Allocation considerations for late life operations and beyond…

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Dr David Stewart
Subsurface, HCA & Production Manager

TAQA Bratani Ltd

POWERING A THRIVING FUTURE

Allocation considerations for late life operations and beyond…

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- ❑ Background
- ❑ Main areas of consideration:
  - Challenges of late life operations
  - Cessation of Production (end of field life)
  - Beyond allocation – Subsurface abandonment
  - Even longer-term requirements
- ❑ Awareness of these and planning ahead
- ❑ System issues or changes required
- ❑ Questions

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Background

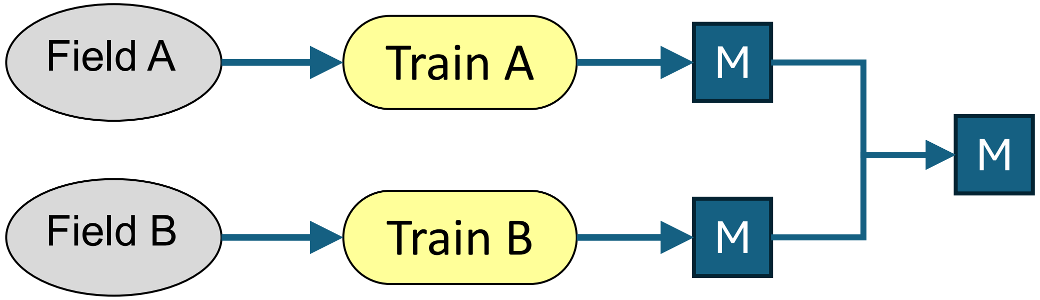
- The early years

❑ Big fields, simpler/better processes… allocation made "easy" (relative to later!).

  - Well designed metering and allocation systems.
  - Meters sized correctly, fit for purpose, fiscal level uncertainty.
  - Generally, no/few issues with field level allocation.

❑ Allocation challenges (should be) limited to "routine" factors:

  - Meter calibrations
  - Sampling compliance
  - Periodic review of any assumptions or fixed factors

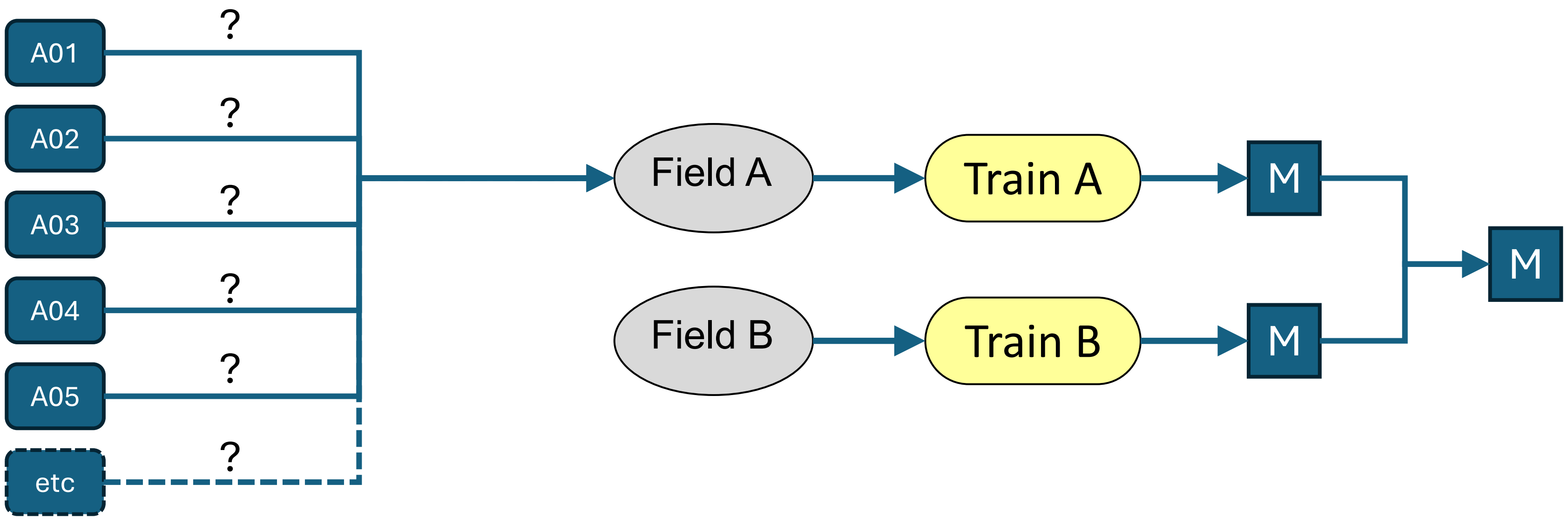


Background

- The early years

❑ Well level allocation? How important is this viewed at this stage?

  - HCA? Maybe not so much if field level is OK.
  - Production Engineers? Should be (for production optimisation).
  - Finance / Commercial? Possibly not interested - depends if any equity/tax issues.
  - Subsurface… they will be (or should be), but are they being catered for?



