Cost benefit analysis for measurement at pipeline entry

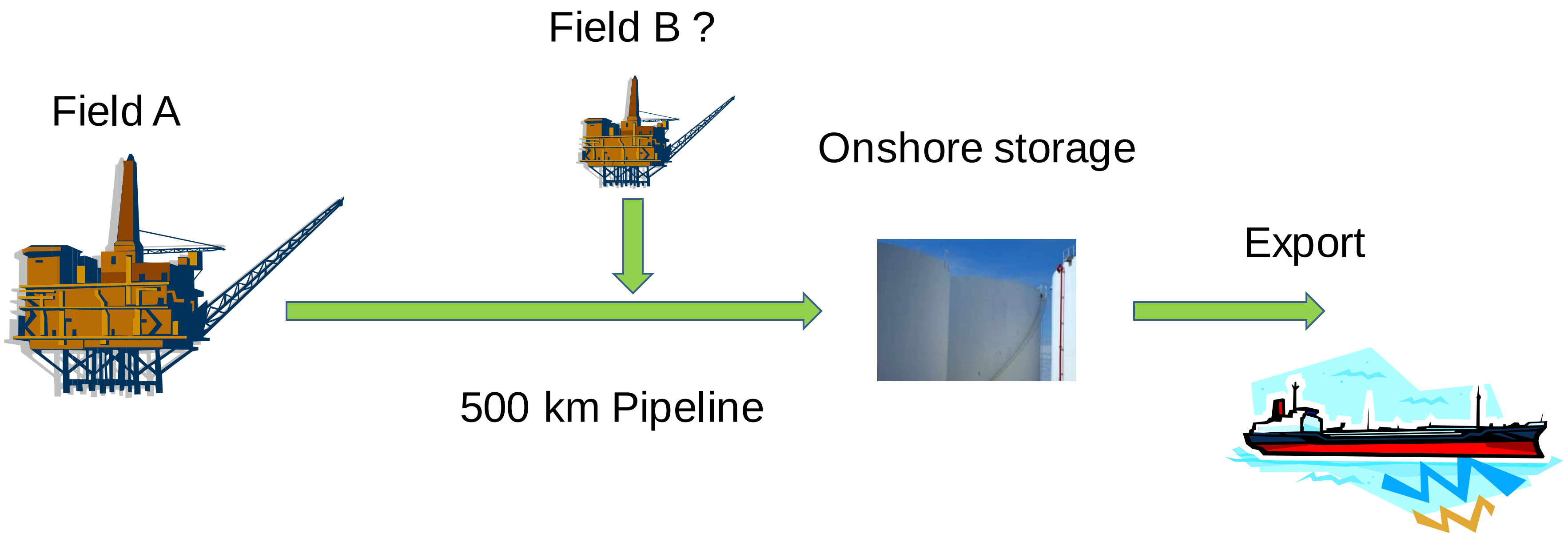
NFOGM temadag

Dag Flølo

Cost Benefit Analysis for measurement at pipeline entry

- Case description
- Authority requirements
- Costs
- Uncertainty
- Risk
- Cost Benefit analysis
- Conclusions

Introduction



- New field development with Field A, pipeline, onshore storage and export
- There will be fiscal measurement from the storage to the tanker
- There **migth** be future tie ins to the pipeline: Field B
- Assume that there will have to be fiscal measurement at pipeline entry from field B
- Metering at pipeline entry from field A will be used for allocation between A and B
- Should we install a conventional metering station at the pipeline entry from field A?

Authority requirements (Norway)

- The purpose of these regulations is to ensure that accurate measurements form the basis of the calculation of taxes, royalties and fees etc. to the Norwegian state, including the CO_2 tax, and the income of the licensees.
- §4 Activities as mentioned in Section 1 of the present regulations shall be carried out in accordance with requirements stipulated by or pursuant to these regulations, and in accordance with recognised standards for such activities.
- Comments to § 4
  The use of recognised standards as mentioned in the first paragraph is optional inasmuch as other technical solutions, methods or procedures may be selected.
  The basis for using alternative methods may be:
  a) documentation demonstrating that measuring uncertainty and operational reliability is equal to or better than conventional equipment,
  b) in metering for allocation purposes, when there is a cost disproportion between a conventional system compared to a simplified system ref NORSOK

Maximum allowed measurement uncertainty for liquid: 0,30 % of standard volume

Basic principle of cost benefit analysis

A simplified solution may be acceptable if cost savings are larger than the increased risk

See NORSOK I-106 - for details

Options to prepare for a possible future tie-in

Install metering system from start:

1. Install conventional metering station from start
2. Install simplified metering station from start

Reserve place and weight reserves and plan for:

3. Future installation of a conventional metering station
4. Future installation of a simplified metering station

Make no preparations:

5. Plan to measure field A by difference

Frame conditions

Total direct and indirect costs over the life time of the metering system are much higher than the purchase order value.

