accord (e.s.i)

"an employee owned company"

NFOGM
NORWEGIAN SOCIETY FOR OIL AND GAS MEASUREMENT

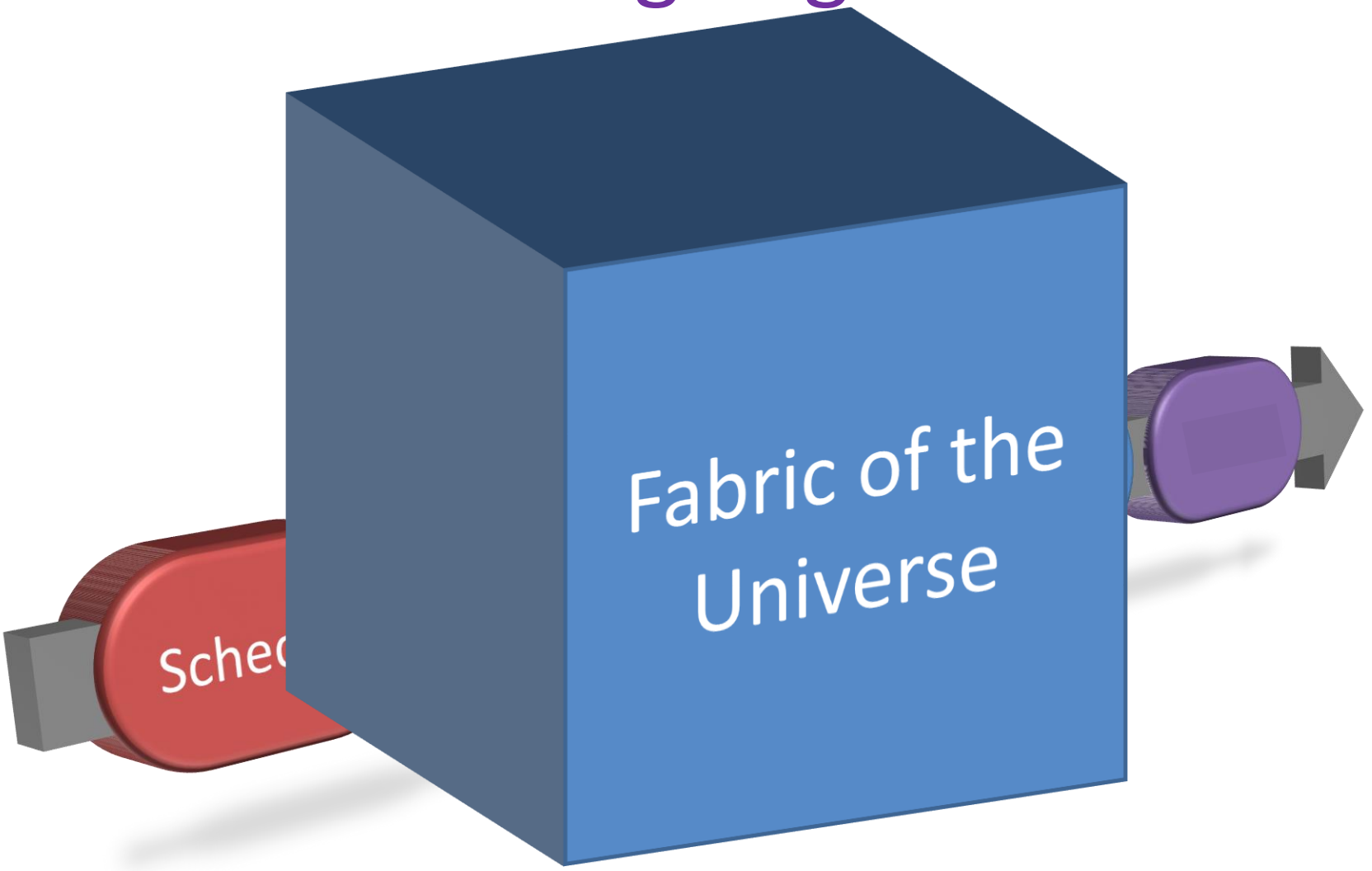
LESSONS LEARNED IN THE PREPARATION OF ALLOCATION AGREEMENTS

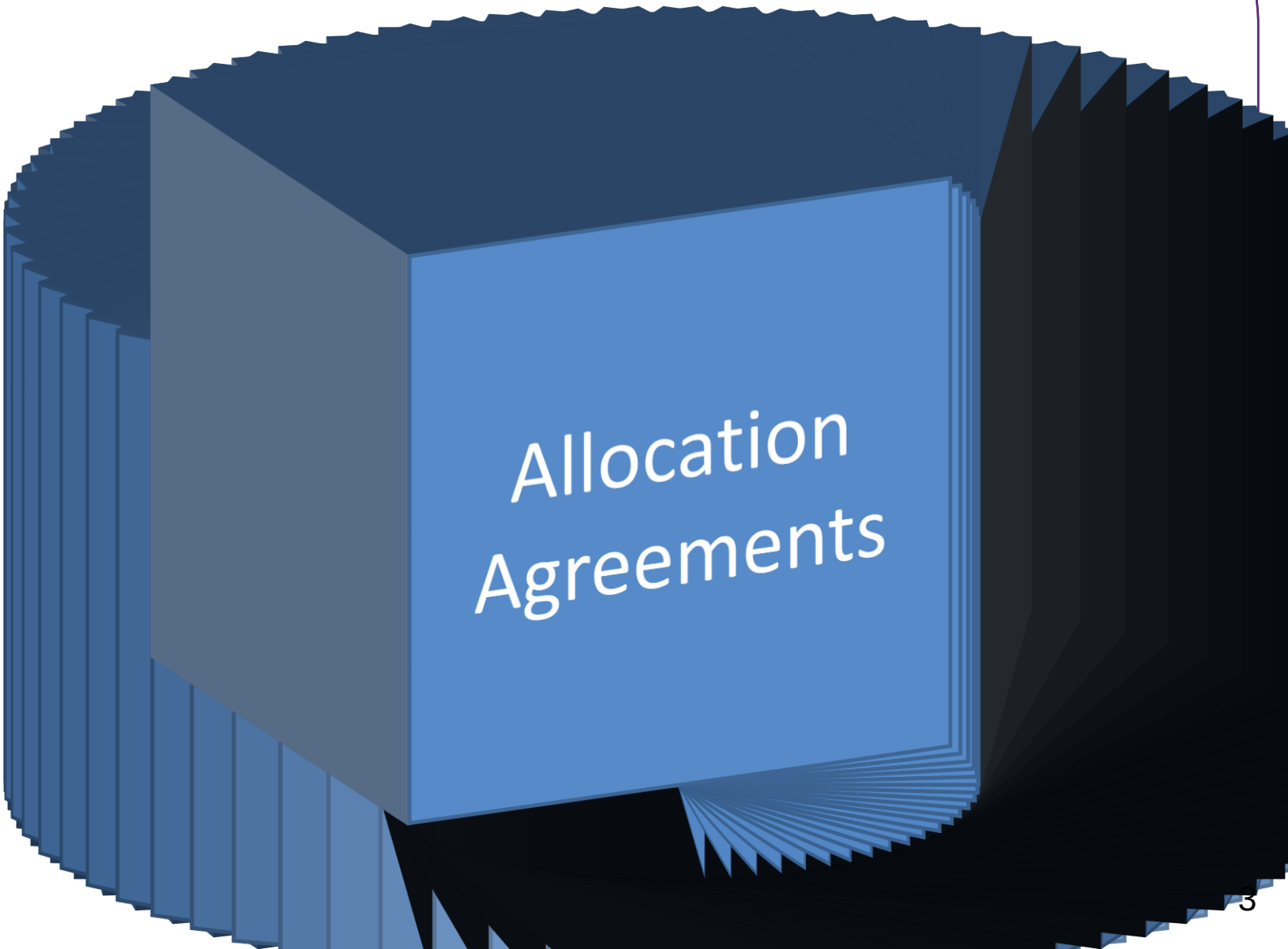
Phil Stockton

Accord Energy Solutions

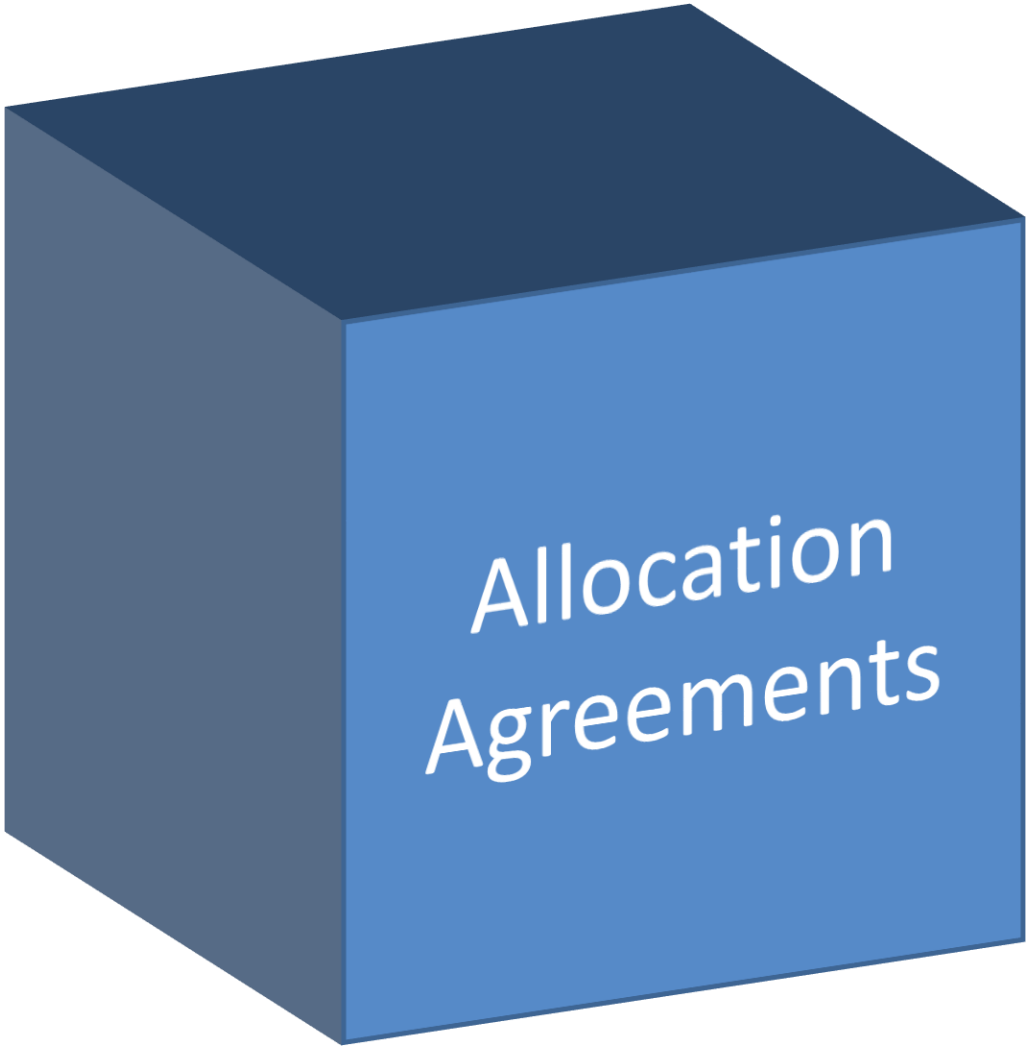
Tekna

This is what I'm going to talk about




Allocation
Agreements

Facets



Facets


E=MC2
ACME Allocation Rules
Schedule 1 – Allocation Rules
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The Field inlet water ratio is thus calculated,
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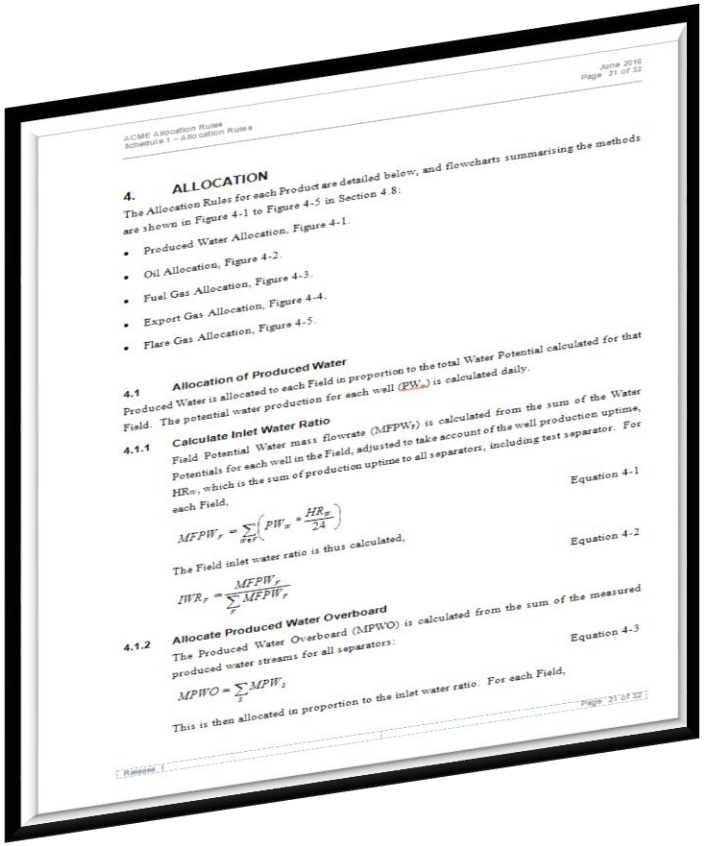