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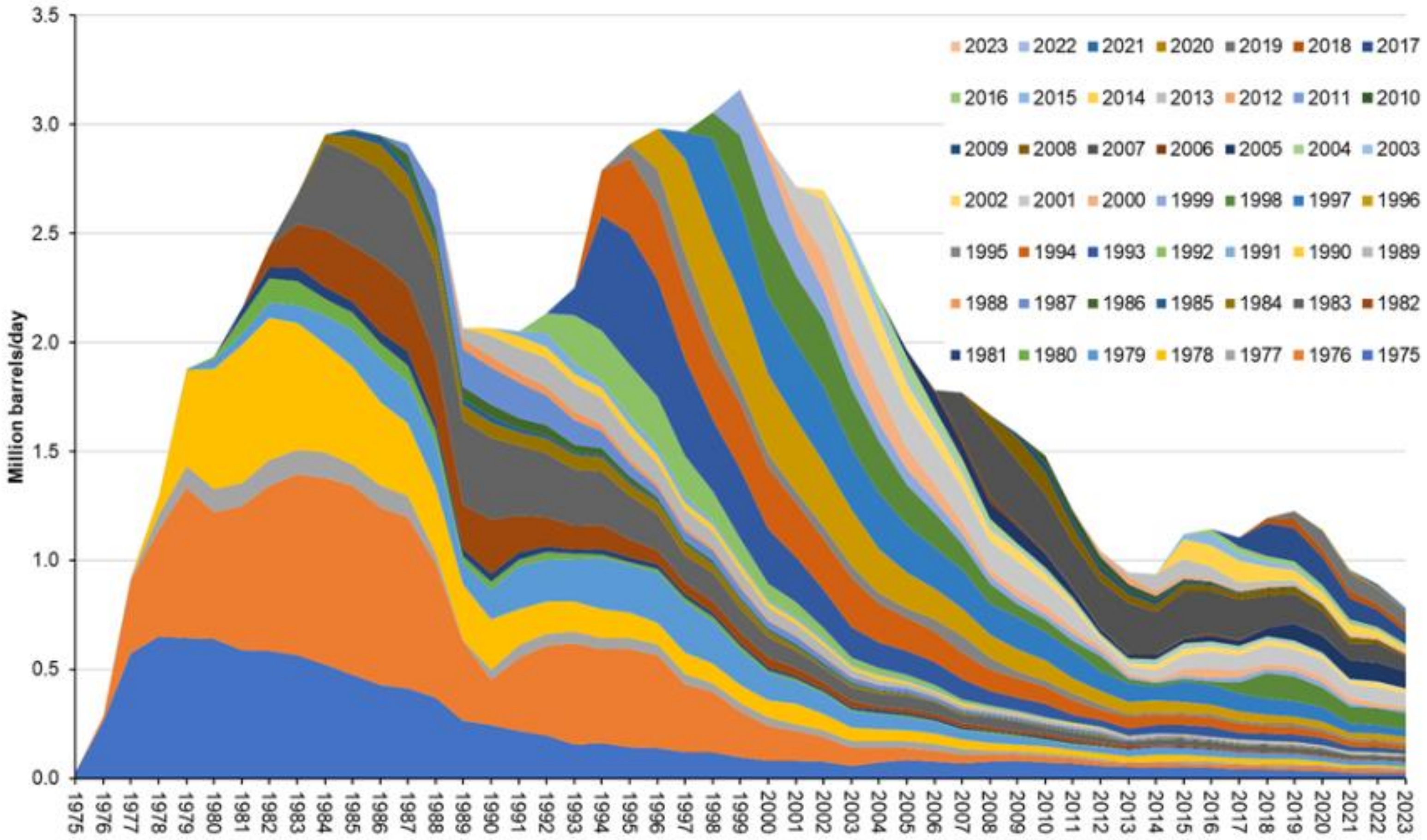
Challenges of late life operations

- The later years

❑ Production from original fields starts to decline.



UK production added by year

Challenges of late life operations

- The later years

❑ Production from original fields starts to decline.

