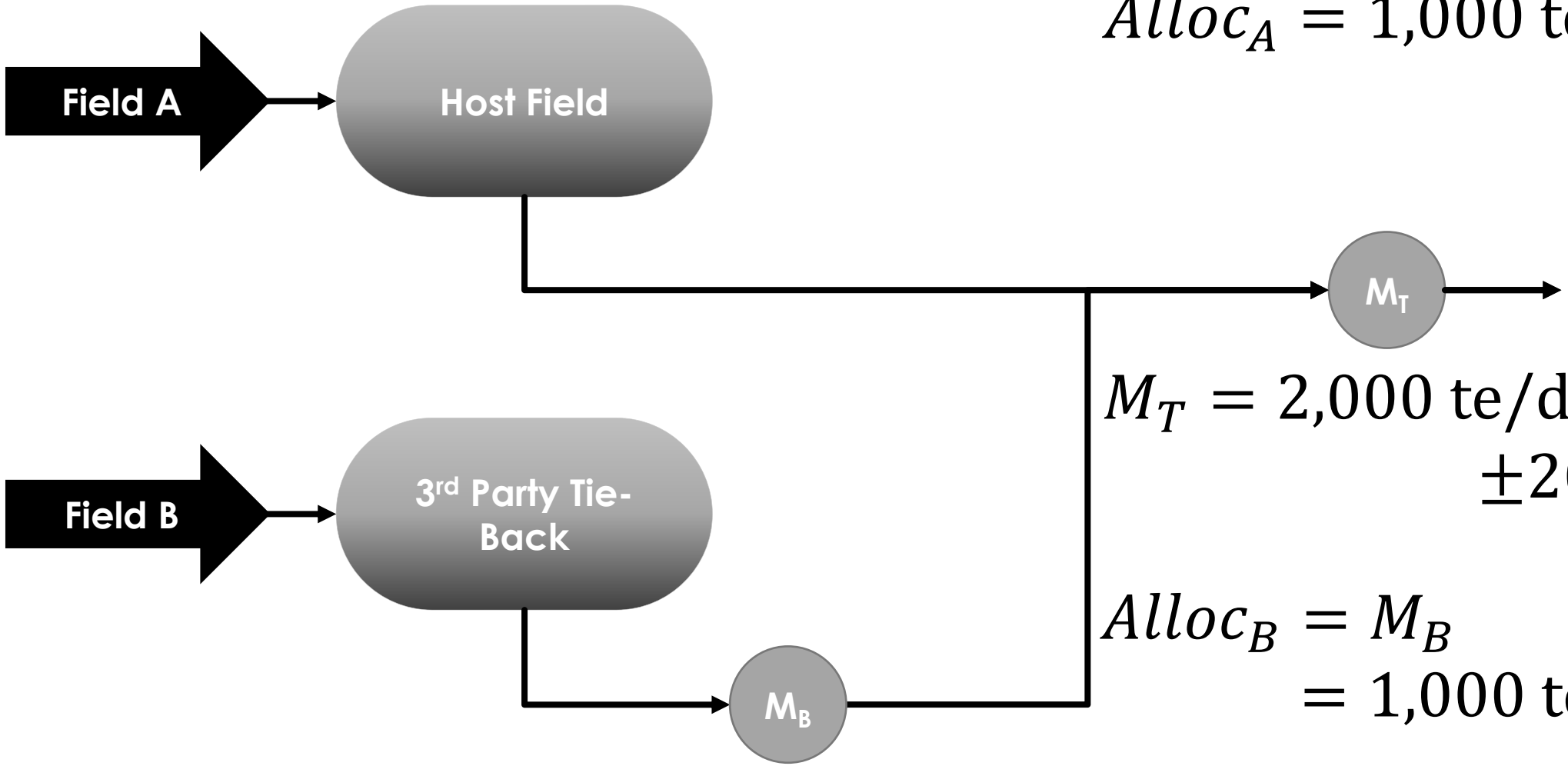
[6] Stockton, P. "Cost benefit analyses in the design of allocation systems." 27th International North Sea Flow Measurement Workshop, Tønsberg 2009.

[7] Sætre, C. et. al "A new methodology for cost-benefit risk analysis of oil metering system lay-outs." 33rd International North Sea Flow Measurement Workshop, Tønsberg 2015

[8] https://nfogm.no/documents/north-sea-flow-measurement-workshop/

Previous Example Allocation Uncertainty

$$Alloc_A = M_T - M_B$$
$$Alloc_A = 1{,}000 \text{ te/d } \pm 2.2\%$$
$$\pm 22 \text{ te/d}$$