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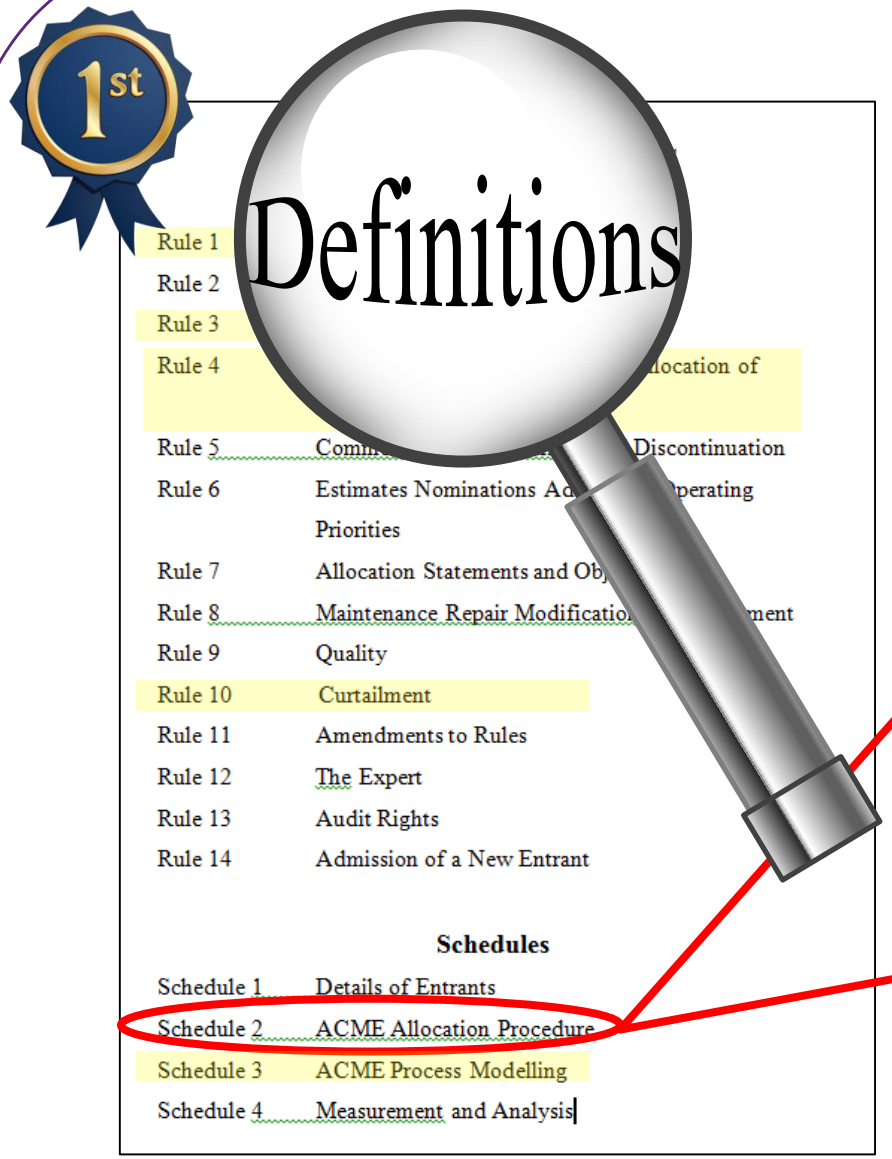

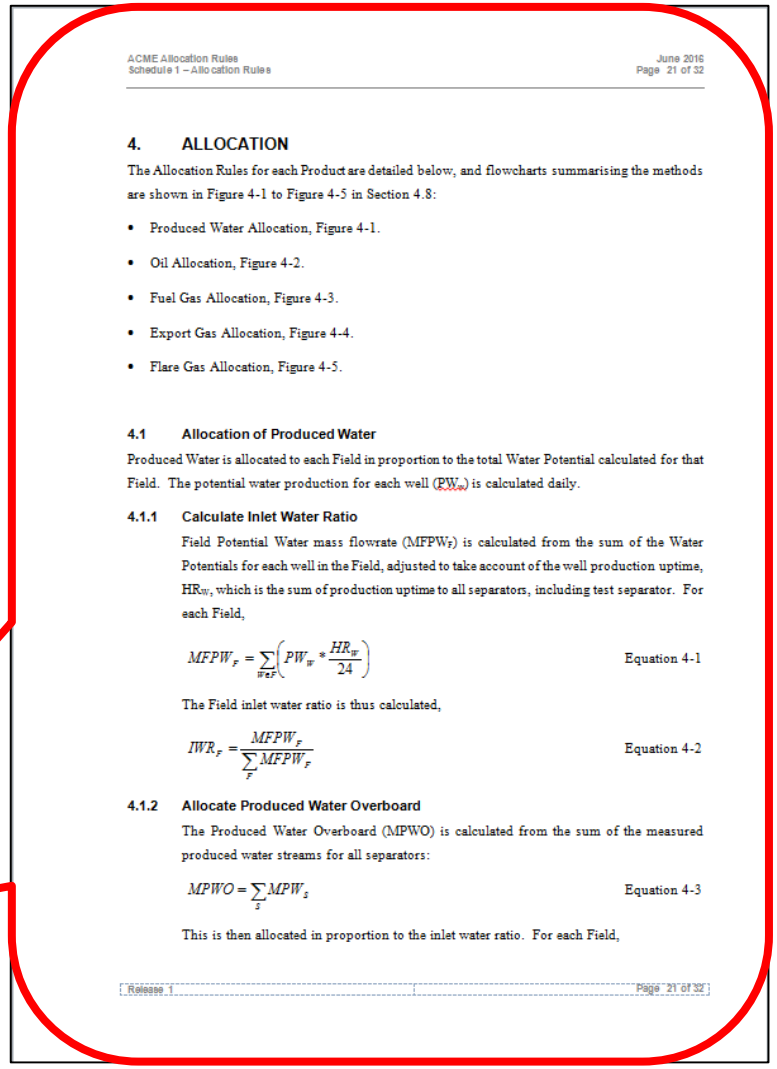

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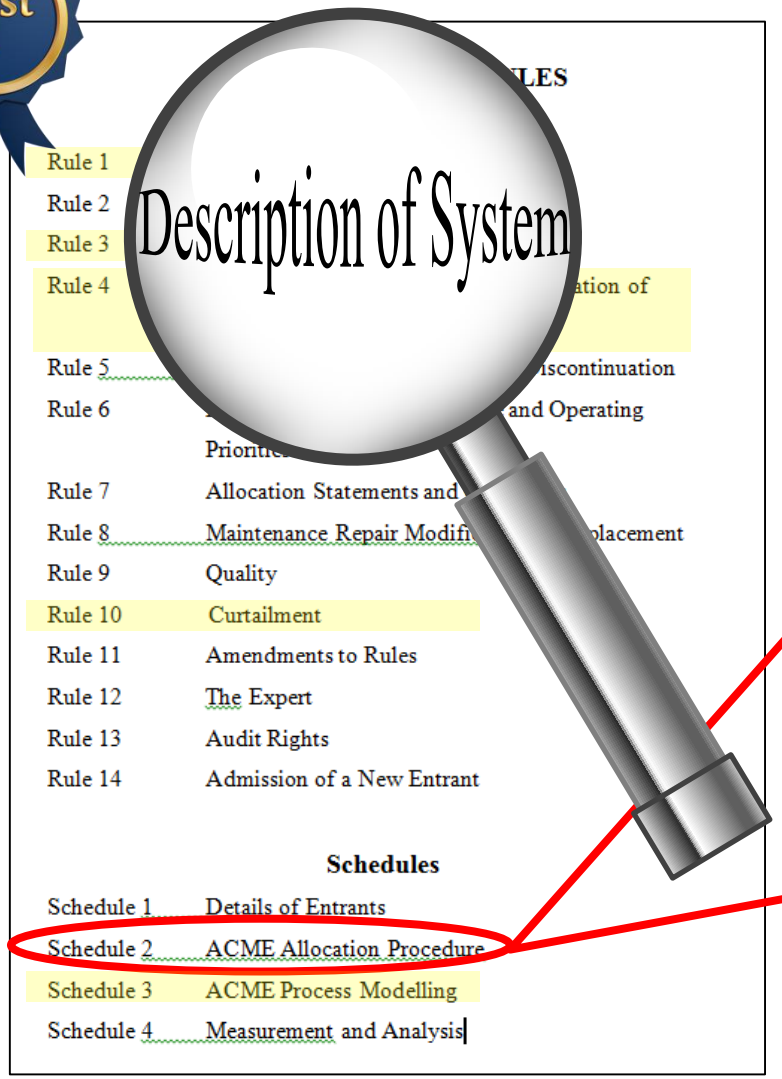

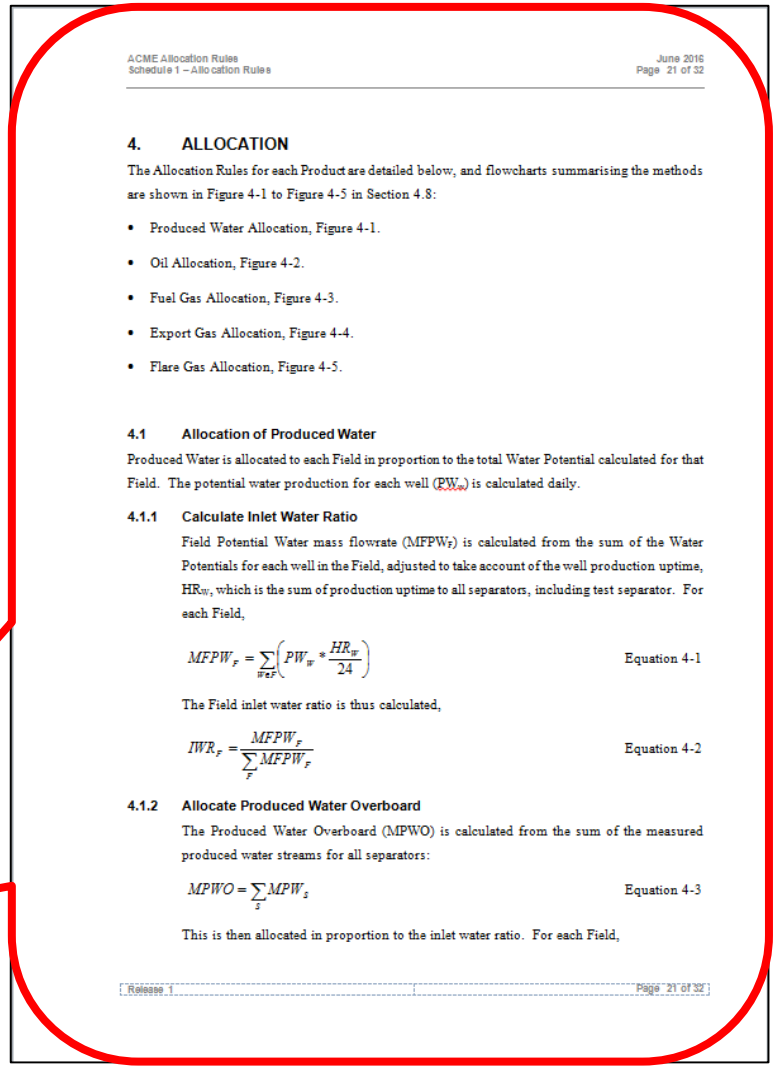

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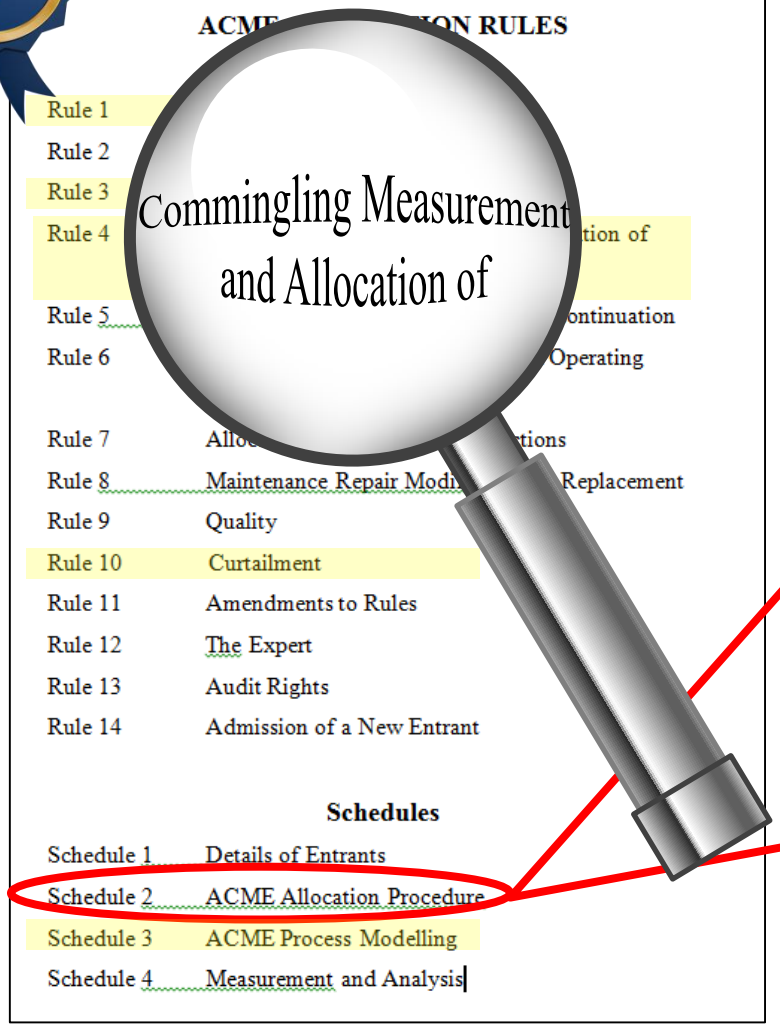