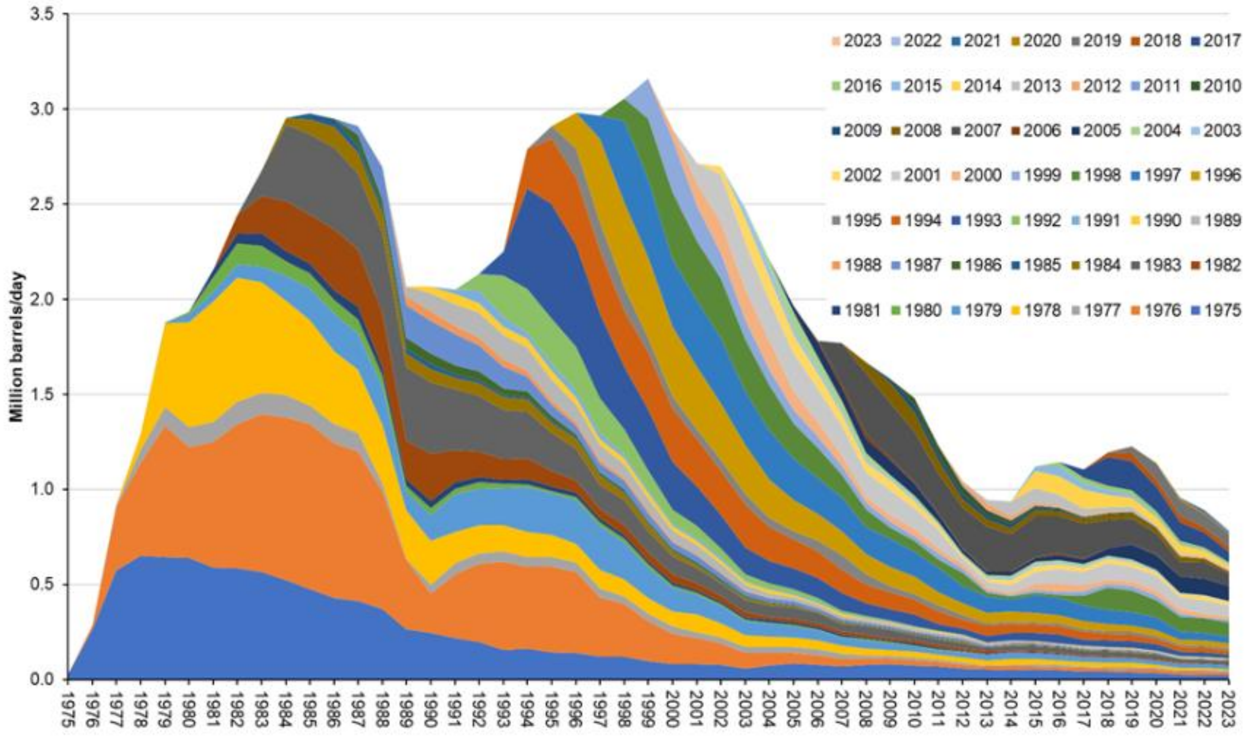
  - In-fill wells, well workovers to sustain production, but eventually…

❑ New field development tie-backs.

  - How is this measured and allocated?
  - Dedicated measurement?
  - Pro-rata field allocation?
  - Allocation by well test?
  - By-difference field allocation?

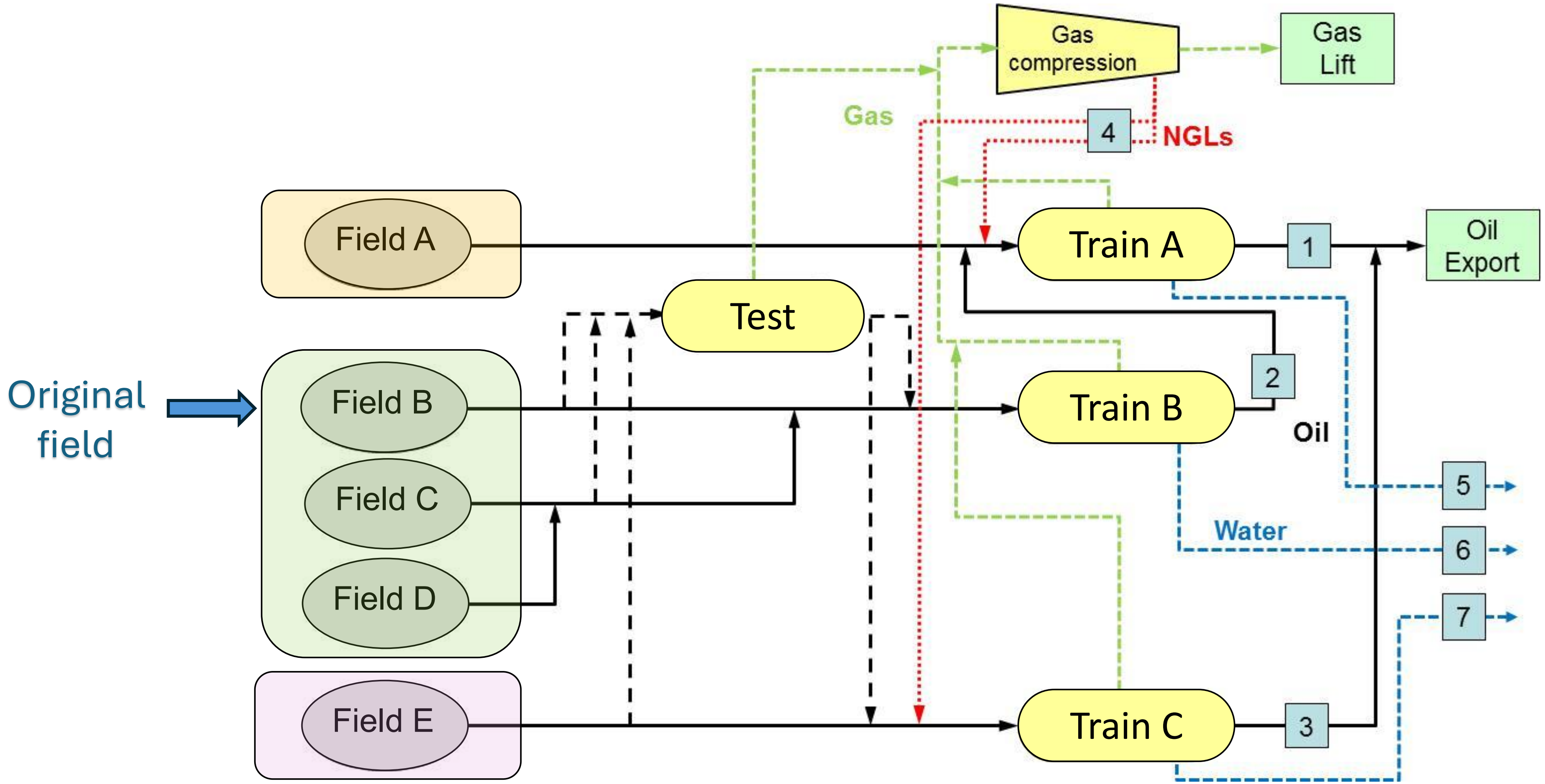
❑ Uncertainty challenges either way

  - Uncertainty affects revenue
  - Gas uncertainty may also affect abandonment planning (see later)