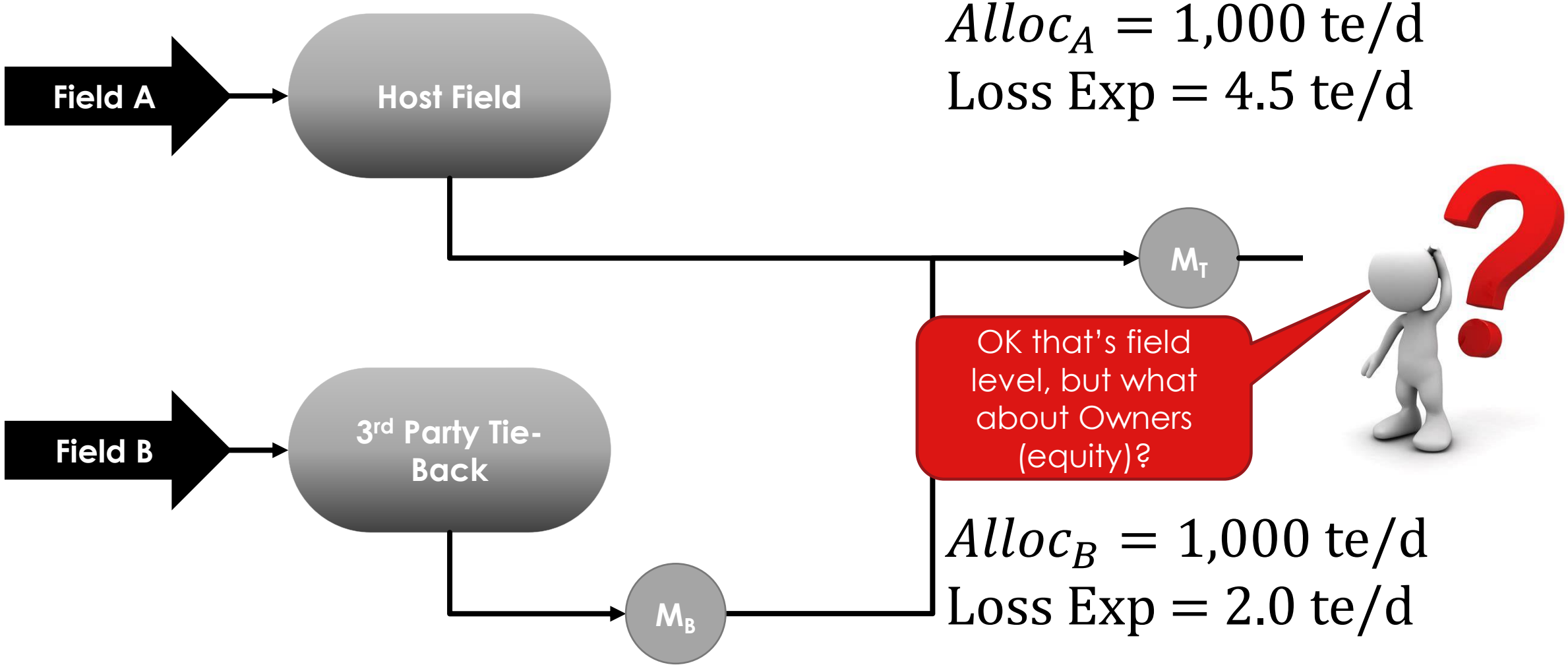


$$M_T = 2{,}000 \text{ te/d } \pm 1\%$$
$$\pm 20 \text{ te/d}$$

$$Alloc_B = M_B$$
$$= 1{,}000 \text{ te/d } \pm 1\%$$
$$\pm 10 \text{ te/d}$$

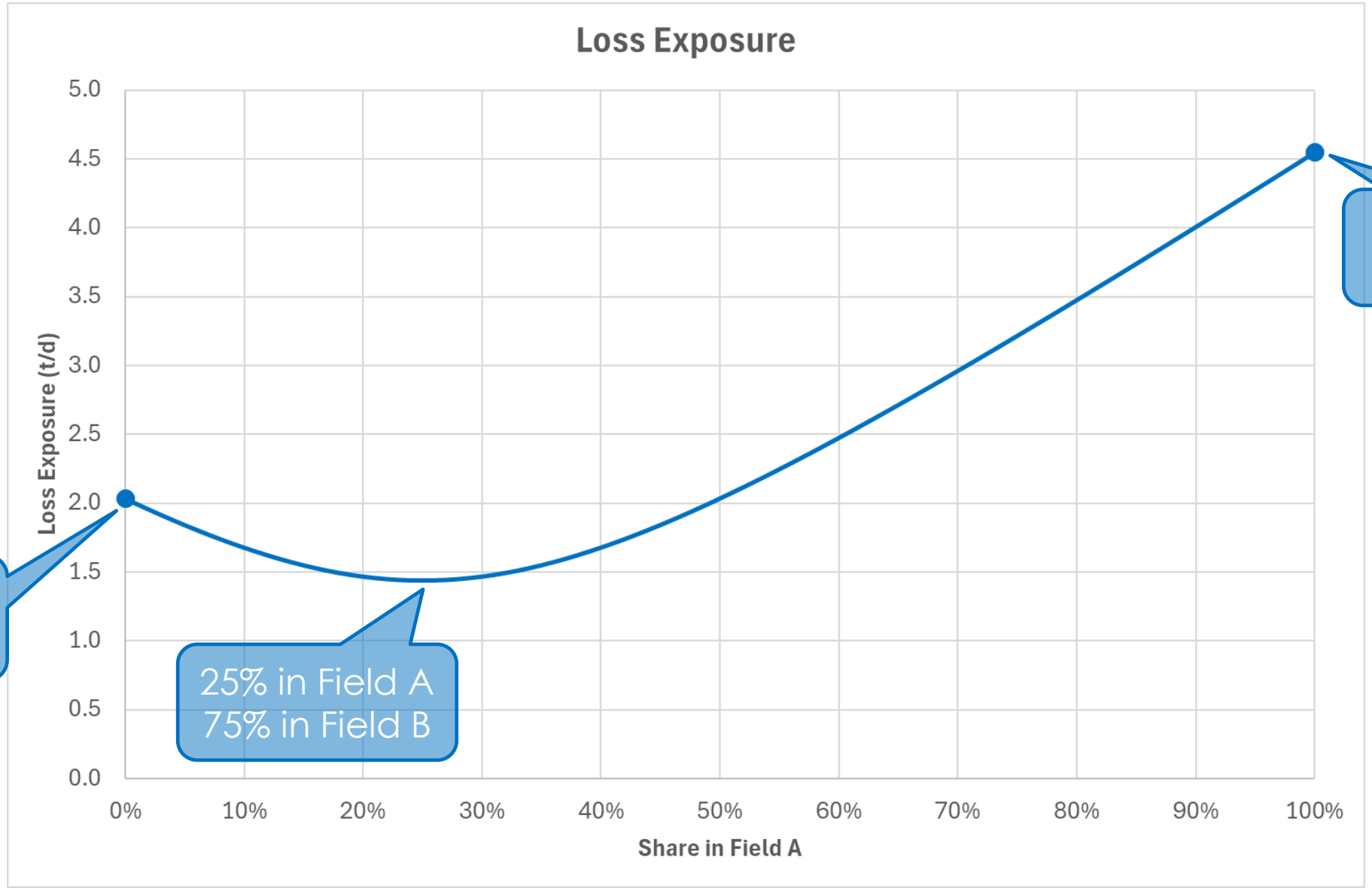
Previous Example Loss Exposure

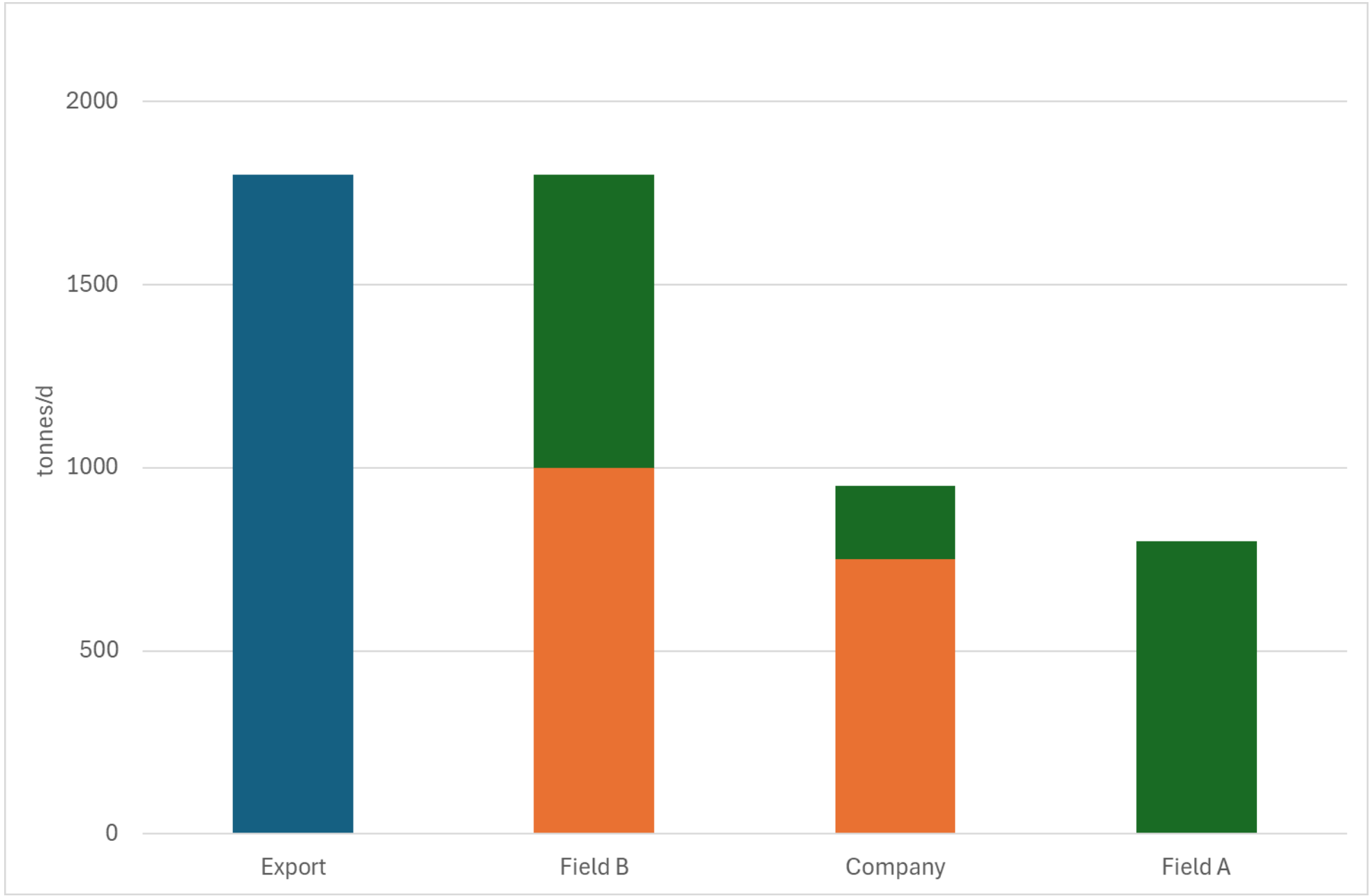
$$Alloc_A = M_T - M_B$$
$$Alloc_A = 1{,}000 \text{ te/d}$$
$$\text{Loss Exp} = 4.5 \text{ te/d}$$