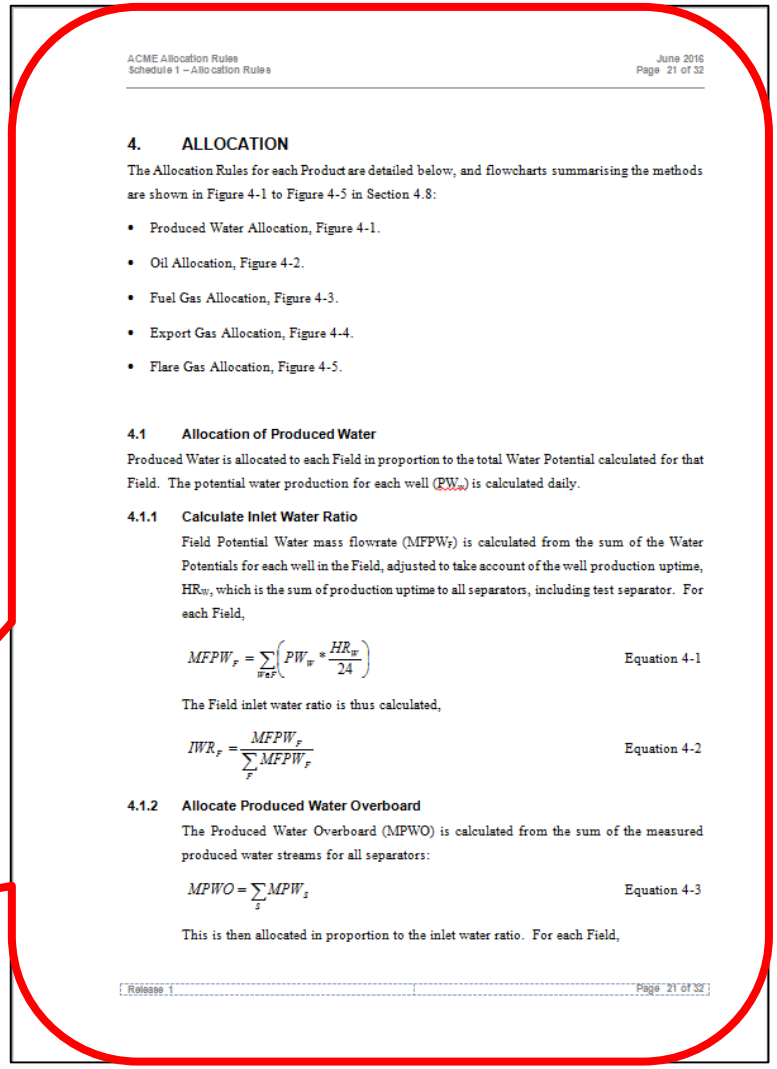

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Schedules

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ACME ALLOCATION RU

Rule 1	Definitions
Rule 2	Entrant Representatives
Rule 3	Description of the System
Rule 4	Commingling Measurement and Natural Gas
Rule 5	Commencement Suspension and Discontinuation
Rule 6	Estimates Nominations Advice and Operating Priorities
Rule 7	Allocation Statements and Objections
Rule 8	Maintenance Repair Modification or Replacement
Rule 9	Quality
Rule 10	Curtailment
Rule 11	Amendments to Rules
Rule 12	The Expert
Rule 13	Audit Rights
Rule 14	Admi… …nt

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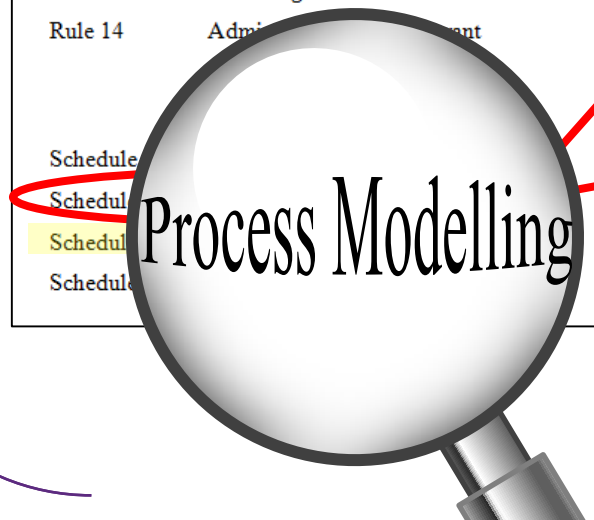

ACME Allocation Rules
Schedule 1 – Allocation Rules

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accord (e.s.i)

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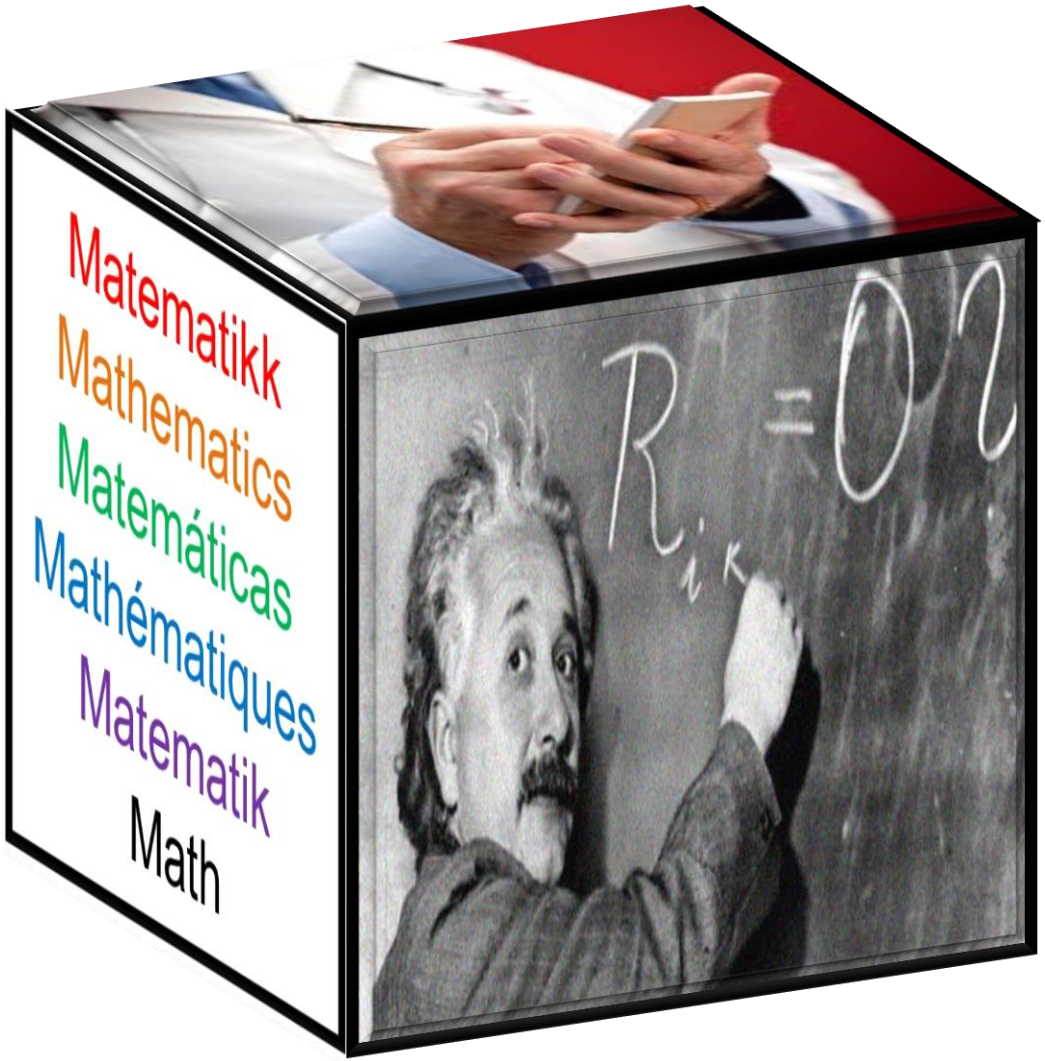
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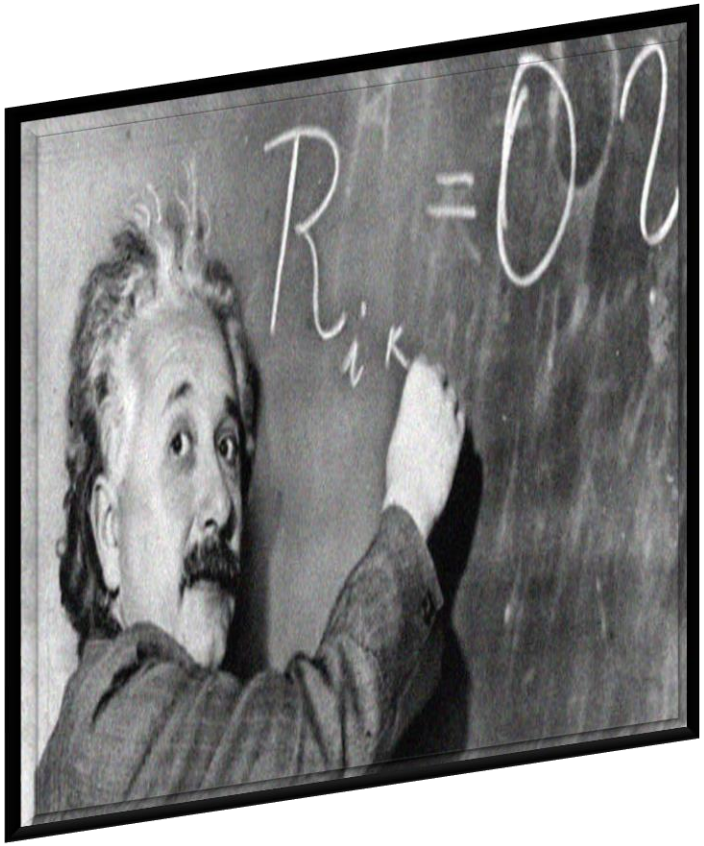
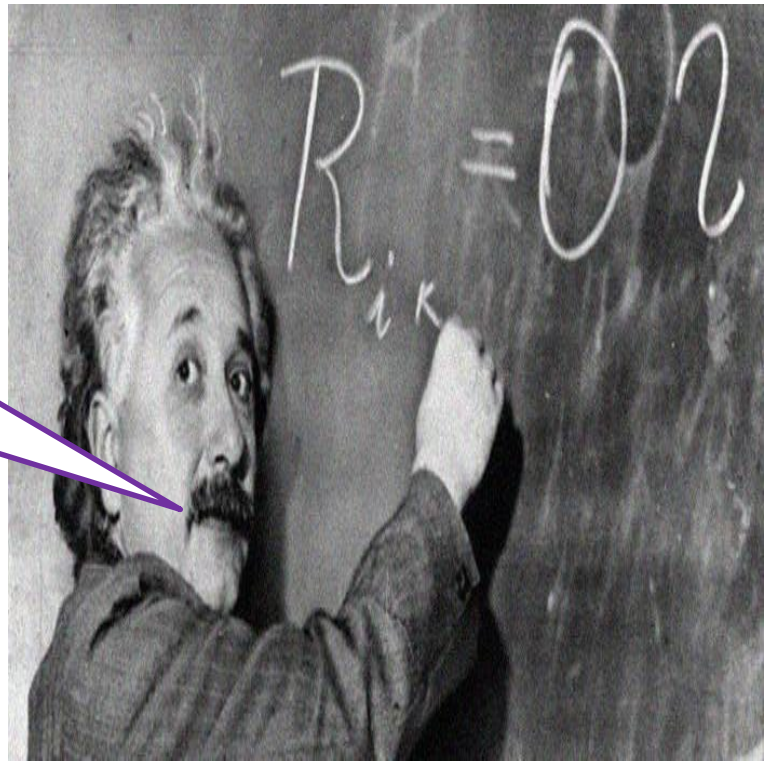

$R_{ik} = 0$

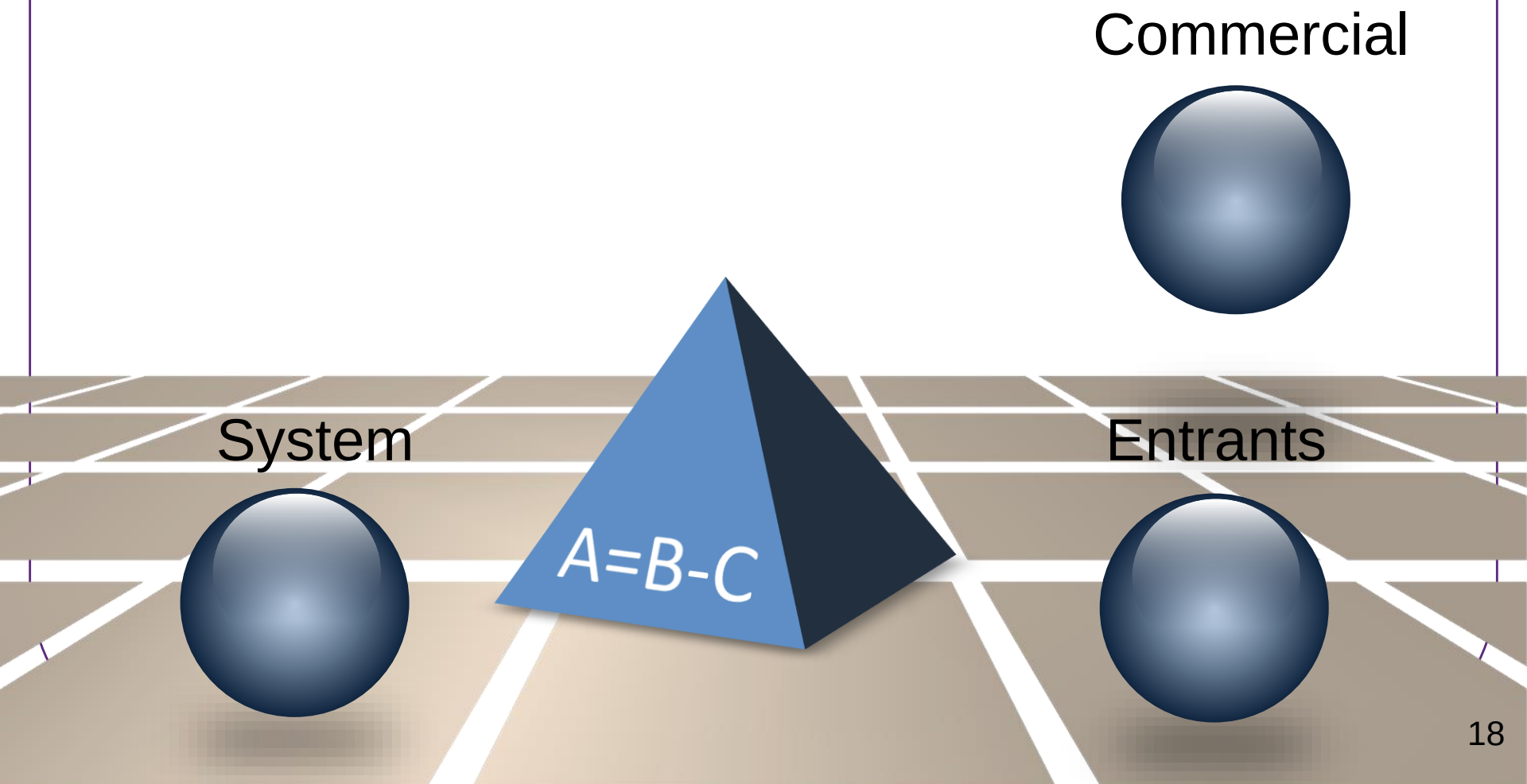
Keep it simple?