Challenges of late life operations

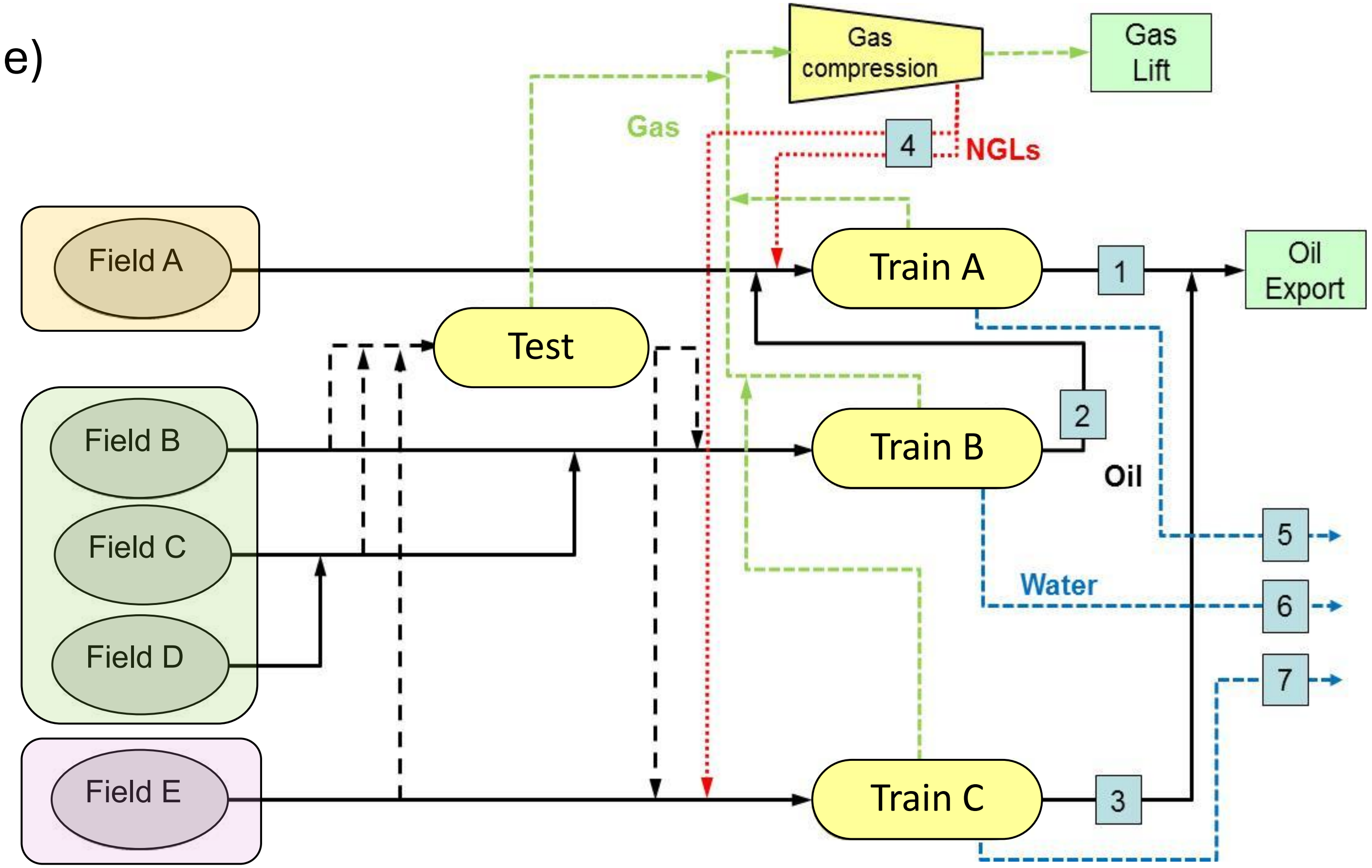
- Allocation uncertainty of new field tie-backs