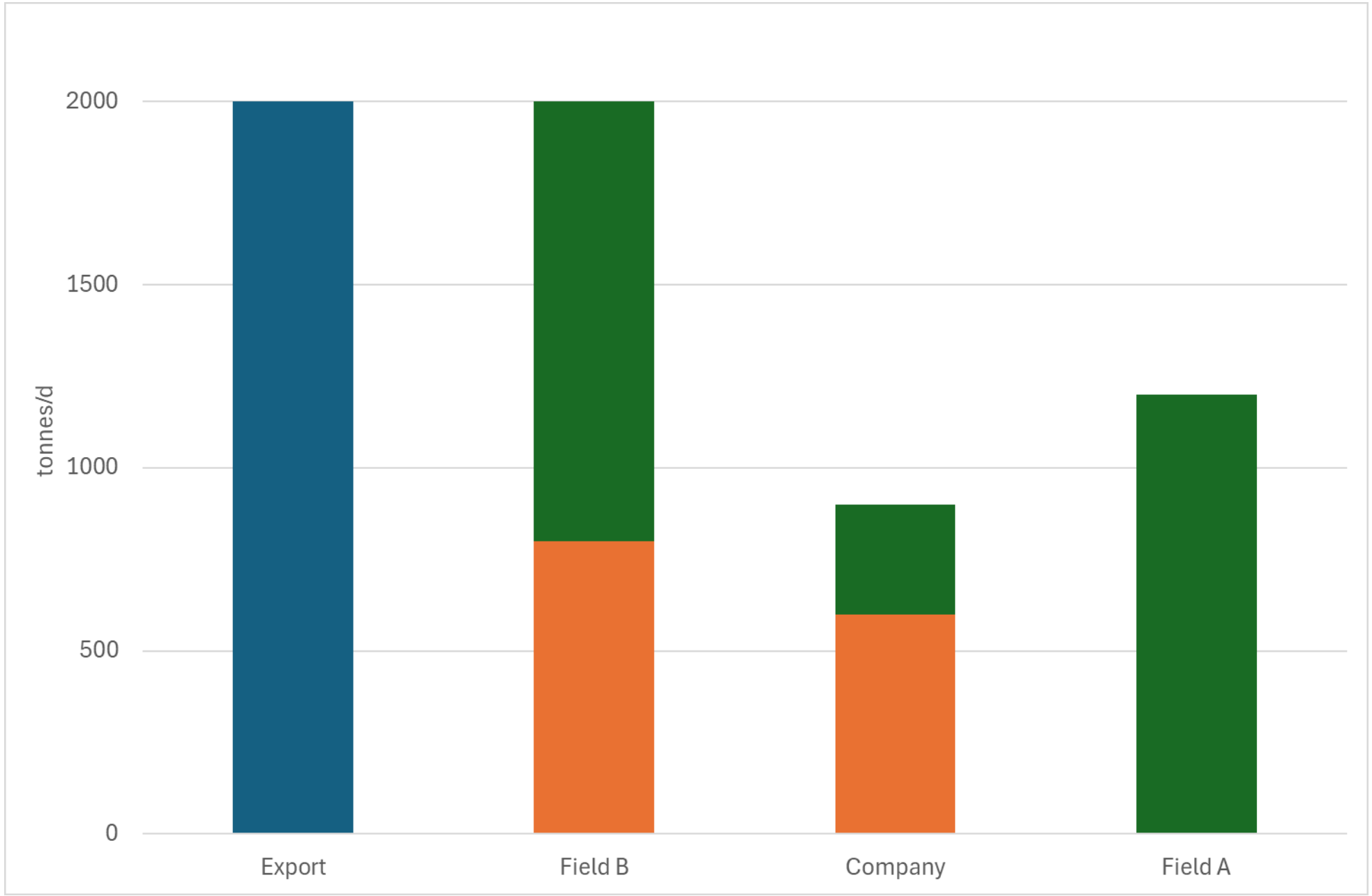


$$Alloc_B = 1{,}000 \text{ te/d}$$
$$\text{Loss Exp} = 2.0 \text{ te/d}$$

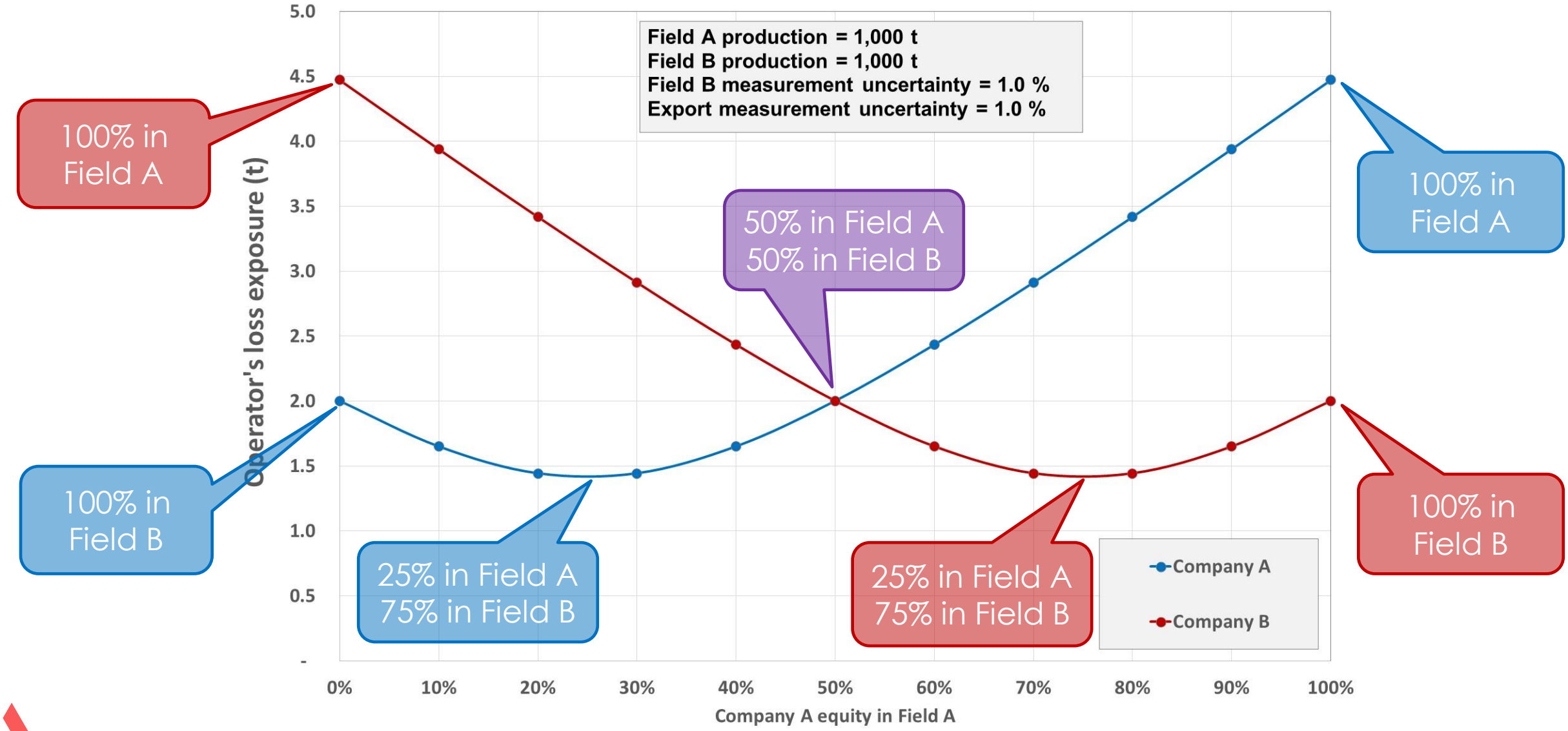
Loss Exposure



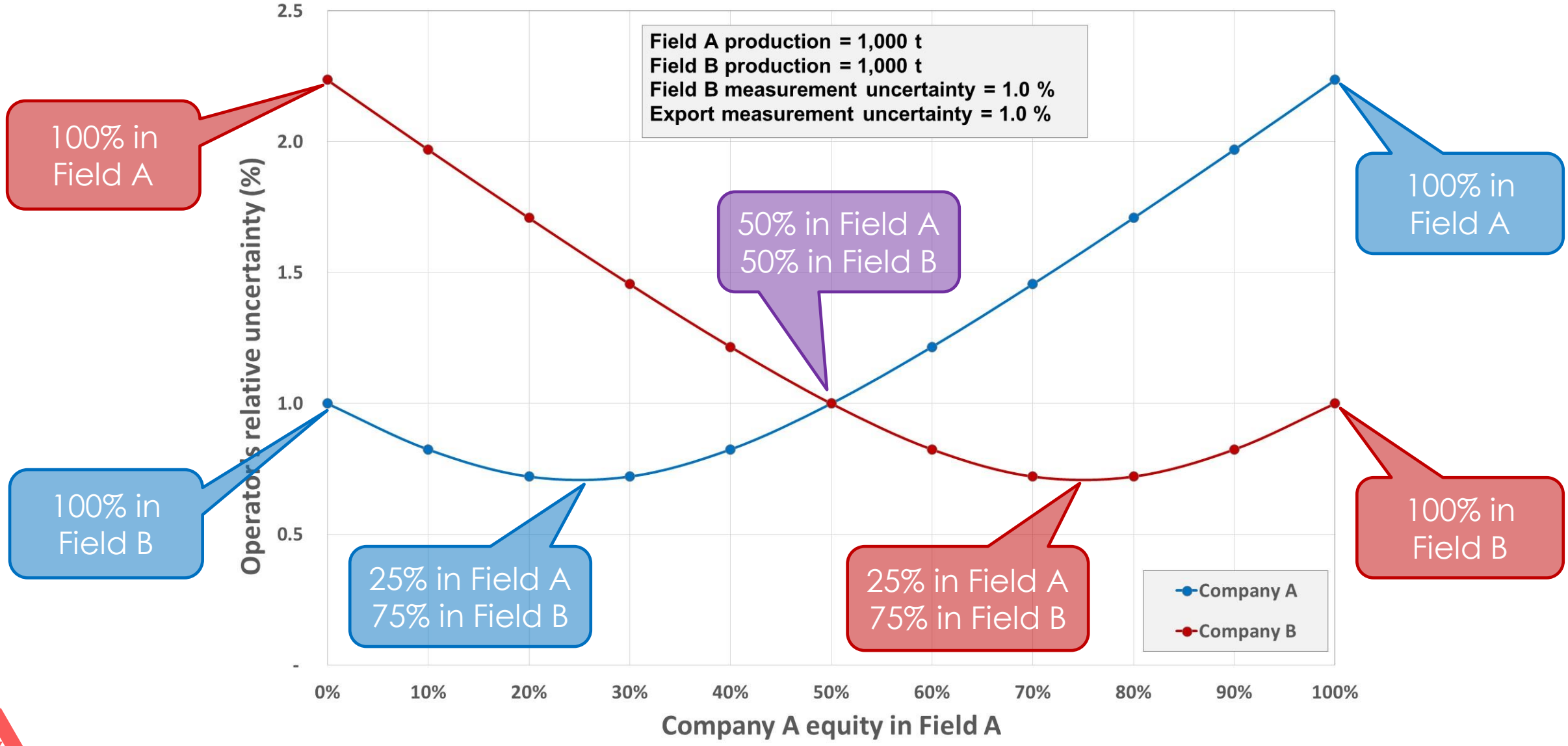

2000
1500
1000
500
0
tonnes/d
Export
Field B
Company