There is huge pressure to cut capital expenditure in every project.

In the operational phase offshore facillities have:

- Weight limitations
- Space limitations
- Limited amounts of beds in the living quarter
- Hard competition and prioritization between possible modification projects

You need a strong argument for every piece of equipment you put in the design.

Conventional solution example

Conventional metering system:

- Weight: 100 tonn
- Size: 15 m X 5 m X 5 m
- Purchase cost: 40 MNOK
- Life cycle cost 160 MNOK
- Life cycle uncertainty < 0,15 %

Simplified solution - example

Simplified metering system:

- Weight: 10 tonn
- Size: 15 m X 1 m X 1 m
- Package cost: 8 MNOK
- Life cycle cost 32 MNOK
- Life cycle uncertainty < 0,3 %

Simplest solution - Measurement by difference

Measurement by difference:

Field A = Export – Field B

Simplest metering system:

- Weight: 0 tonn
- Size: 0 m X 0 m X 0 m
- Package cost: 0 MNOK
- Life cycle cost 0 MNOK
- Uncertainty < **?**

Uncertainty measurement by difference

$$Allocated\ to\ field\ A\ = Measured\ Export\ - Measured\ import\ from\ field\ B$$

$$Uncertainty\ field\ A\ = \sqrt{\left((Uncertainty\ export^2) + (Uncertainty\ field\ B^2)\right)}$$

Uncertainty from measurement by difference

Production from field A = export from the onshore terminal C - production from field B								
Export from the onshore terminal C			**Production from field B**			**Allocated to field A**		
Amount	**Uncertainty**	**Uncertainty**	**Amount**	**Uncertainty**	**Uncertainty**	**Amount**	**Uncertainty**	**Uncertainty**
m3	**%**	**m3**	**m3**	**%**	**m3**	**m3**	**m3**	**%**
100	0,15	0,15	0	0,15	0,000	100	0,15	0,15
100	0,15	0,15	10	0,15	0,015	90	0,15	0,17
100	0,15	0,15	20	0,15	0,030	80	0,15	0,19
100	0,15	0,15	30	0,15	0,045	70	0,16	0,22
100	0,15	0,15	40	0,15	0,060	60	0,16	0,27
100	0,15	0,15	50	0,15	0,075	50	0,17	0,34
100	0,15	0,15	60	0,15	0,090	40	0,17	0,44
100	0,15	0,15	70	0,15	0,105	30	0,18	0,61
100	0,15	0,15	80	0,15	0,120	20	0,19	0,96
100	0,15	0,15	90	0,15	0,135	10	0,20	2,02

- Relative uncertainty for the amount allocated to A increases when A gets relatively smaller!

Uncertainty when all streams are measured

Each of the inputs are adjusted pro rata to match the measured export

$$Allocated\ to\ A = f(Meas\ A, Meas\ B, Export) = Meas\ A * \frac{Export}{Meas\ A + Meas\ B}$$

$$Uncertainty\,A\,(m^3) = \sqrt{\left(\frac{df}{dA}\right)^2 * Meas\,unc\,A^{\,2} + \left(\frac{df}{dB}\right)^2 * Meas\,unc\,B^2 + \left(\frac{df}{dExport}\right)^2 * Export^2}$$

$$\left(\frac{df}{dA}\right) = Meas\ B\ *\ \left(\frac{Export}{(Meas\ A)^2 + (2 * Meas\ A * Meas\ B) + (Meas\ B)^2}\right)$$

$$\left(\frac{df}{dB}\right) = Meas\ A\ *\ \left(\frac{Export}{(Meas\ A)^2 + (2 * Meas\ A * Meas\ B) + (Meas\ B)^2}\right)$$