Challenges of late life operations

- Allocation uncertainty of new field tie-backs

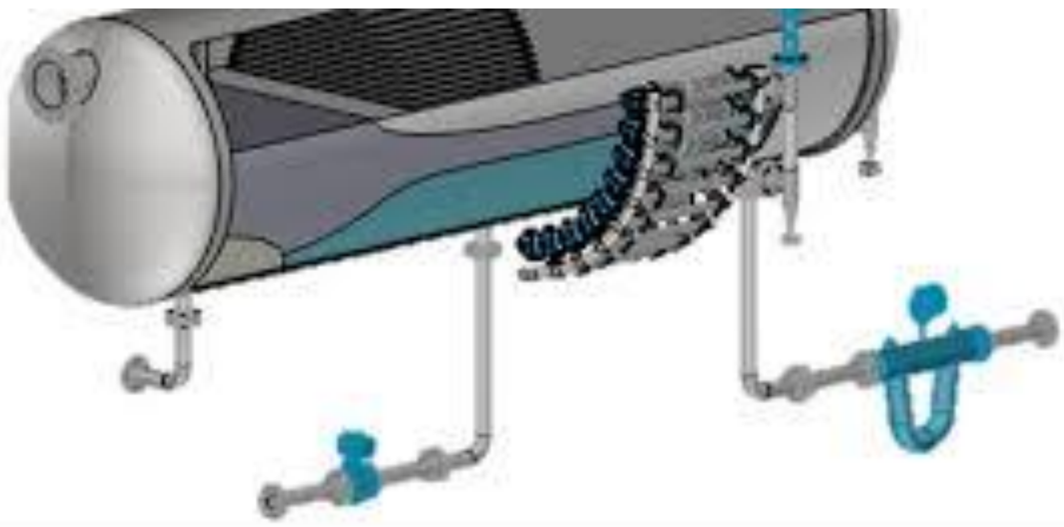
- ❑ Field E = Meter 3 (direct)
- ❑ Field A = Meter 1 – Meter 2 (by difference)
- ❑ Fields (B+C+D) = Meter 2
    - B, C and D subsequently split by well test
    - Note – C & D cannot be tested individually when both are flowing



Challenges of late life operations

- Allocation by well testing – measurement uncertainty

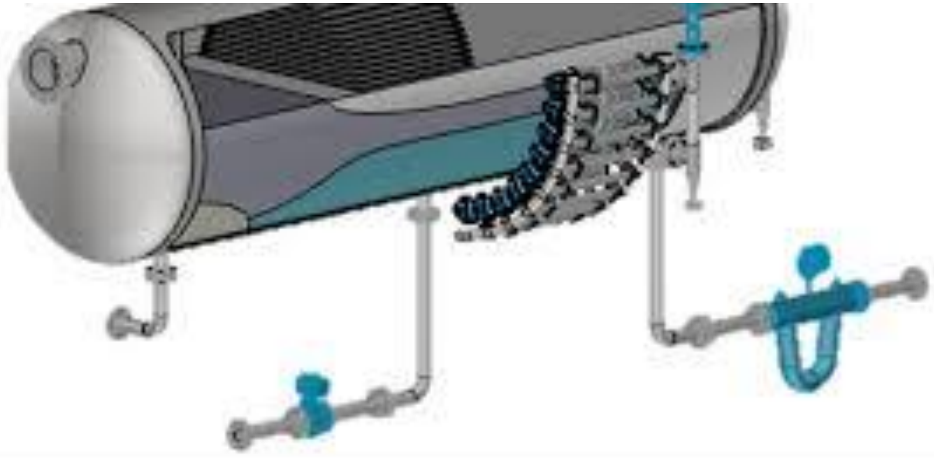
- ❑ What's the uncertainty in a well test?
  - o Test separator metering uncertainty?
  - o 3-phase or 2-phase separation?
  - o Water cut sampling uncertainty?
- ❑ High water cut wells?
- ❑ Realistic oil uncertainty?
  - o 2% to 5% if you're lucky
  - o >10% for poor systems