Field A


2000
1500
1000
500
0
tonnes/d
Export
Field B
Company
Field A

Loss Exposure



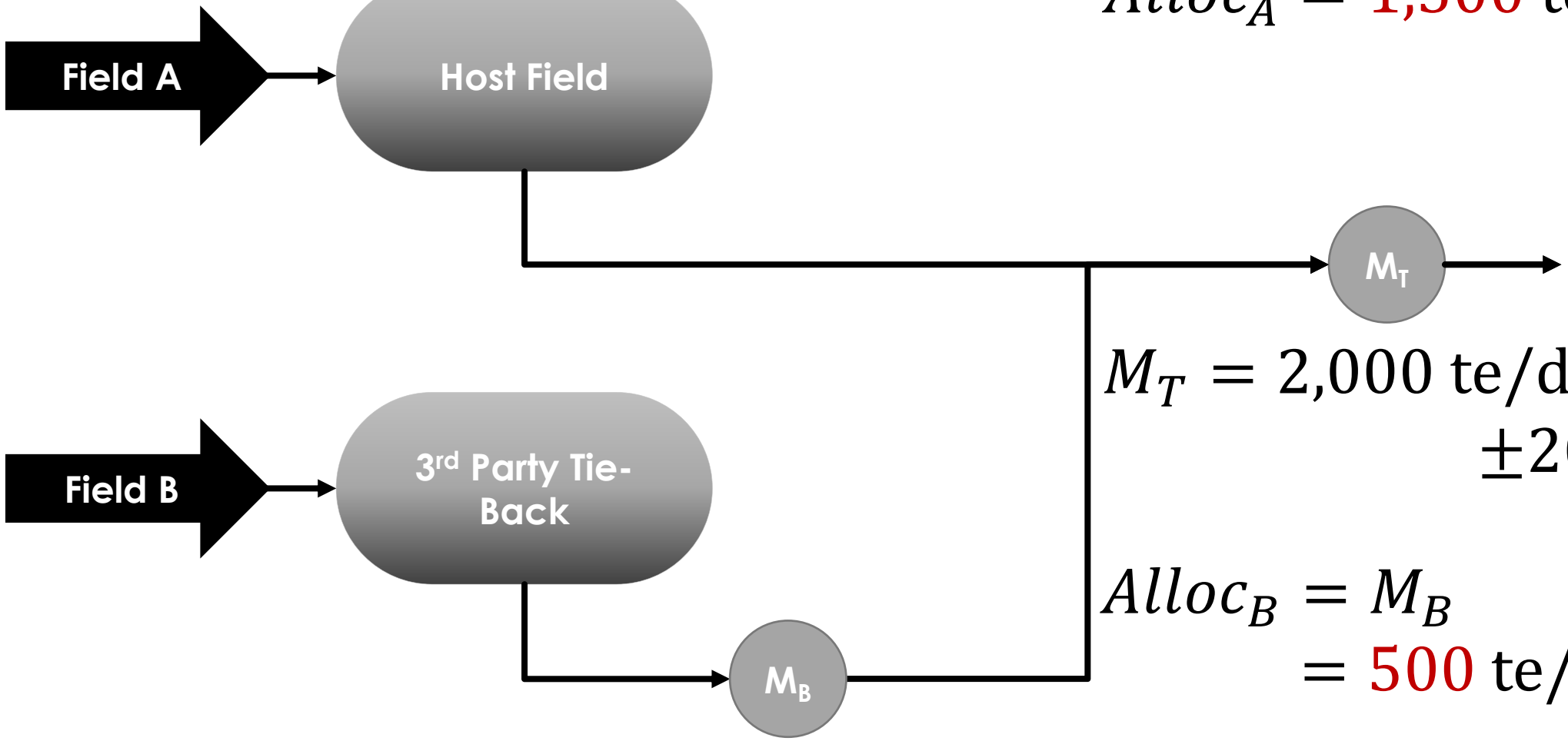
Allocation Uncertainty



Loss Exposure

- How does exposure for each Operator vary with…
  - Production rates?
  - Meter uncertainties?