Everything should be made as simple as possible, but not simpler

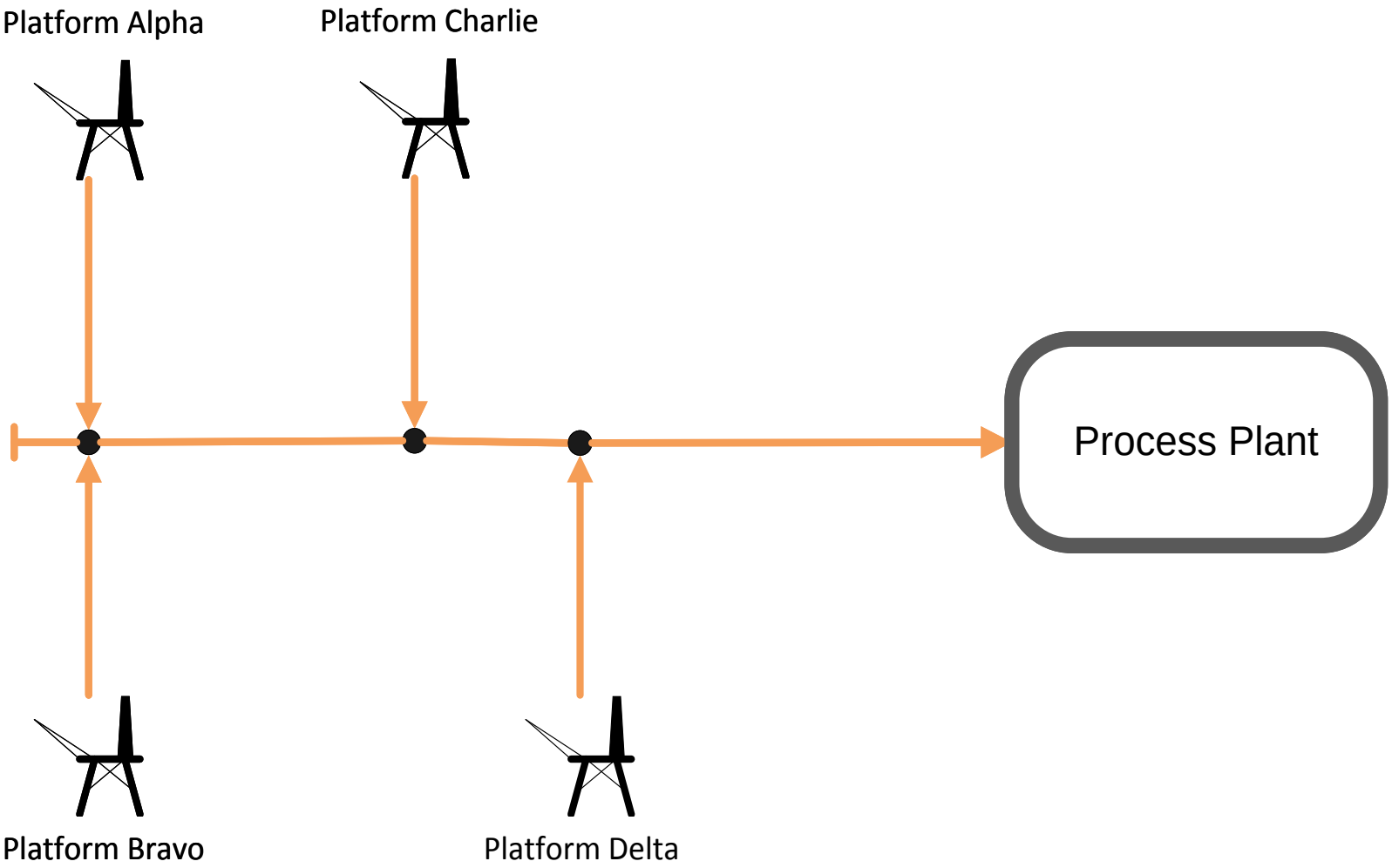


“It ain’t easy”

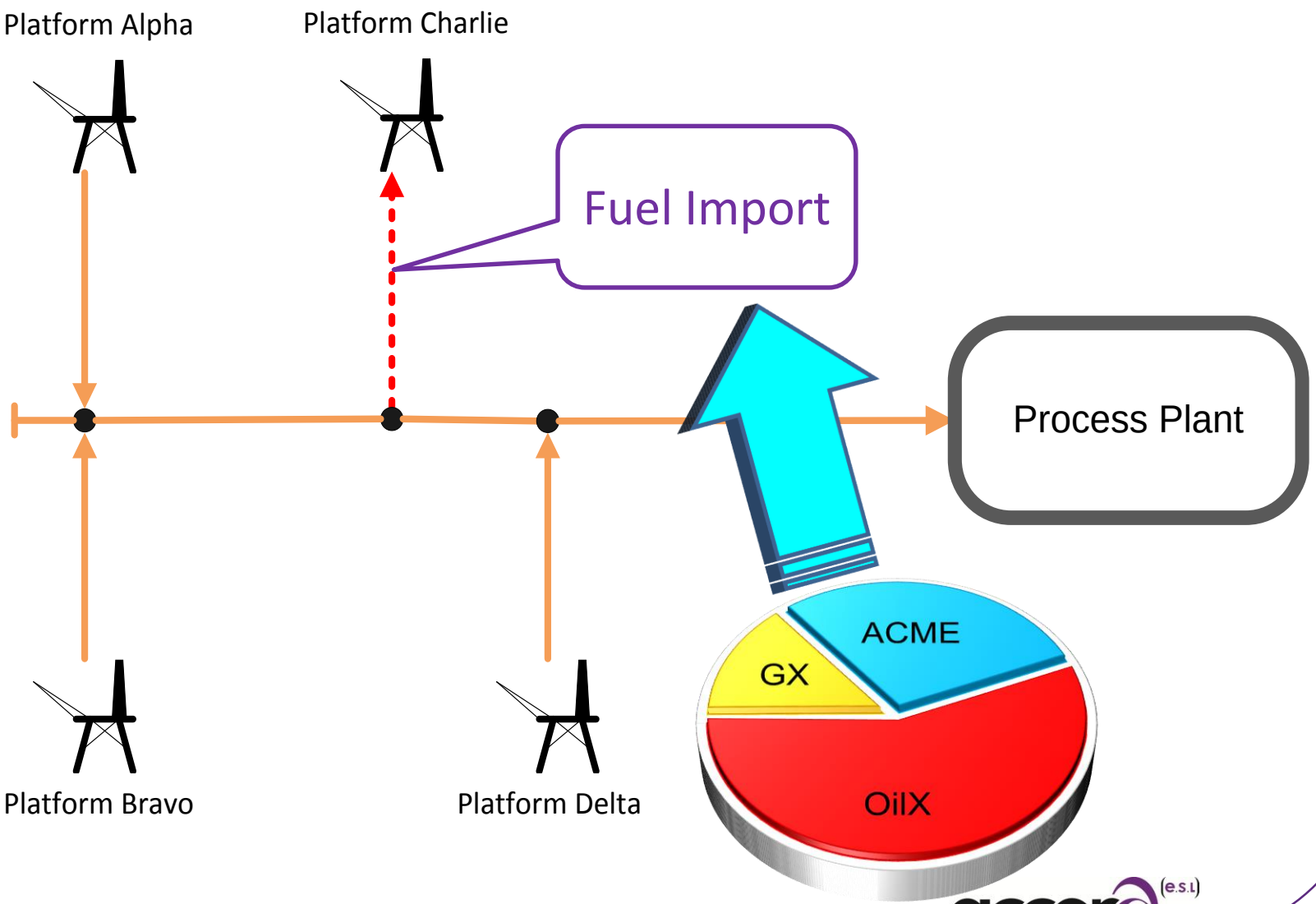
Measurements + Concepts → Equations



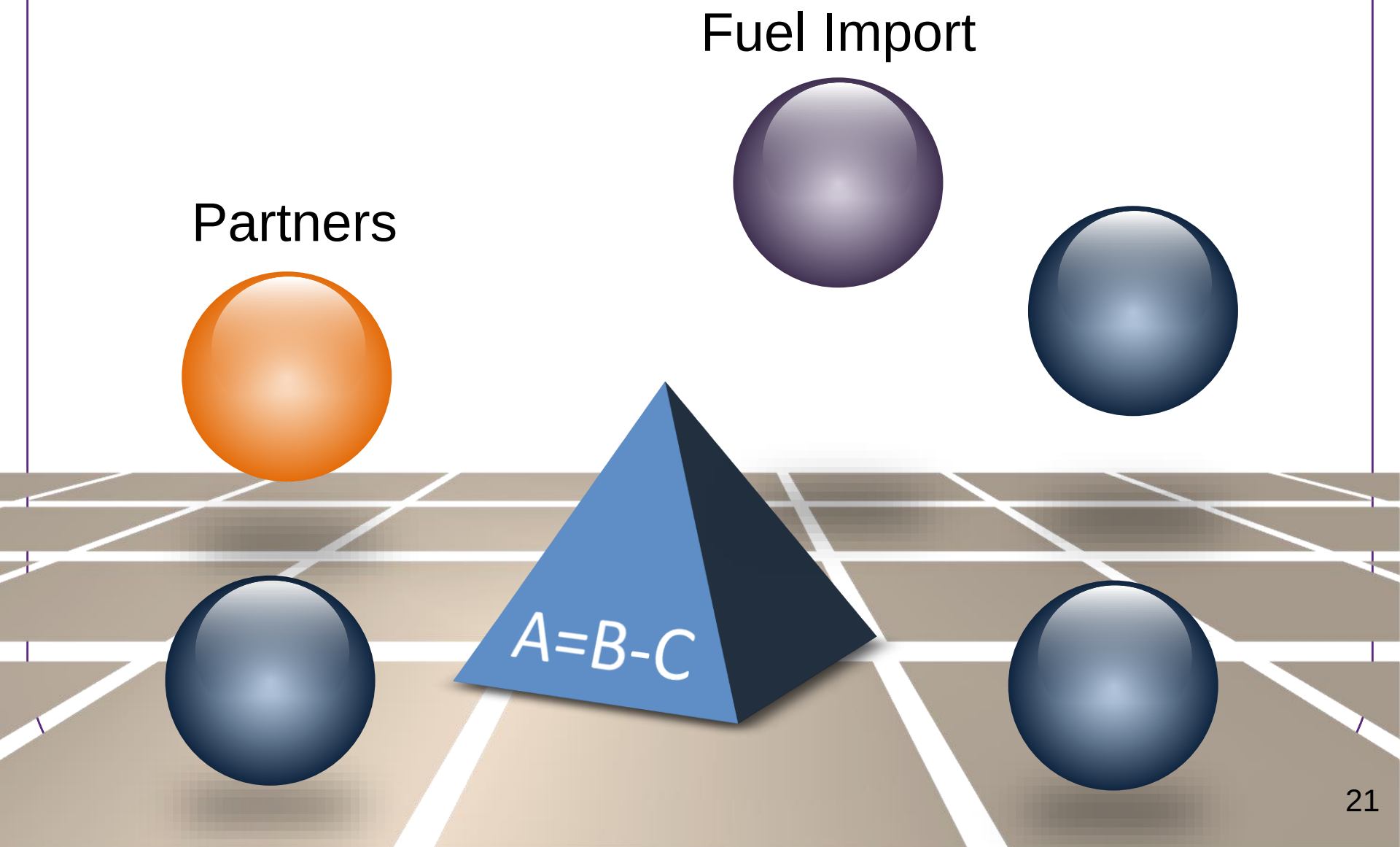
New Entrant - Easy



New Feature - Difficult



Mathematical Model



Re-Opening Agreements

Re-Opening Agreements

Keep it simple?

$$PSX_{FG,C} = \frac{PSMFG_C}{\sum_C PSMFG_C}$$ Equation 4-15

$$HFG^{ISO} = MFG * \sum_C \left(PSX_{FG,C} * CV_C\right)$$ Equation 4-16

This is initially allocated in proportion to the each Field's allocated mass of Export Oil. For each Field,

$$HFGI'_F = HFG^{ISO} * \frac{MEO_F}{\sum_F MEO_F}$$ Equation 4-17

4.4.2 Check Sufficiency of Processed Gas

The Fuel Gas Energy allocated to any Field must be limited to the available Processed Gas Energy for that Field, taking account of any balance in the Fuel Gas Energy Bank.