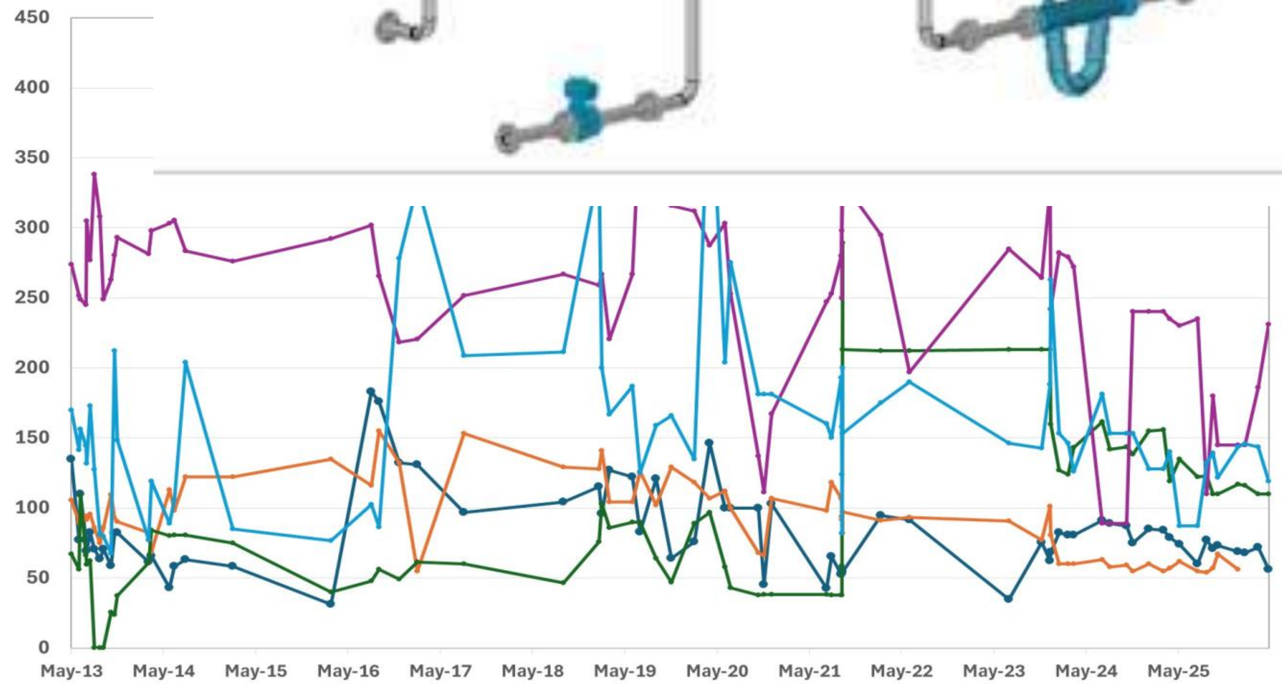


Challenges of late life operations

- Allocation by well testing – time-based uncertainties

- ❑ Short term:
  - o Separator size, residence time and liquid level.
  - o Need to ensure no/minimal change in liquid level.
  - o Need representative duration - 12 to 24 hrs at least?
- ❑ Long(er) term
  - o Changing production rates
  - o Production optimisation
    - (choke position, gas lift, water injection)
  - o Changes on one well backing out others?
- ❑ Potential for huge uncertainty
  - o Depends on type of allocation.
    - By-difference could be risky?
  - o Well level uncertainty definitely high.

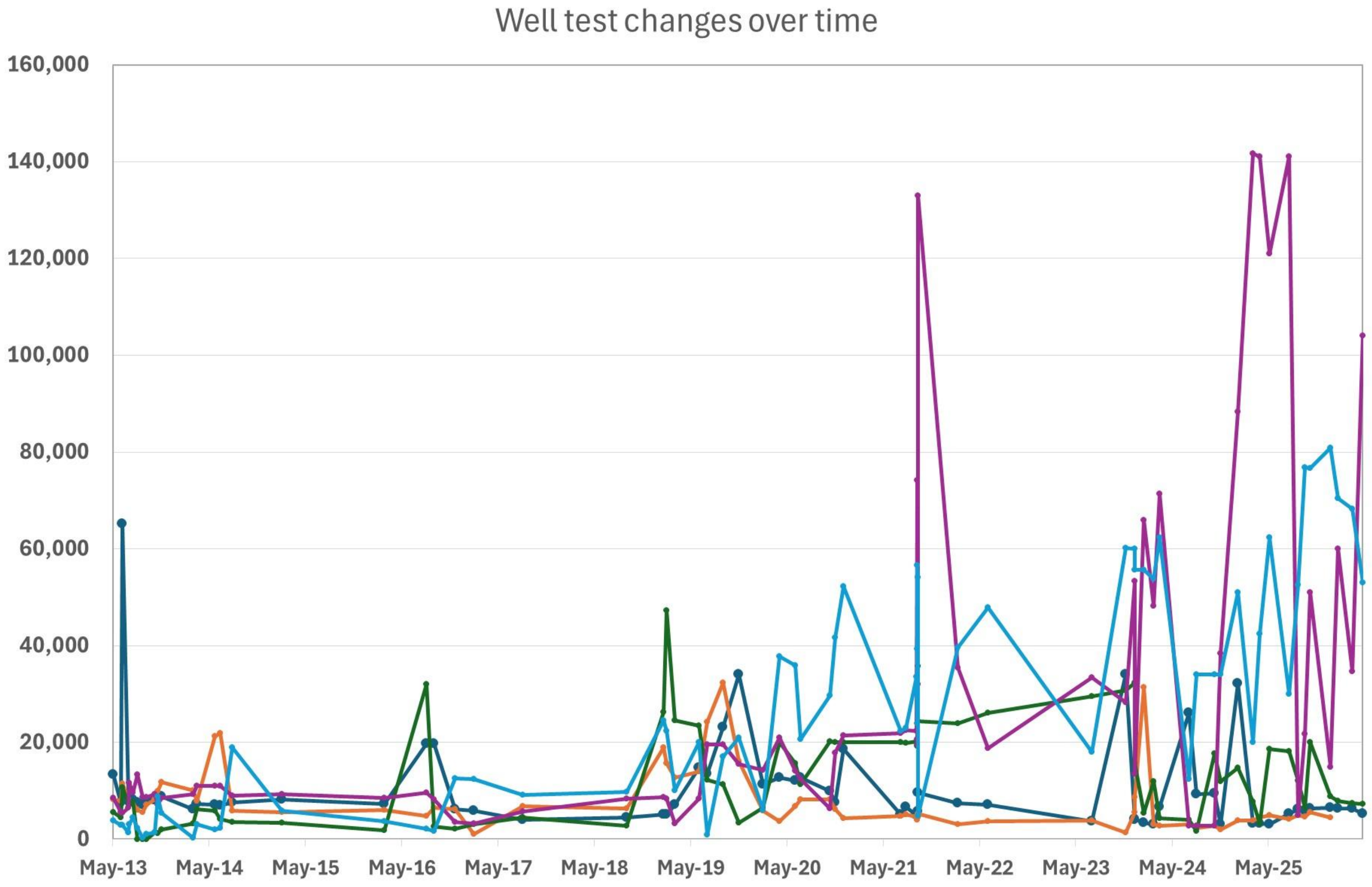




Challenges of late life operations

- Allocation by well testing – time-based uncertainties (gas)

- ❑ Well test gas rate uncertainty is typically much higher than oil rate
- ❑ Especially so if reservoir has a known gas cap.
- ❑ Example here shows field with horizontal wells and gas cap above.
- ❑ Capturing gas "coning" events can be important for subsurface (see later).