Loss Exposure



$$Alloc_A = M_T - M_B$$

$$Alloc_A = 1{,}500 \text{ te/d } \pm 1.4\%$$

$$\pm 21 \text{ te/d}$$

$$M_T = 2{,}000 \text{ te/d } \pm 1\%$$

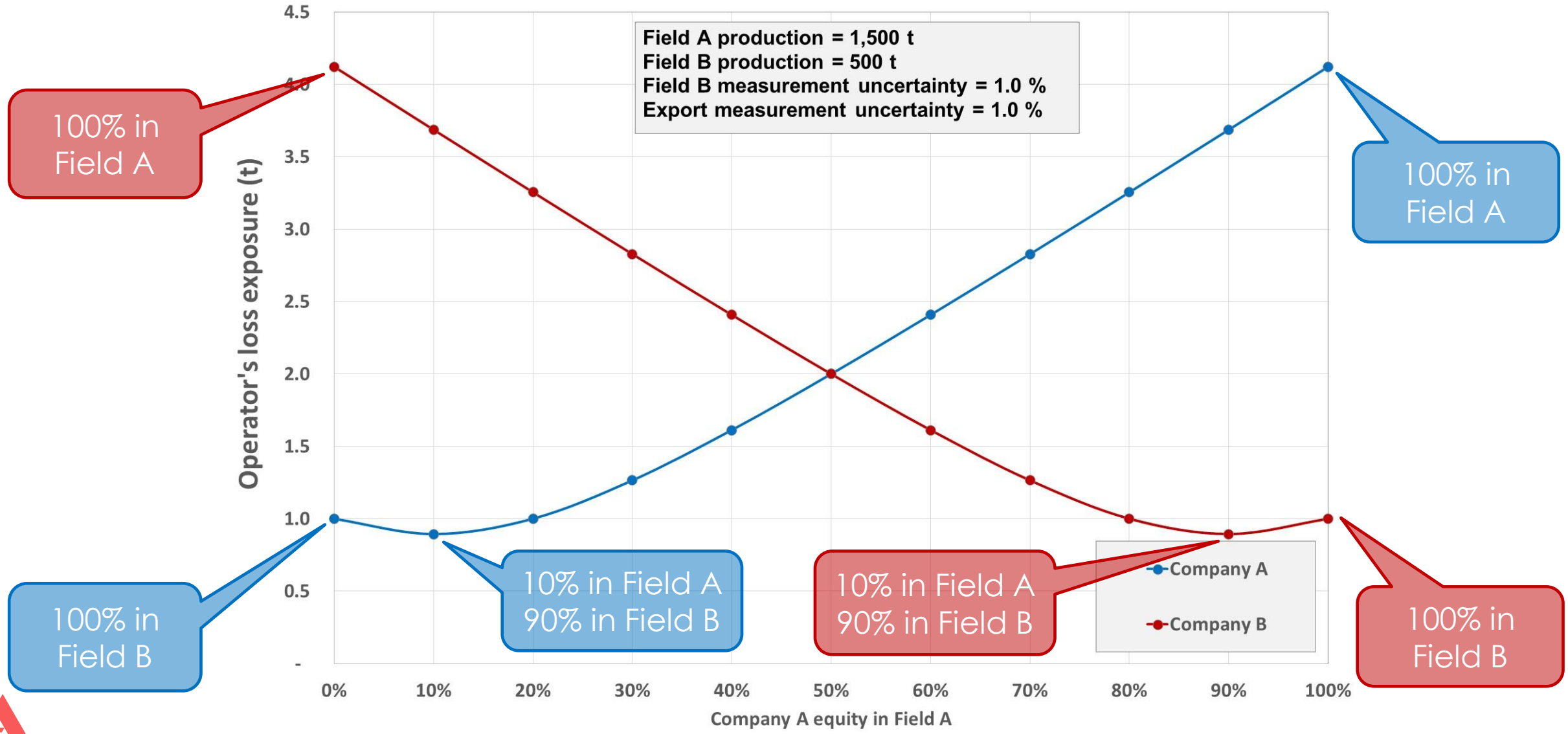
$$\pm 20 \text{ te/d}$$

$$Alloc_B = M_B$$

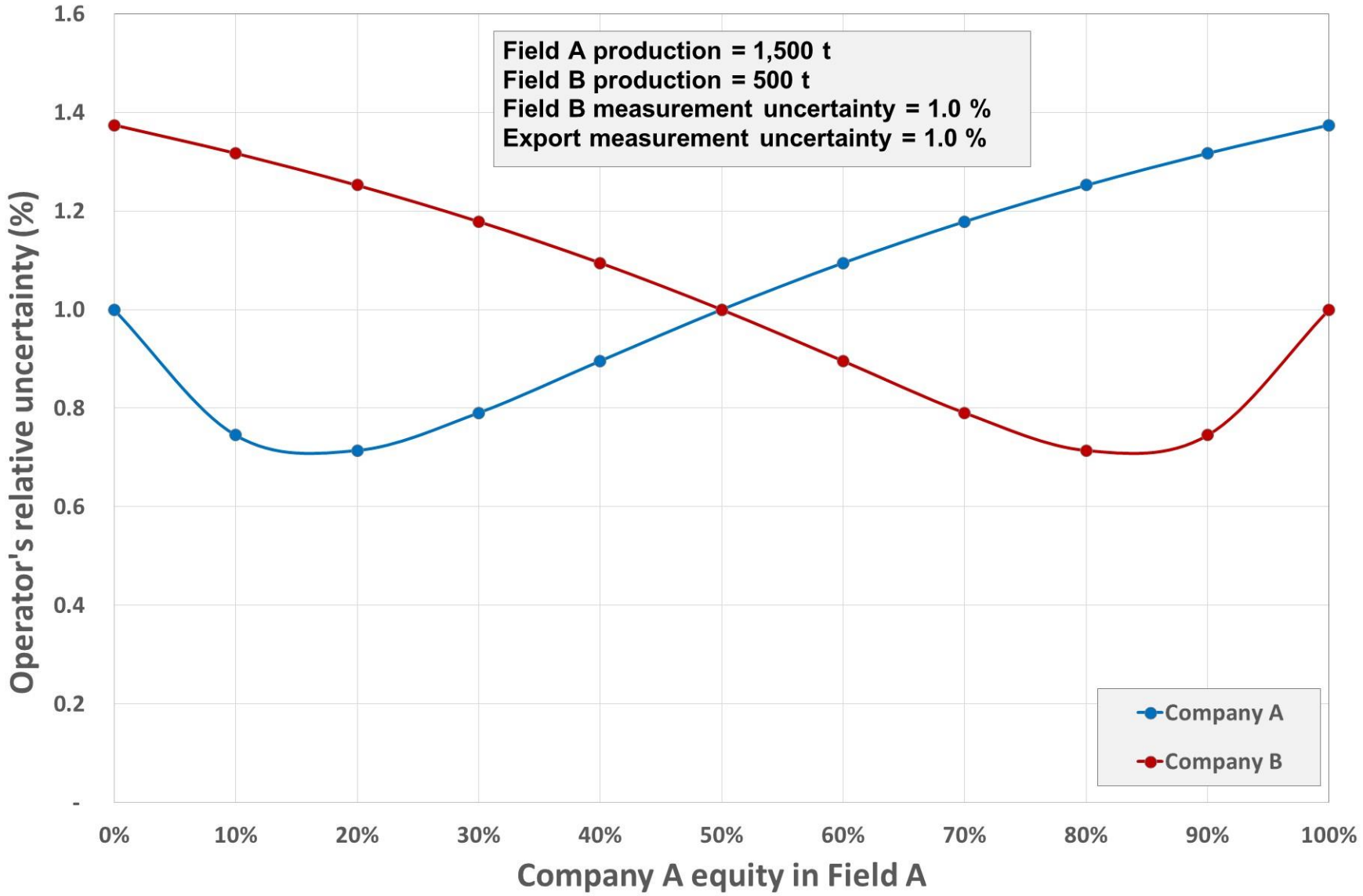
$$= 500 \text{ te/d } \pm 1\%$$

$$\pm 5 \text{ te/d}$$

Loss Exposure



Allocation Uncertainty

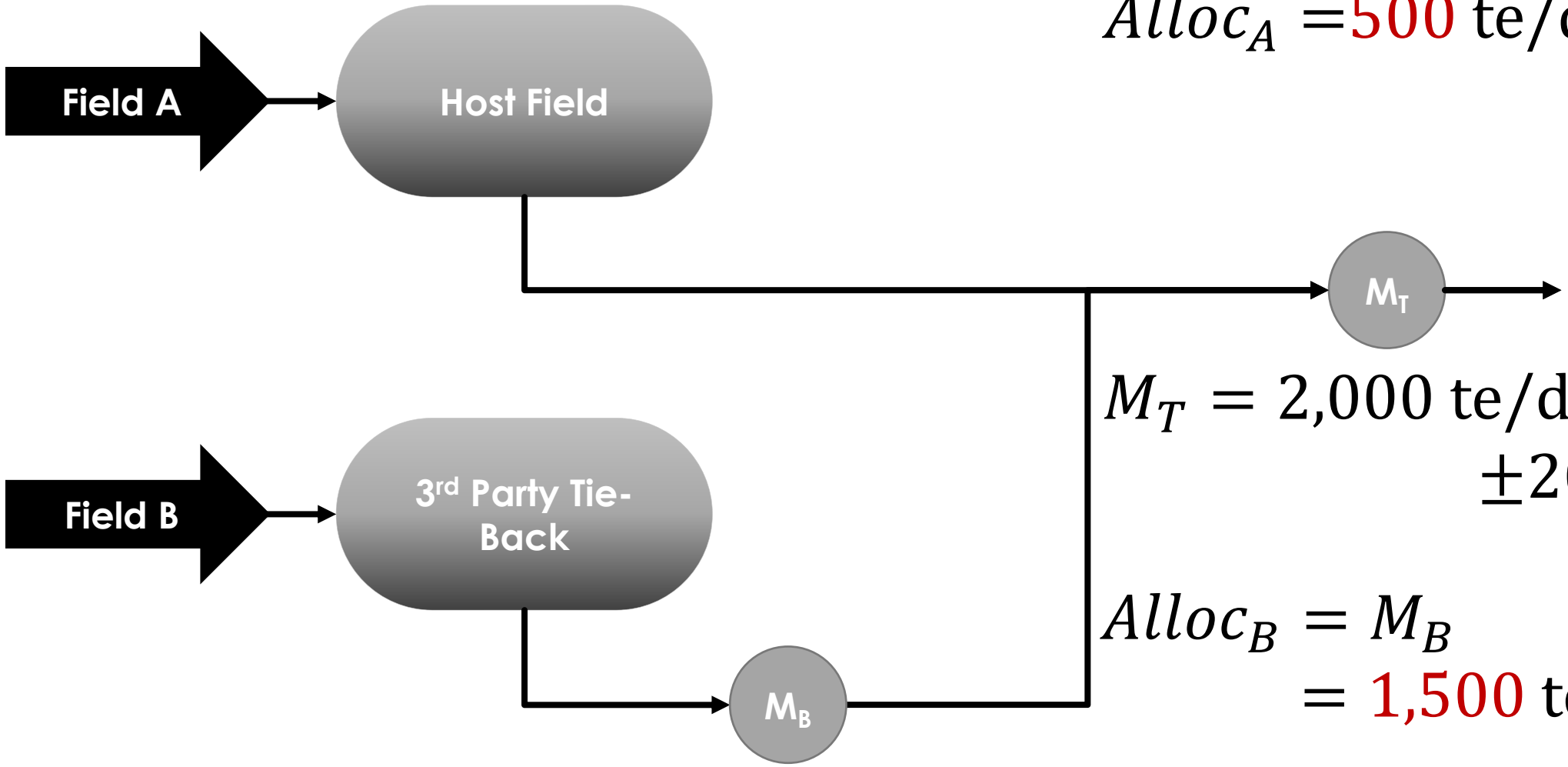


Loss Exposure

$$Alloc_A = M_T - M_B$$

$$Alloc_A = 500 \text{ te/d} \pm 5\%$$

$$\pm 25 \text{ te/d}$$



$$M_T = 2{,}000 \text{ te/d} \pm 1\%$$

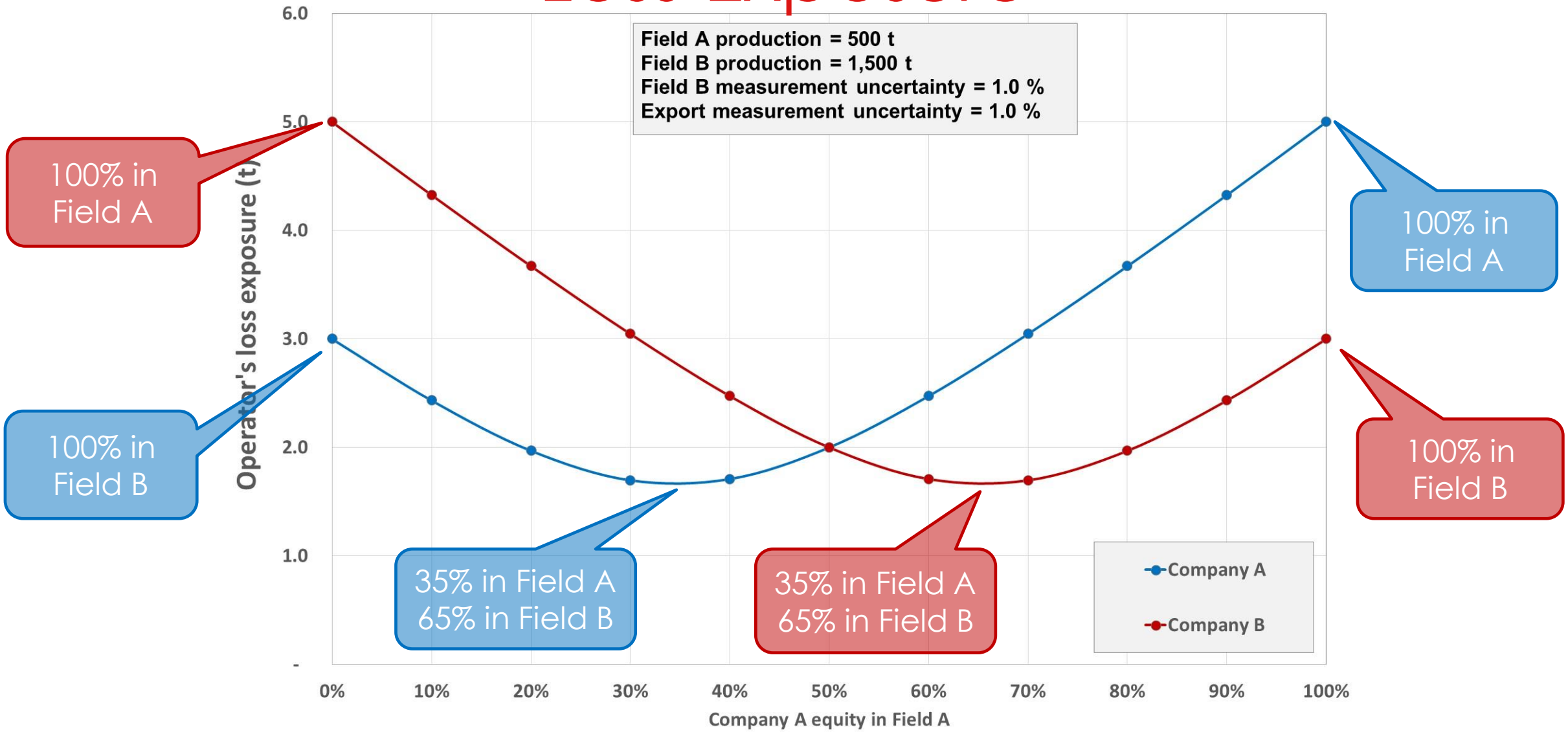
$$\pm 20 \text{ te/d}$$

$$Alloc_B = M_B$$

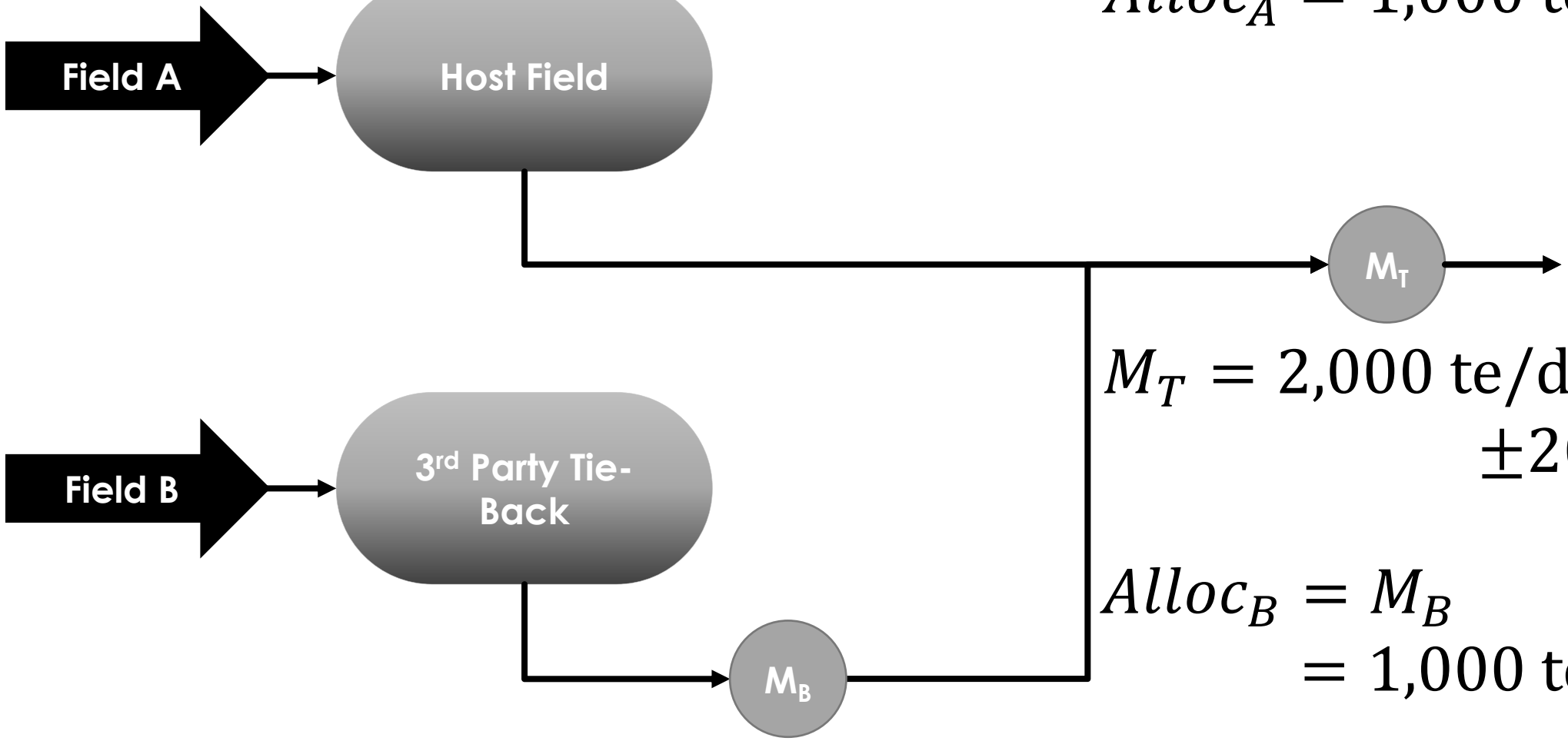