$$\left(\frac{df}{dExport}\right) = \frac{Meas\ A}{(Meas\ A + Meas\ B)}$$

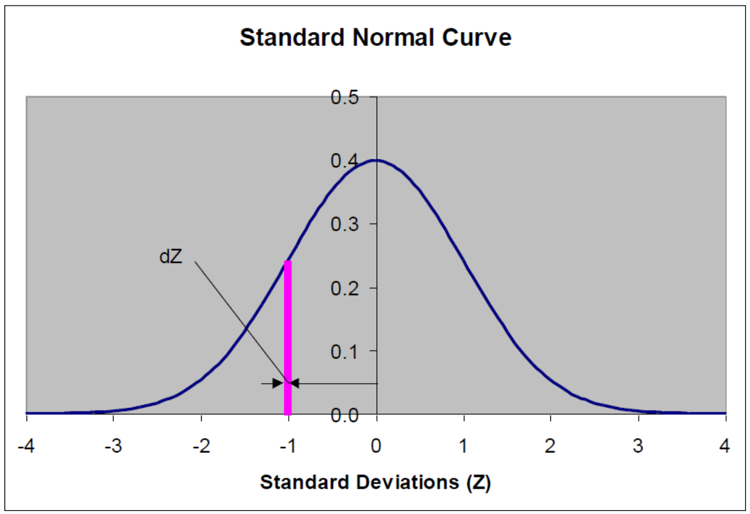
This is not just for fun - you really need to do this to get it right!

Uncertainty vs. risk for loss Phillip Stockton (NSFMW 2009)

$Risk\ for\ loss \neq Uncertainty\ @\ 2\ standard\ deviations$

Because:

$Risk\ for\ loss = Probability * consequence$



Probability for an error in an interval is equal to the area under the curve in this interval.

$$Risk\ for\ loss = \int_{0}^{-\infty} (Probability * error)$$

$$Risk\ for\ loss = \mathbf{0,2} * (Uncertainty\ @\ 2\ Standard\ deviations)$$

Benefit of transposing uncertainty to risk

Risk for loss from meas. uncertainty = Risk for loss of income

Risk for loss of income = Risk for loss of profit

Risk for loss from meas. uncertainty is a Risk for loss of profit

Consequence * Probability = Risk

Cost = Consequence

Probability = 1

Cost * 1 = Risk for loss of profit

Costs are also Risk for loss of profit

Risk for loss from measurement uncertainty and costs are both: Risk for loss of profit

We can add the risks for competing alternatives and compare them

Case 1

Parameter	Unit	Value
Field A – value of planned production	NOK	100E9
Field B – value of planned production	NOK	250E9
Simplified system – uncertainty	%	0,3
All - conventional systems - uncertainty	%	0,15

Metering concept	Total Cost NOK	Risk for loss from measurement uncertainty NOK	Total risk for Reduction of profit NOK
Simplified	32E6	57E6	89E6
By difference	0E6	129E6	129E6
Conventional	160E6	43E6	203E6

The risk for production loss (shut down) may also have to be taken into account.

Case 2

Parameter	Unit	Value
Field A – value of planned production	NOK	100E9
Field B – value of planned production	NOK	250E9
Simplified system – uncertainty	%	0,3
All - conventional systems - uncertainty	%	0,1

Metering concept	Total costs NOK	Risk for loss From meas uncertainty NOK	Total risk for Reduction of profit NOK
Simplified	32E6	49E6	81E6
By difference	0E6	**86E6**	86E6
Conventional	160E6	28E6	188E6

Lower uncertainty makes the «By difference» concept more competitive.

Case 3

Parameter	Unit	Value
Field A – value of planned production	NOK	200E9
Field B – value of planned production	NOK	250E9
Simplified system – uncertainty	%	0,3
All conventional systems - uncertainty	%	0,15

Metering concept	Total Costs NOK	Risk for loss From meas uncertainty NOK	Total risk (Reduction of profit) NOK
Simplified	32E6	96E6	146E6
By difference	0E6	154E6	154E6
Conventional	160E6	76E6	236E6

A relatively larger production from Field A makes the «By difference» concept more competitive

Conclusion

- Add the risks – choose the lowest risk for loss of profit
- A simplified metering system will probably cause the lowest reduction of profit
- A simplified system will probably give
  - The greatest profit for the company
  - Greater income to the state than a conventional system

The conclusion we made was to:

- Plan for future installation of a simplified metering station

We are aware that:

- Other modifications may win the competition for modification resources
- Measurement by difference will be an alternative and a feasible back-up method