Allocation considerations for late life operations and beyond…

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Cessation of Production

- Allocation stops

- ❑ When there is no more oil/gas production, is there anything left to do?
- ❑ More than likely, yes!

Cessation of Production

- Gas allocation/reporting with no oil allocation

- At end of field/asset life, when there is no oil production, there might still be gas usage.
  - Import gas for fuel (maybe not in Norway).
  - May need to flare for safety reasons (again, maybe not in Norway).
- How does this gas get allocated?
  - Not production, but import.
  - Assigned to a specific field?
  - Spread across all (previous) fields on the asset? If so, on what basis?
- Reporting and cost allocation.
  - Needs to be picked up in Government / partner reporting.
  - Needs to filter through to Environmental reporting.
- Is the allocation system set up to do this already, or do you need system updates?

Cessation of Production

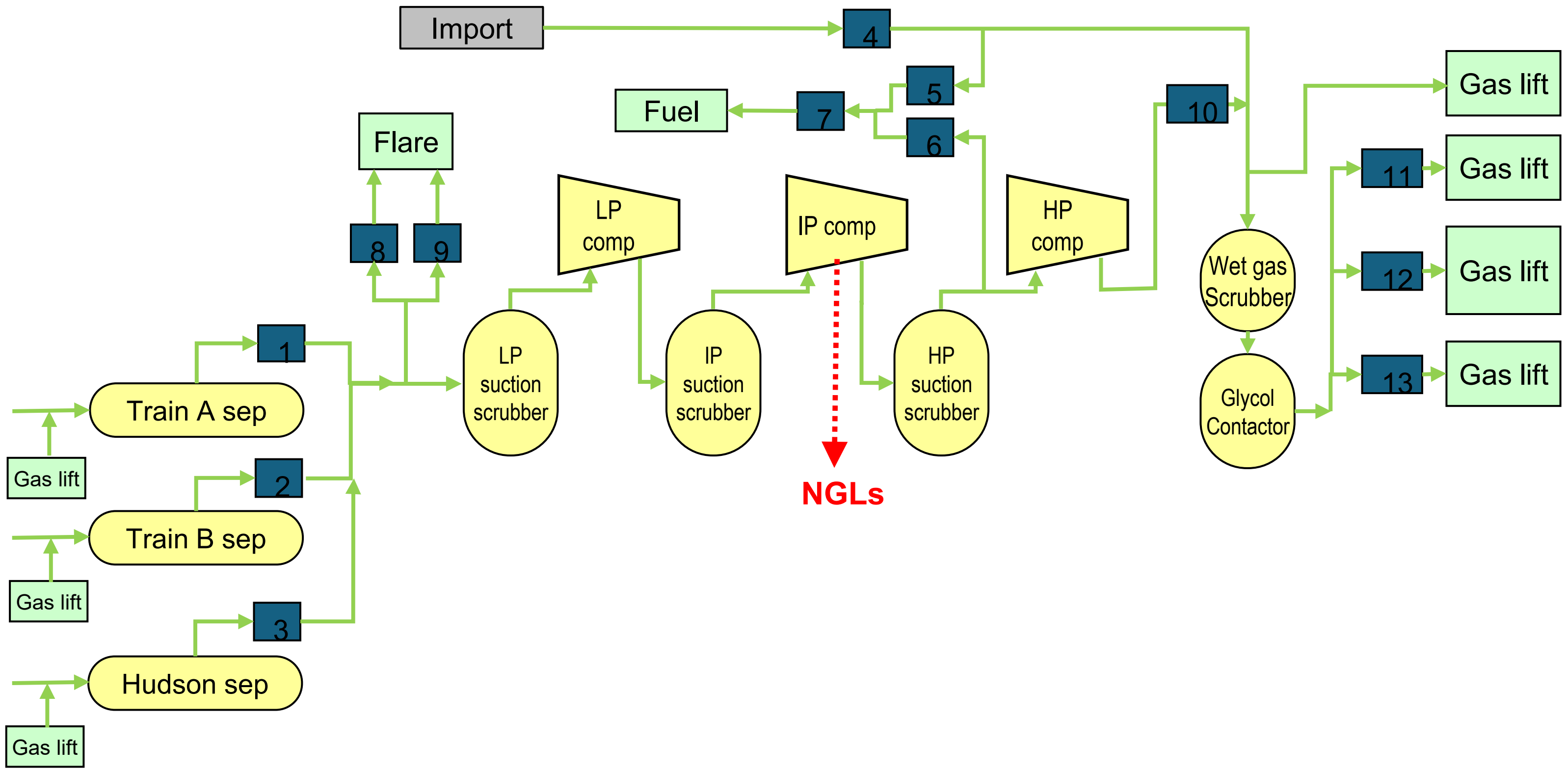
- Historic production reporting

- In the UK, when fields reach CoP the Government Regulator requires life of field data reporting.
  - Used for historic analysis, academic research, etc.
- More extensive than normal production reporting during operational life.