The Fuel Gas energy Requirement ($HFGR'_F$) is calculated for each Field,

$$HFGR'_F = HFGI'_F - HFGB_{F,Open}$$ Equation 4-18

The Processed Gas Deficiency ($HPGD_F$) is calculated for each Field,

$$\begin{aligned} &If \quad HPG_F^{ISO} \geq HFGR'_F \\ &Then \quad HPGD_F = 0 \\ &Else \quad HPGD_F = HFGR'_F - HPG_F^{ISO}, \quad HFGR'_F = HPG_F^{ISO} \end{aligned}$$ Equation 4-19

The total deficiency (which is zero for normal operation) is then redistributed among the non-deficient Fields in proportion to their Processed Gas Energy less required Fuel Gas Energy, to obtain the allocated theoretical Fuel Gas Energy (HFG'_F).

$$HFG'_F = HFGR'_F + \left(\sum_F HPGD_F\right) * \frac{\left(HPG_F^{ISO} - HFGR'_F\right)}{\sum_F \left(HPG_F^{ISO} - HFGR'_F\right)}$$ Equation 4-20

The Closing Balance of the Fuel Gas Energy Bank is then calculated. For each Field,

$$HFGB_{F,Close} = HFGB_{F,Open} + HFG'_F - HFGI'_F$$ Equation 4-21

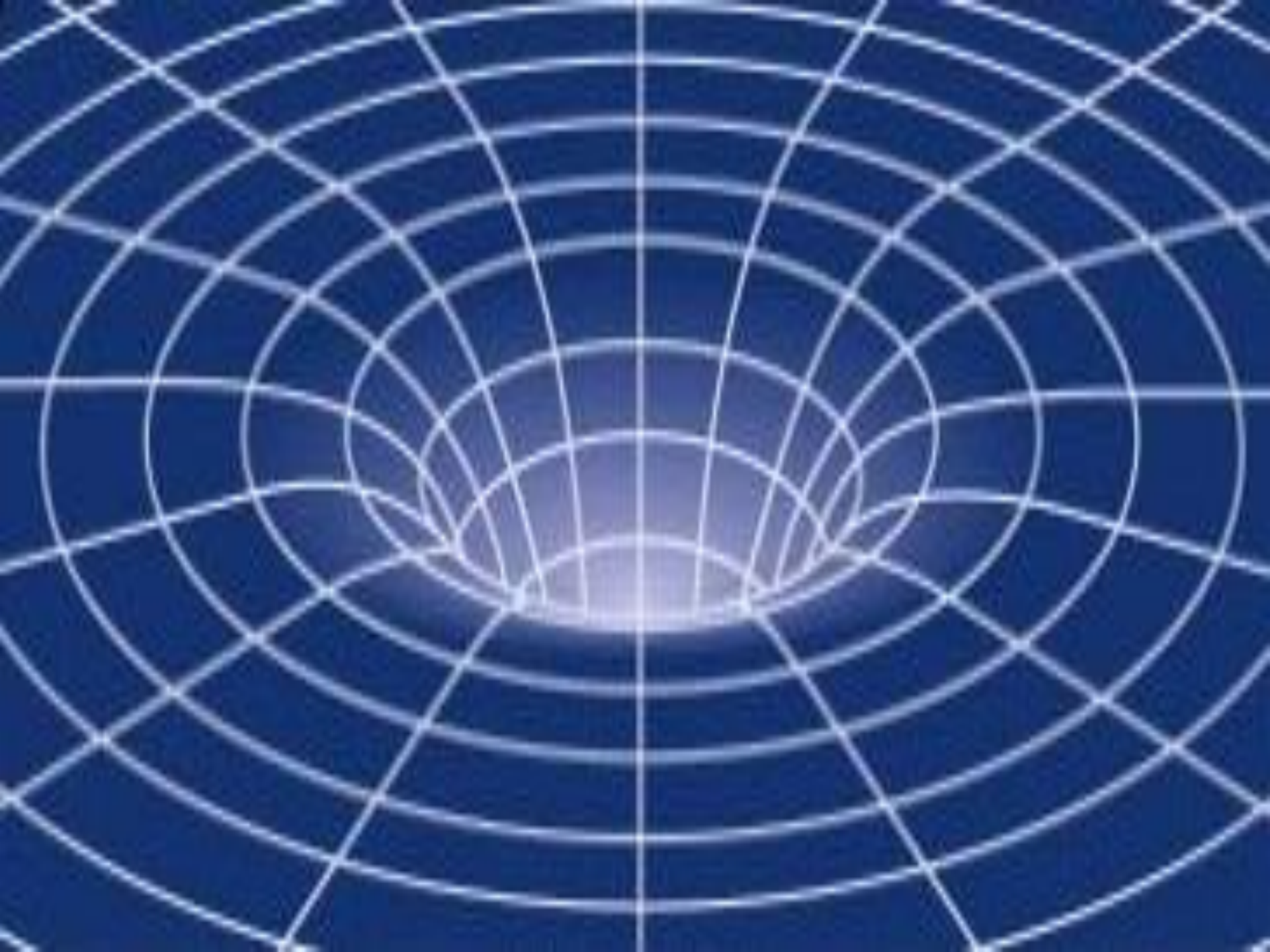
4.4.3 Allocate Mass of Fuel Gas

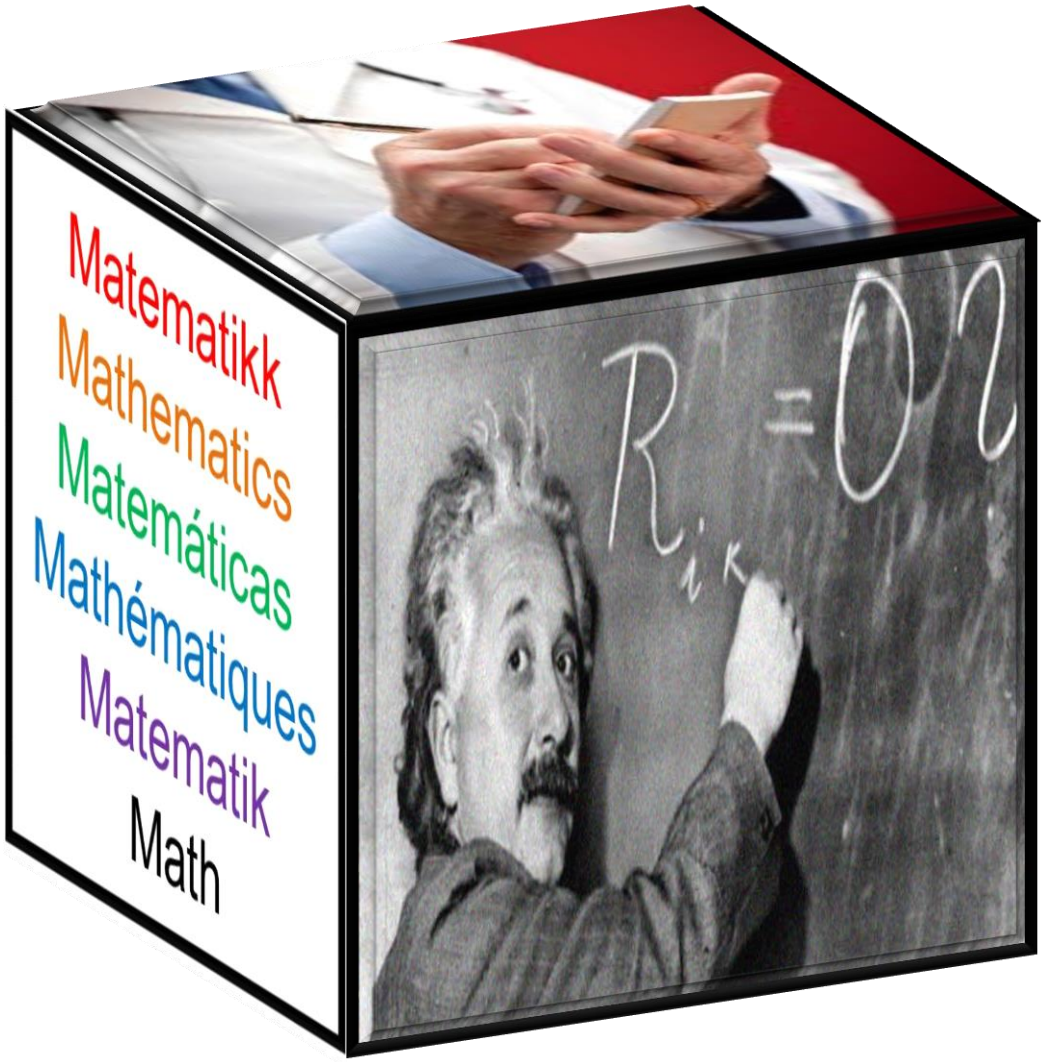
The measured mass of Fuel Gas (MFG) is allocated in proportion to the allocated theoretical Fuel Gas energy (HFG'_F). For each Field,

$$MFG_F = MFG * \frac{HFG'_F}{\sum_F HFG'_F}$$ Equation 4-22

The Unreasonable Effectiveness of Mathematics in the Natural Sciences

"The miracle of the appropriateness of the language of mathematics to the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve"

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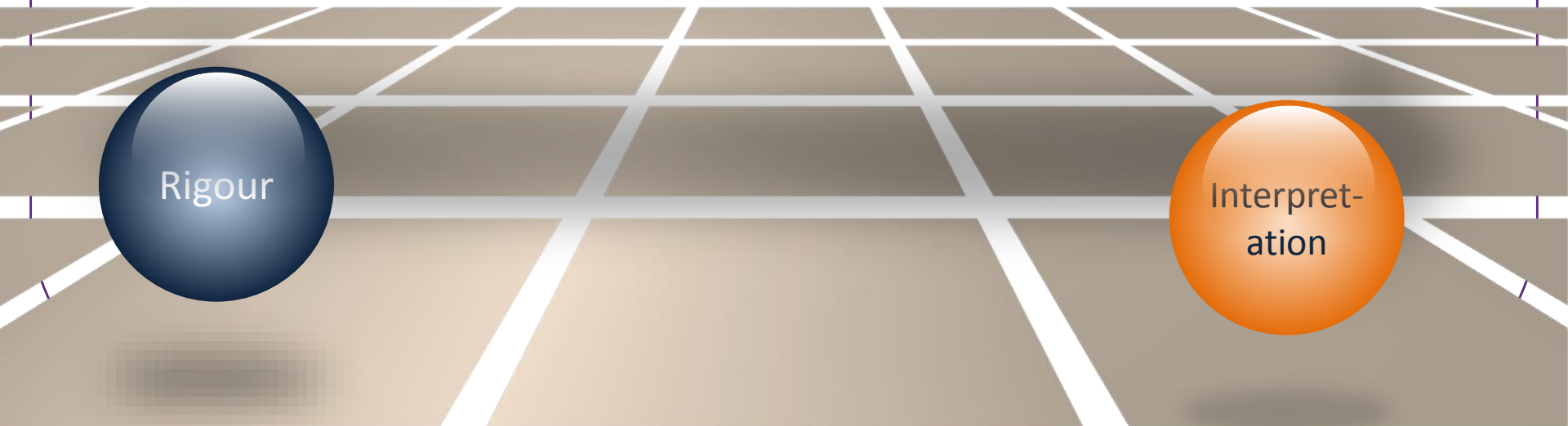

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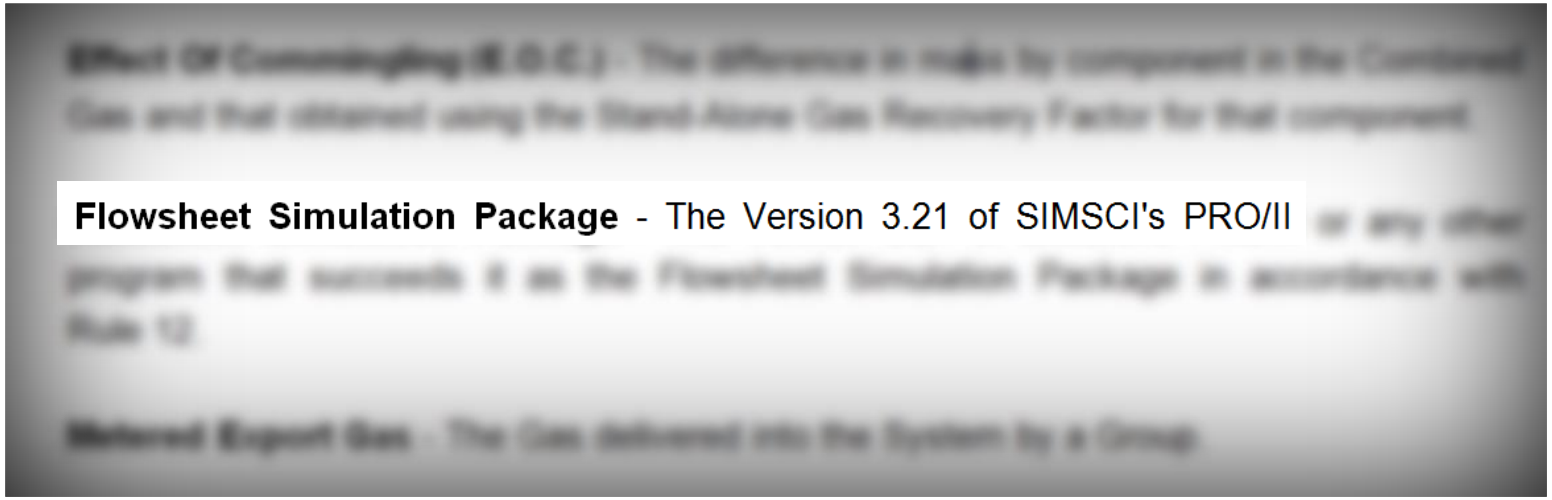