$$= 1{,}500 \text{ te/d} \pm 1\%$$

$$\pm 15 \text{ te/d}$$

Loss Exposure



Loss Exposure



$$Alloc_A = M_T - M_B$$

$$Alloc_A = 1{,}000 \text{ te/d } \pm 3.6\%$$

$$\pm 36 \text{ te/d}$$

$$M_T = 2{,}000 \text{ te/d } \pm 1\%$$

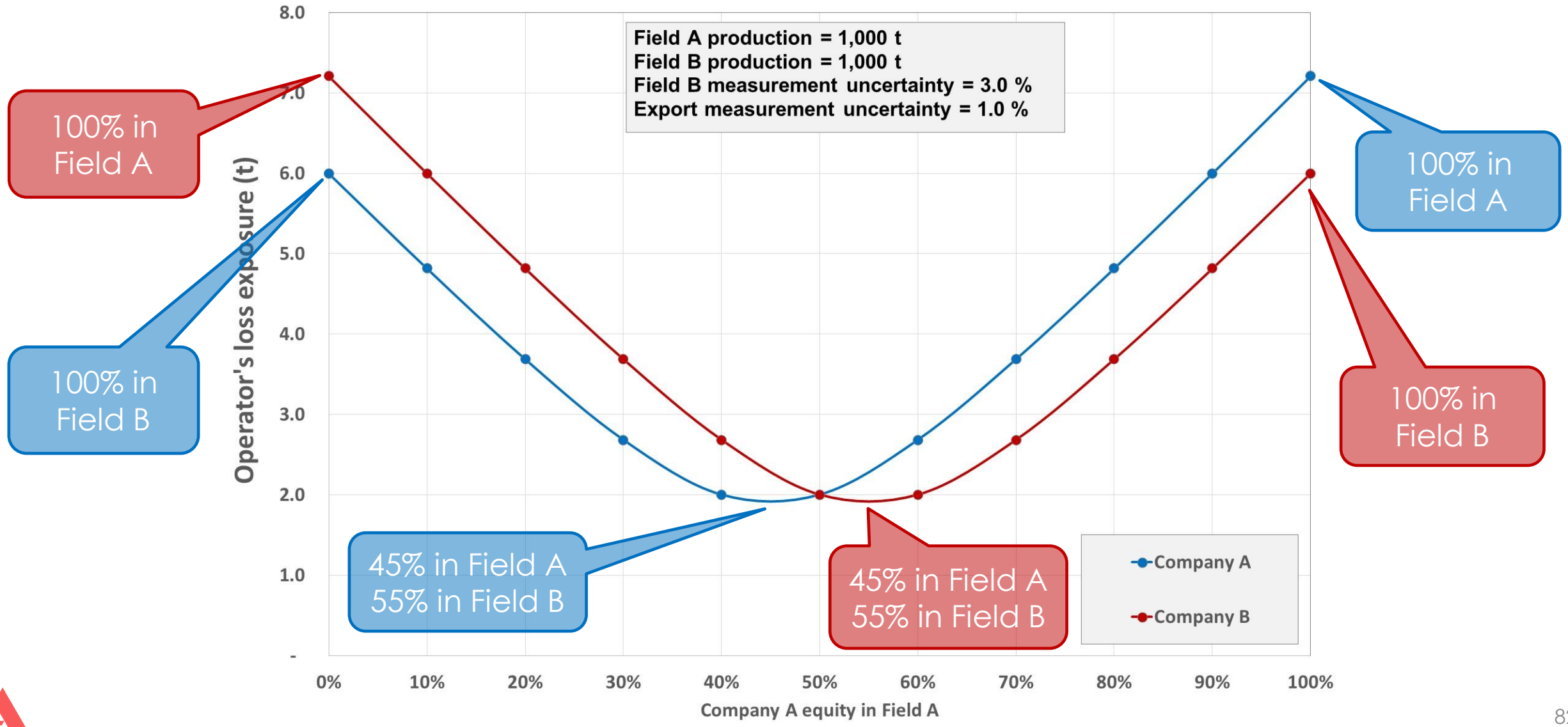
$$\pm 20 \text{ te/d}$$

$$Alloc_B = M_B$$

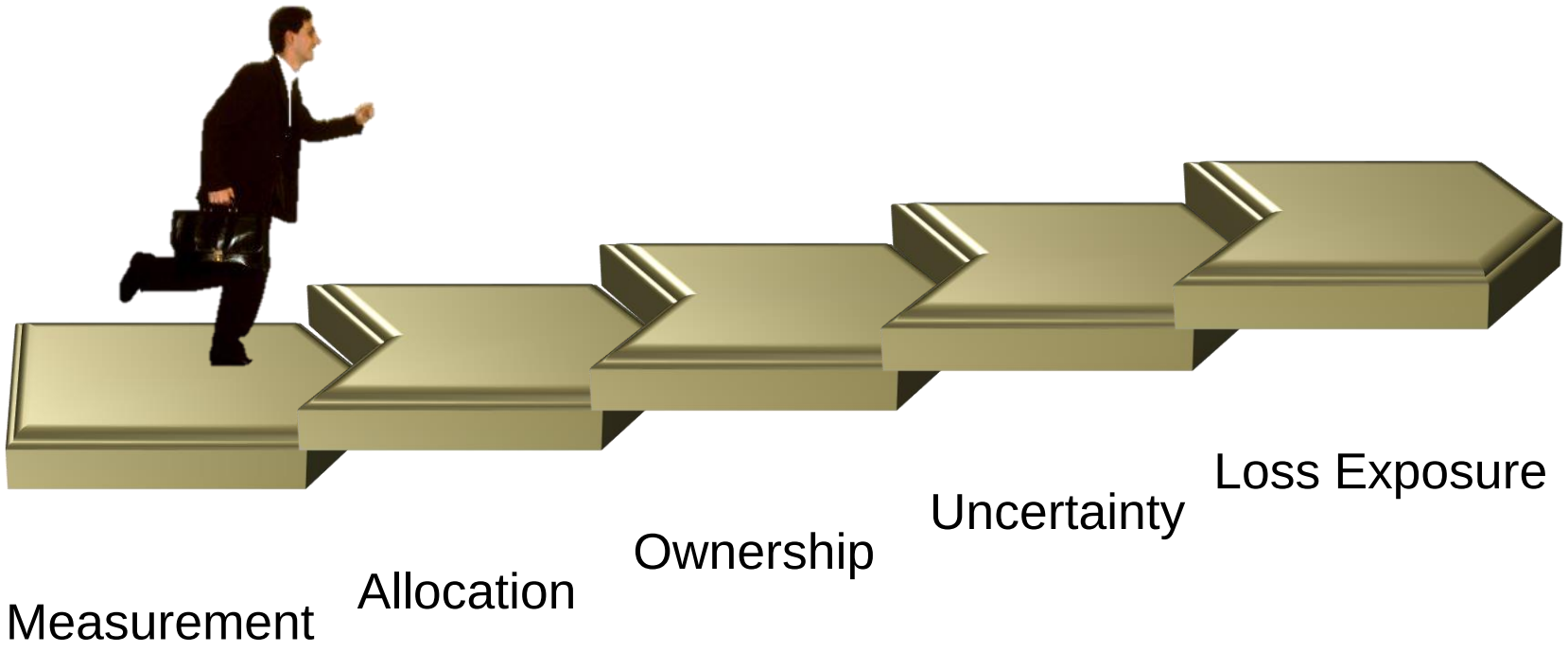
$$= 1{,}000 \text{ te/d } \pm 3\%$$

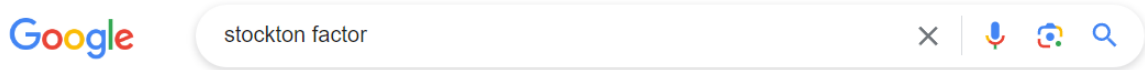
$$\pm 30 \text{ te/d}$$

Loss Exposure



Value Realisation and Loss Exposure





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Allocation Uncertainty: Tips, Tricks and Pitfalls