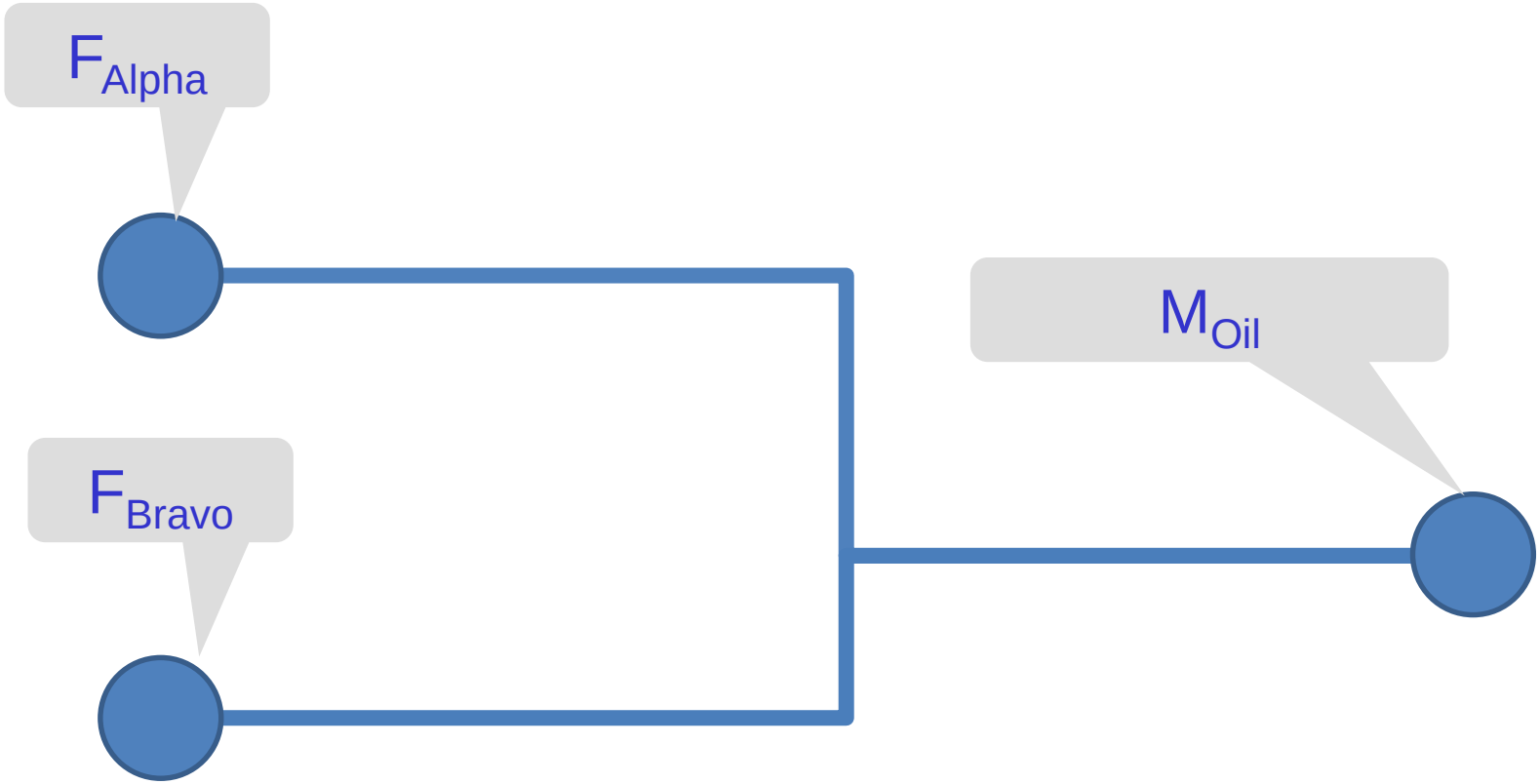
- Separate schedule for process model
- Describe properties
  - Inputs
  - Outputs
  - Methods

ISO 6976

AGA8

Flexibility

Flexibility



Specific vs General

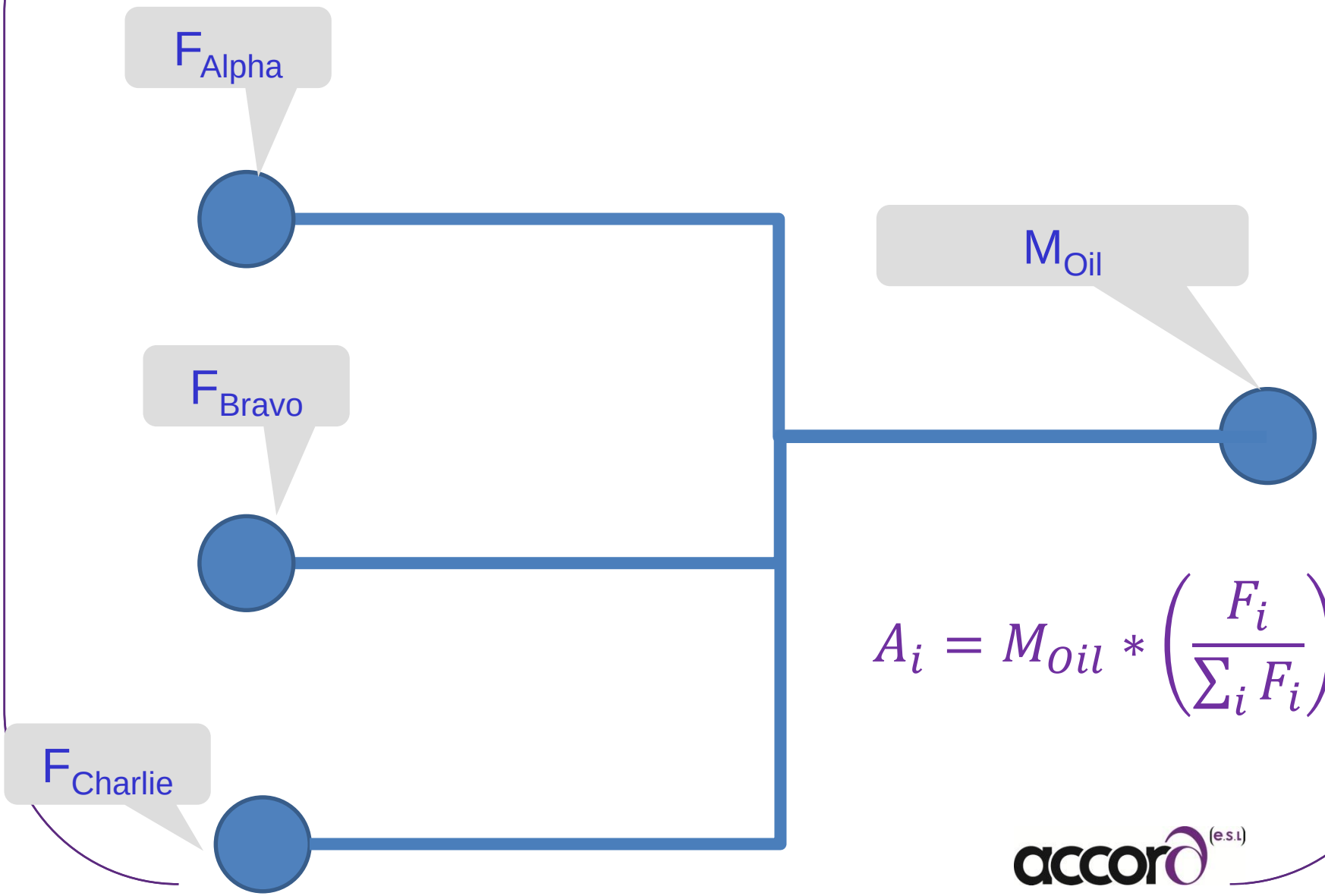
$$A_{Alpha} = M_{Oil} * \left(\frac{F_{Alpha}}{F_{Alpha} + F_{Bravo}} \right)$$

$$A_{Bravo} = M_{Oil} * \left(\frac{F_{Bravo}}{F_{Alpha} + F_{Bravo}} \right)$$

$$A_i = M_{Oil} * \left(\frac{F_i}{\sum_i F_i} \right)$$

i=Entrant
Alpha
Bravo

Flexibility



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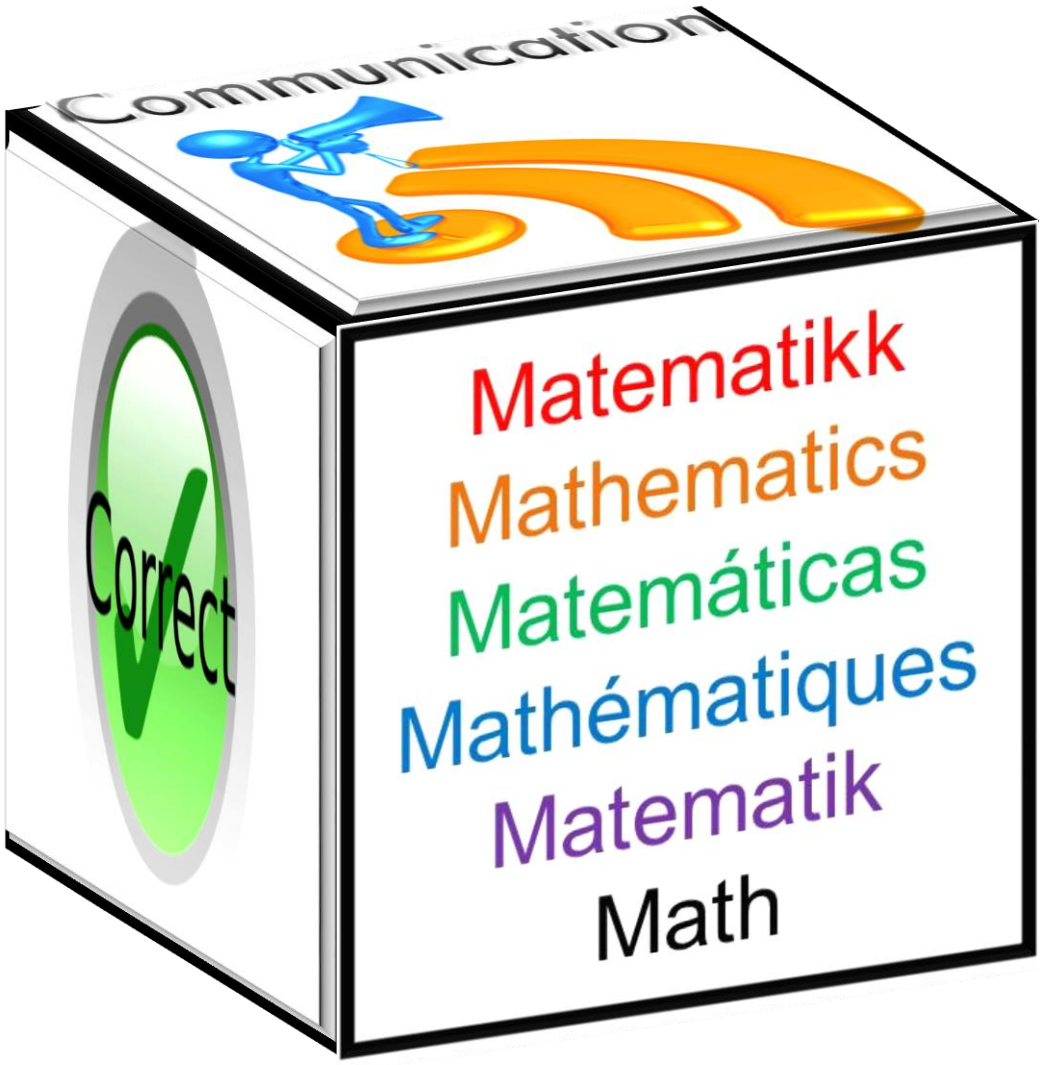
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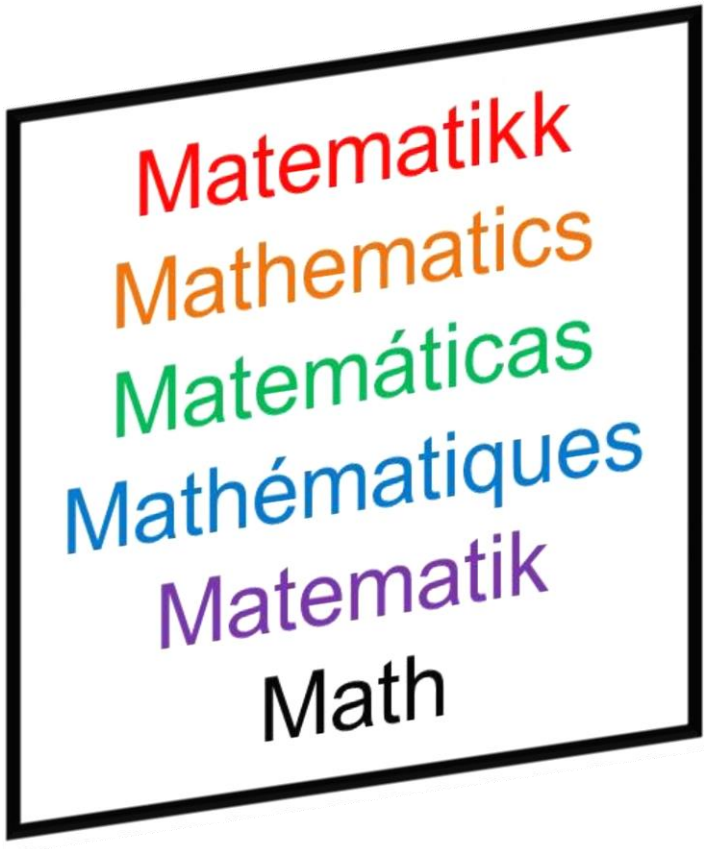
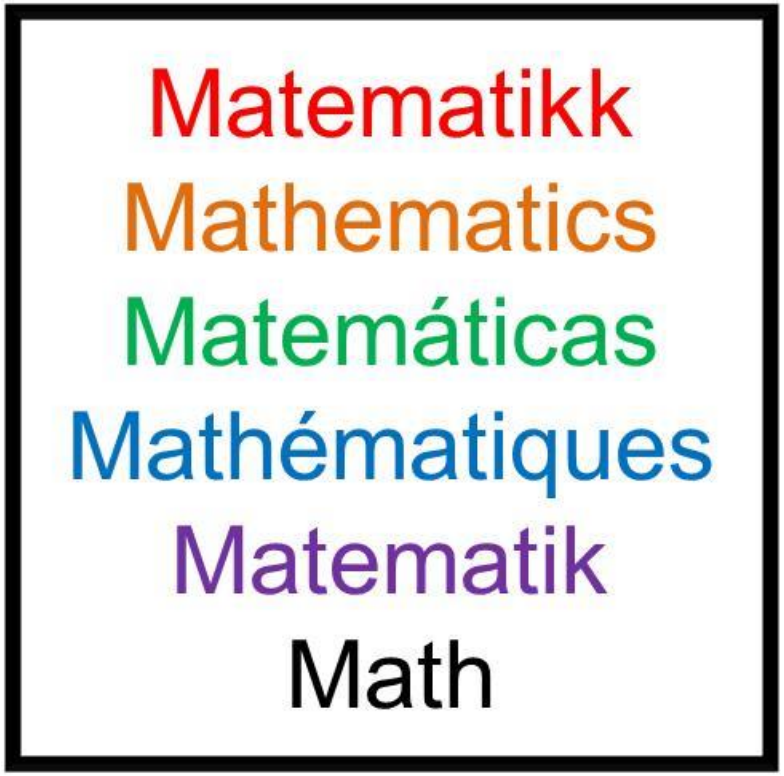

Matematikk
Mathematics
Matemáticas
Mathématiques
Matematik
Math

A Universal Language

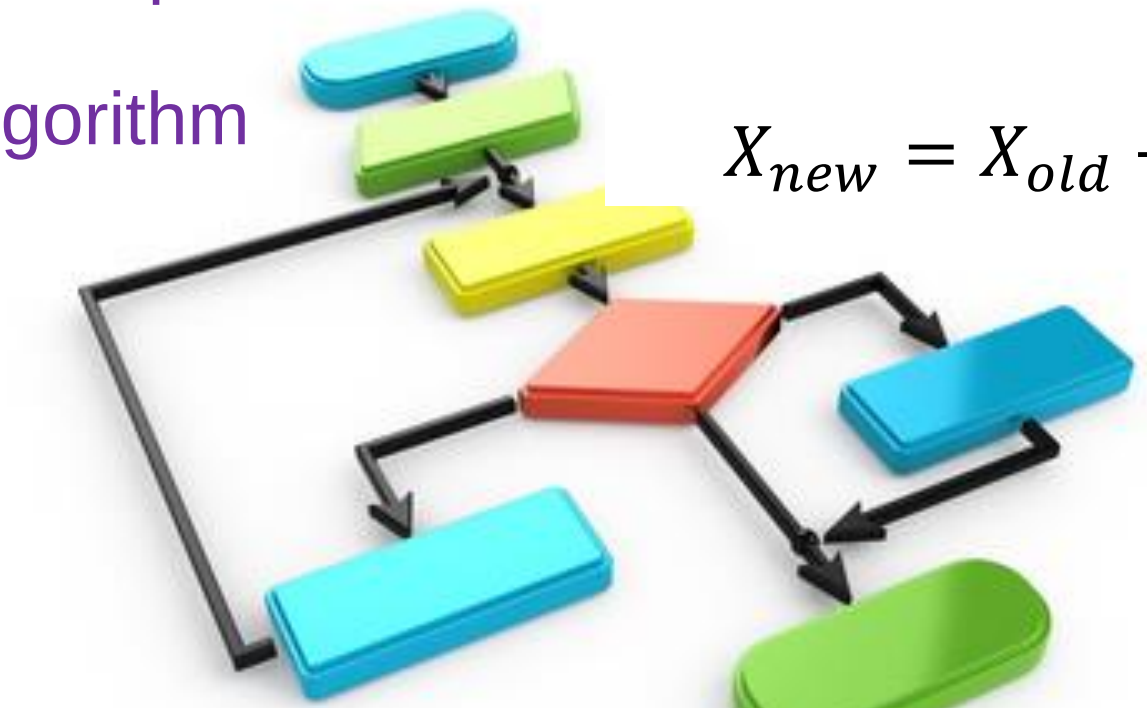


Mathematical format

Not a mathematical proof

Mathematical algorithm

$$X_{new} = X_{old} + Y$$



Not a software design document

$$Y = f(X, Z)$$

Notation

DEFINED TERMS

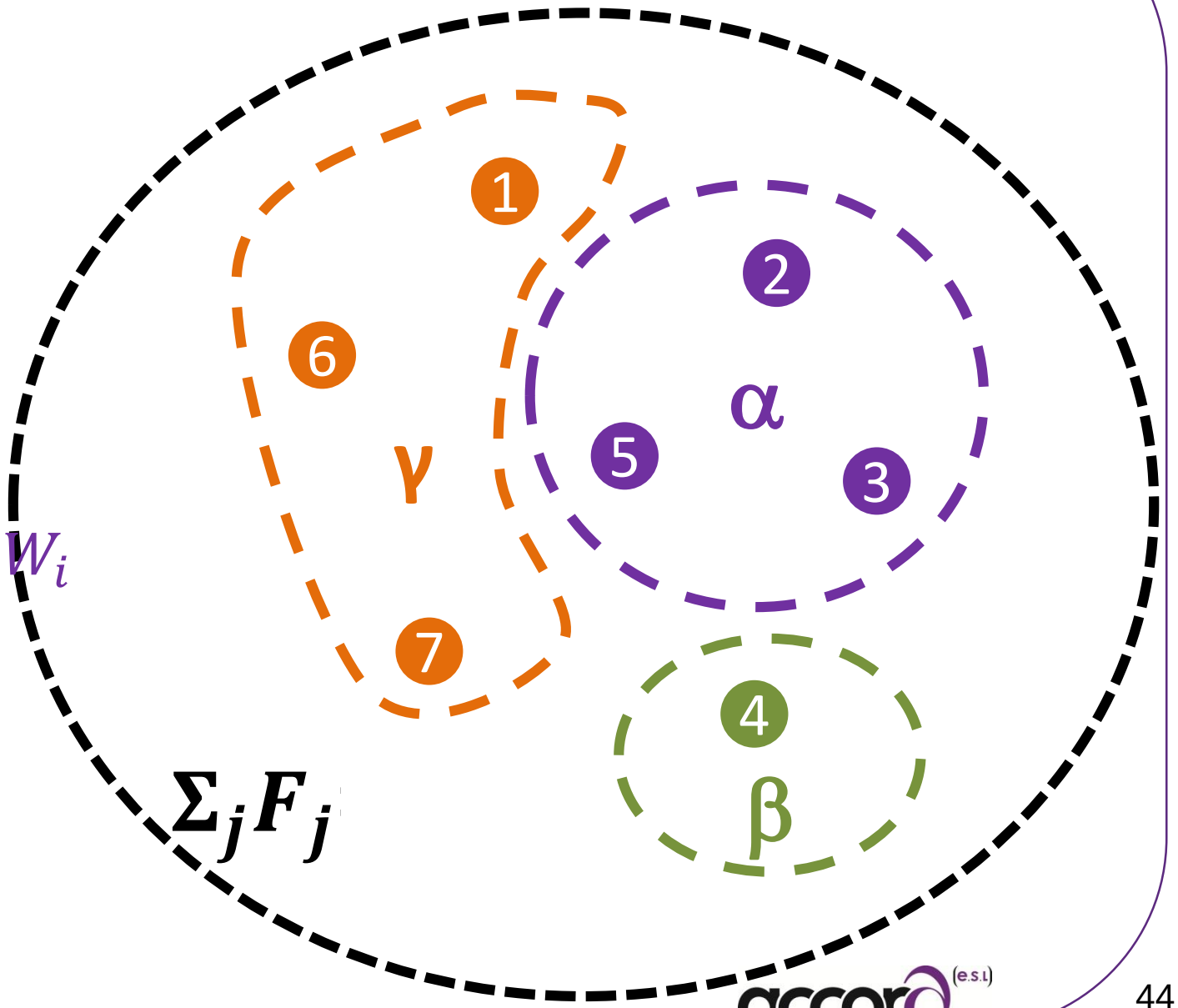
Day	24 hour period of Allocation
Field	Group of Wells with common Party equity interest
Party	Company or Group of Companies with an interest in a Field
Processed Gas	Sum of Fuel Gas and Export Gas
Standard Volume	Volume of stream at 15^{o}C, 1.013 bara.
Well	Single hydrocarbon producing well

Mathematical Observations

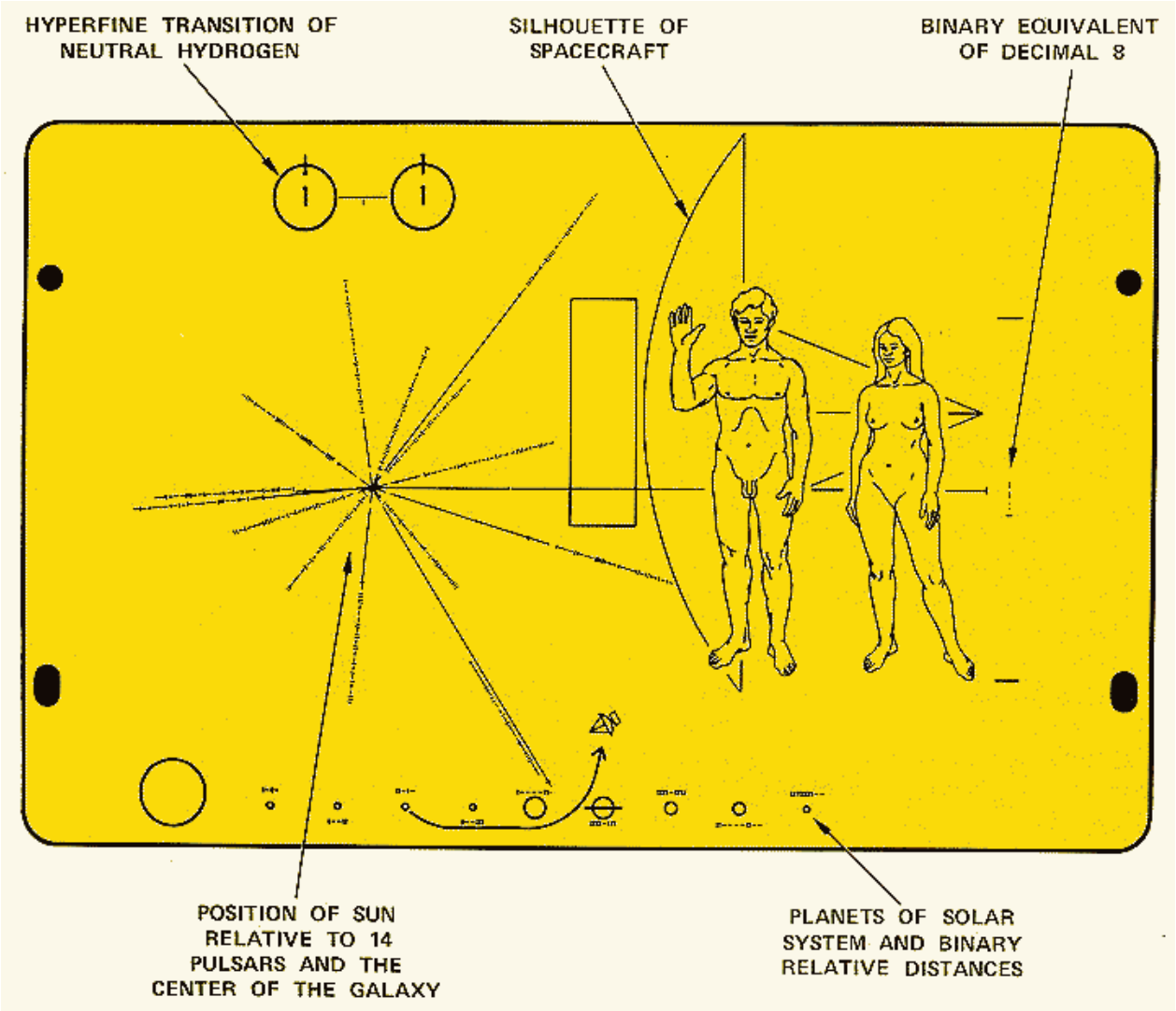
- Division by zero
  - $\mathrm{A}_{\alpha} = MO \frac{F_{\alpha}}{\sum_{\mathrm{j}} F_j}$
  - What happens when $\sum_{\mathrm{j}} F_j$=0?
  - General statement at start
- $$F_{\alpha} = \sum_{i \in \alpha} W_i$$
  - $\in$
  - Is an element of

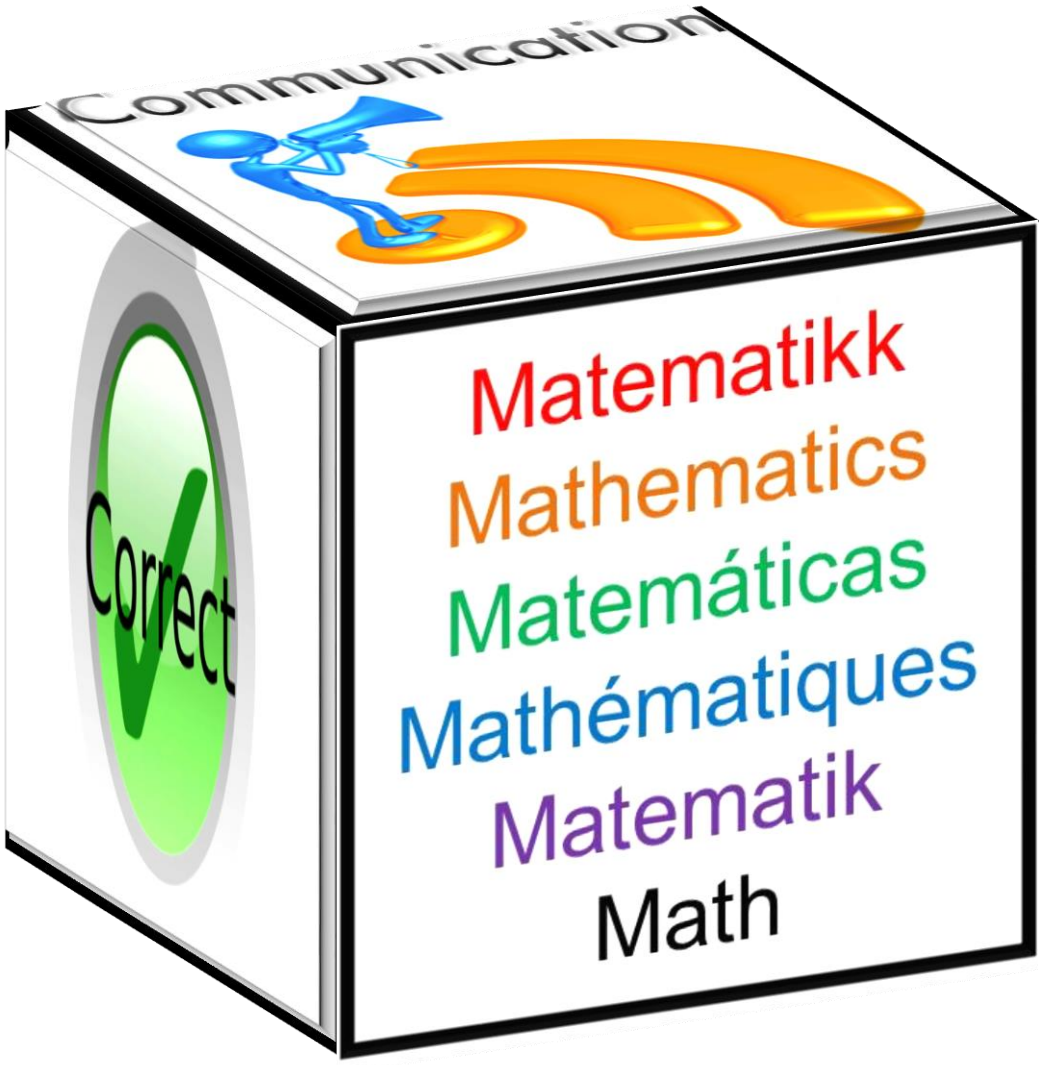
$$F_j = \sum_{i \in j} W_i$$

$$F_\alpha = \sum_{i \in \alpha} W_i$$



A Universal Language?