[7] Experiences in the Use of Uncertainty Based Allocation in a North Sea Offshore Oil. Allocation System, P. **Stockton** and A. Spence, Production and Upstream ...
32 pages

- Total Theatre
http://totaltheatre.org.uk › archive › features › stockton-f...

The Stockton Factor | Total Theatre Magazine Print Archive

We had a crowd of about 4000 for the latter and, of course, the show is quite visceral – acrobatic stilt work, Mad Max motorbikes, rock music and lots of pyro.

National Institutes of Health (NIH) (.gov)
https://pubmed.ncbi.nlm.nih.gov › ...

Factor X Stockton: a mild bleeding diathesis associated ...

by TL Messier · 1996 · Cited by 17 — Bleeding in family members with the mutation, termed factor X Stockton, appears to be due to **disruption of normal hemostasis** by the presence in…

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https://open.spotify.com › track

Stockton Factor - song and lyrics by Melly Mel

Sign in to see lyrics and listen to the full track. Sign up. **Melly Mel**. Artist. Melly Mel. Recommended based on this song. Nigga PleaseKool Daddy Fresh.

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2014-09-Process-Simulation-Uncertainties-Stockton- ...

factors, which include: •. The process being modelled. •. The information obtained from the model (e.g. **shrinkage factor, expansion factor recovery factor**, etc.).

ctor
/ Mel

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