Communication
Correct
Matematikk
Mathematics
Matemáticas
Mathématiques
Matematik
Math


Correct
Communication


Communication

Primacy of the equations

$$PSX_{FG,C} = \frac{PSMFG_C}{\sum_C PSMFG_C}$$

$$HFG^{ISO} = MFG * \sum_C \left(PSX_{FG,C} * CV_C\right)$$

$$HFGI'_F = HFG^{ISO} * \frac{MEO_F}{\sum_F MEO_F}$$

$$HFGR'_F = HFGI'_F - HFGB_{F,Open}$$

$$HFGB_{F,Close} = HFGB_{F,Open} + HFG'_F - HFGI'_1$$

$$MFG_F = MFG * \frac{HFG'_F}{\sum_F HFG'_F}$$

Communication aided by text

$$PSX_{FG,C} = \frac{PSMFG_C}{\sum_C PSMFG_C}$$ Equation 1

$$HFG^{ISO} = MFG * \sum_C \left(PSX_{FG,C} * CV_C\right)$$ Equation 2

$$HFGI'_F = HFG^{ISO} * \frac{MEO_F}{\sum_F MEO_F}$$

$$HFGR'_F = HFGI'_F - HFGB_{F,Open}$$

$$HFGB_{F,Close} = HFGB_{F,Open} + HFG'_F - HFGI'_F$$

The fuel gas energy (HFG^{ISO}) is initially allocated in proportion to the each Field's allocated mass of Export Oil. For each Field:

$$MFG_F = MFG * \frac{HFG'_F}{\sum_F HFG'_F}$$ Equation 3

Equation 4

Equation 5

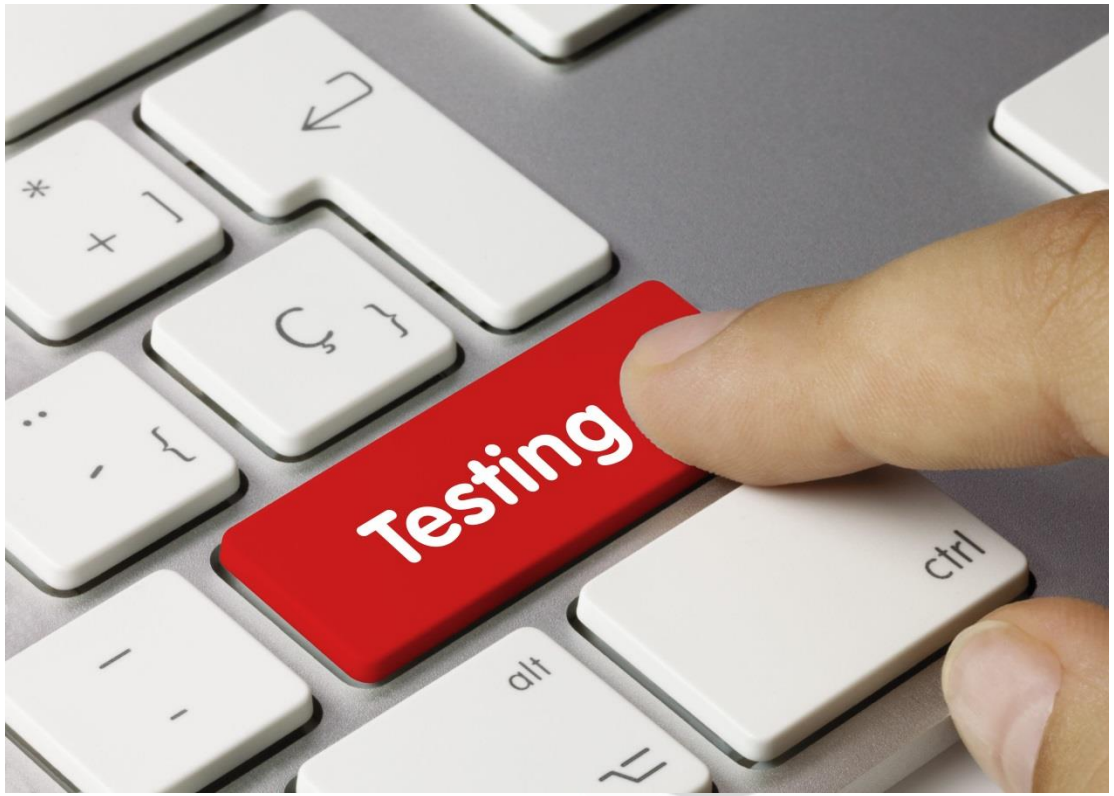
Equation 6


Correct
Communication


Correct


Correct

Mathematically correct?

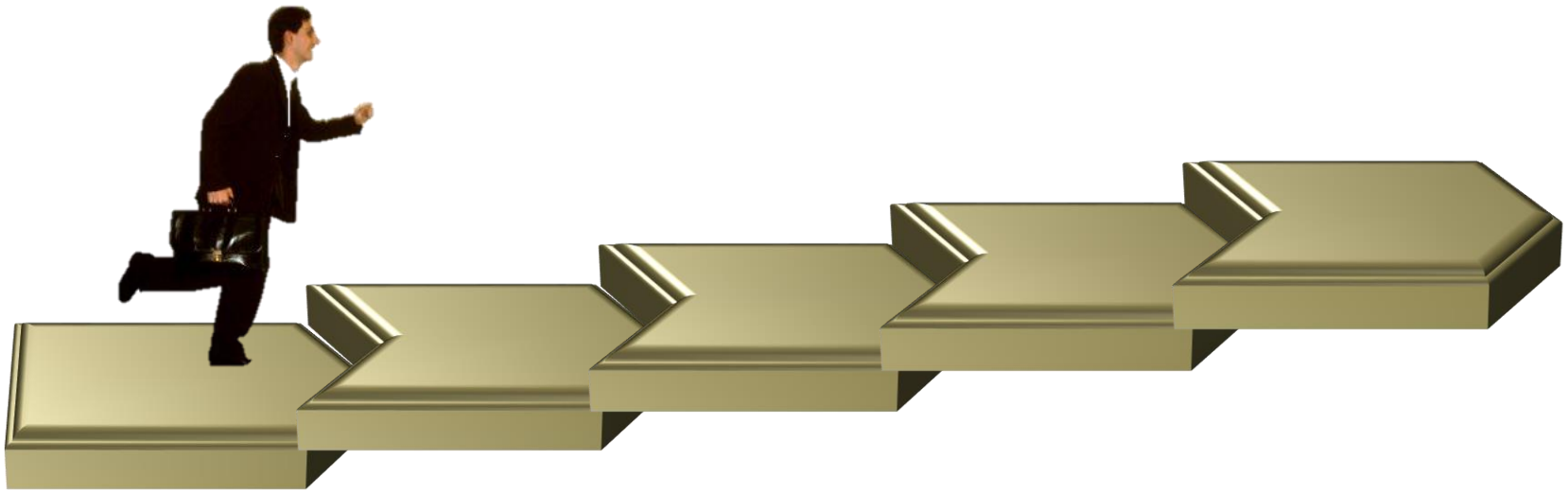


Testing the Mathematical Algorithm

- Use of simplified models
  - Spreadsheets
  - Reduced components, entrants
- Test logic
  - Functionality
  - Robustness
- Test with (semi
- Monte Carlo

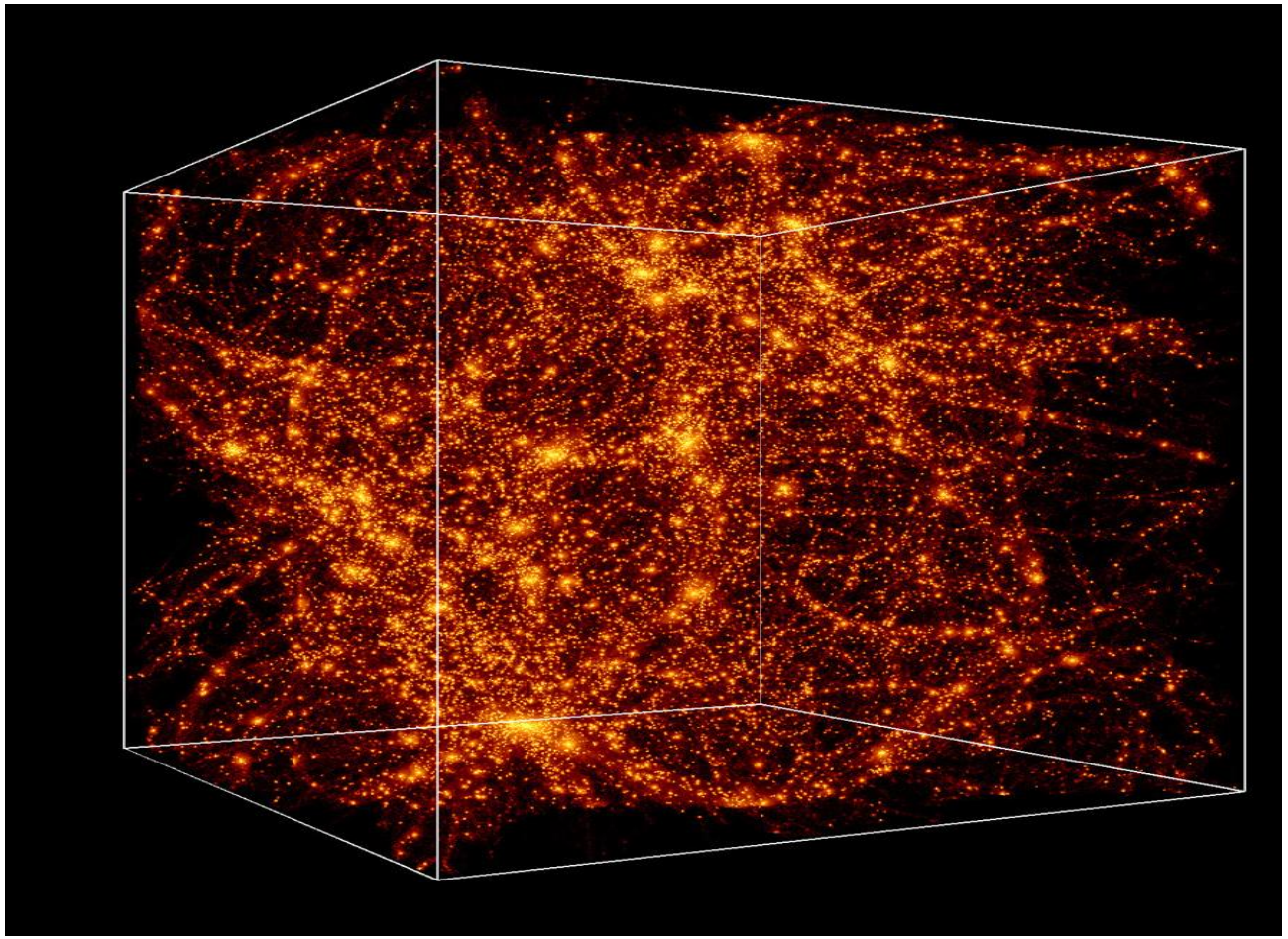
	Alpha	Beta	Gamma	Total	ACME Plant
Export					
C1	70%	80%	60%		
C2	20%	15%	25%		
C3	10%	5%	15%		
Mass	100	200	250		
C1	70	160	150	380	
C2	20	30	62.5	112.5	
C3	10	10	37.5	57.5	
Plant Disposal					
C1					65%
C2					19%
C3					16%
Mass					620

Agreement Writing Process



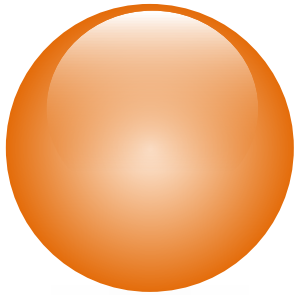
Concepts Principles Write Test Issue

Is the Universe a Mathematical Structure?



Fundamental Particles' Properties

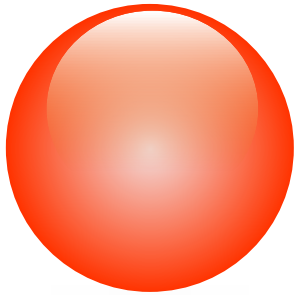
Electron



Mass : 0.511 MeV
Charge : -1
Spin : ½
Isospin : - ½
Baryon No. : 0
Lepton No. : 1

Fundamental Particles' Properties

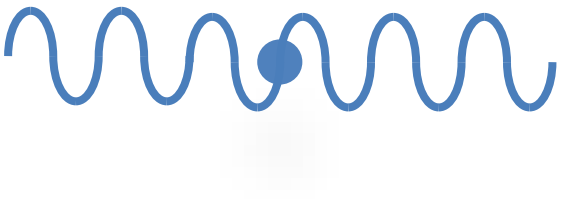
Proton



Mass : 938.3 MeV
Charge : +1
Spin : ½
Isospin : ½
Baryon No. : 1
Lepton No. : 0

Fundamental Particles' Properties

Photon



Mass	: 0
Charge	: 0
Spin	: 1
Isospin	: 0
Baryon No.	: 0
Lepton No.	: 0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GAME OVER

- Score 4%
- Red Dwarf


CAT

Questions?
Comments?
Contributions?