  - Production (or injection) data by well – daily data requested, monthly if daily not available.
  - Choke valve positions
  - Tubing head temp/pressure
  - Downhole temp/pressure
- Where is this data stored?
  - Probably not all the allocation system.
  - PI data historian? OFM? Multiple systems?
- May not be a small task. Time consuming data validation.

Cessation of Production

- Process depressurisation and pipeline flushing

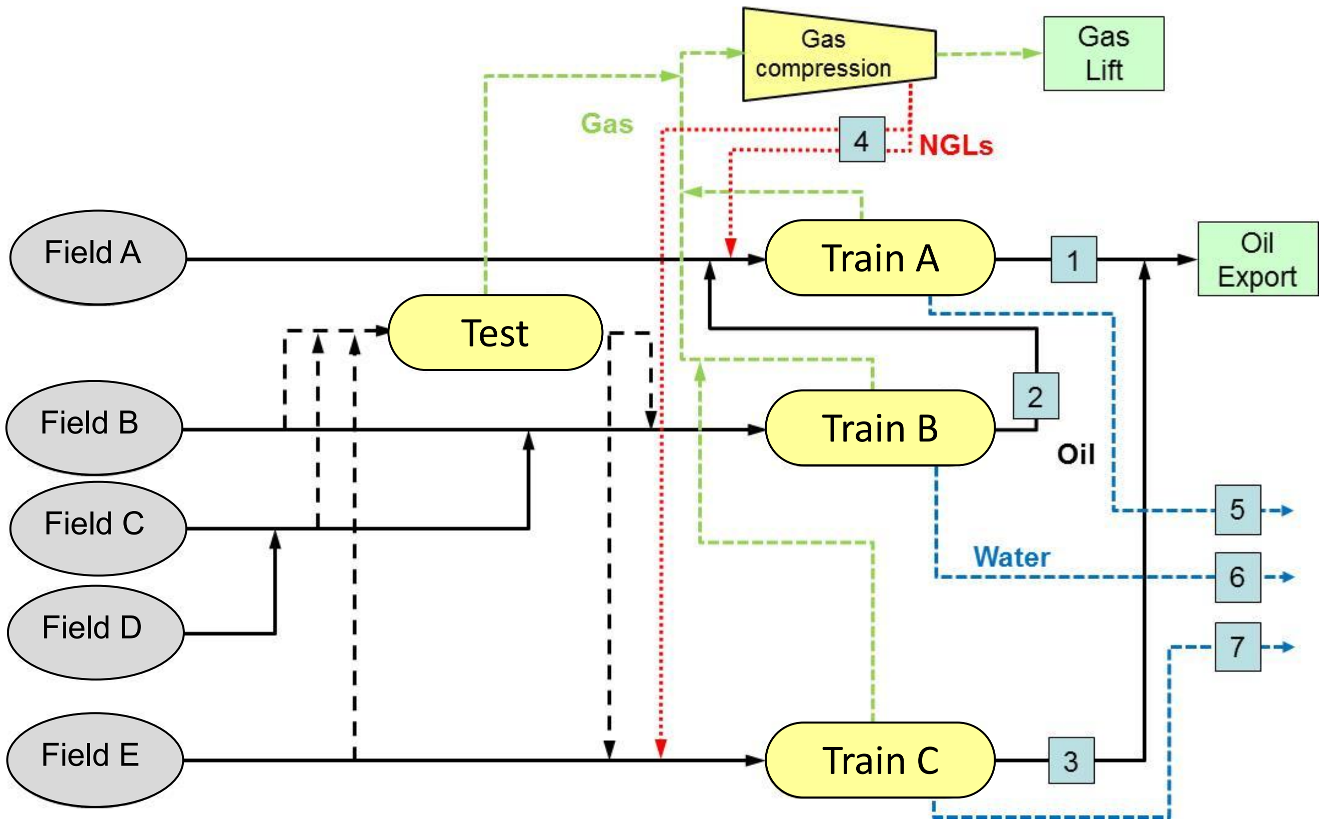
- ❑ Following CoP, the process will be depressurised and flushed, to make safe for disembarkation.
- ❑ What needs measured, allocated and reported during this phase?
- ❑ Gas inventory.
  - ○ Flared or vented?
  - ○ Measured or calculated?
  - ○ Allocated to field(s)?



Cessation of Production

- Process depressurisation and pipeline flushing

- ❑ Oil in separators, pipelines, vessels.
  - Measurement and allocation challenges
  - Oil exported to pipeline/tanker or safely disposed?
  - Flush water exported or discharged overboard?
  - Anything exported needs measured and allocated.



Cessation of Production

- Pipeline stock

- Flushing will usually displace pipeline fluids, which may be held as pipeline stock in hydrocarbon accounts.

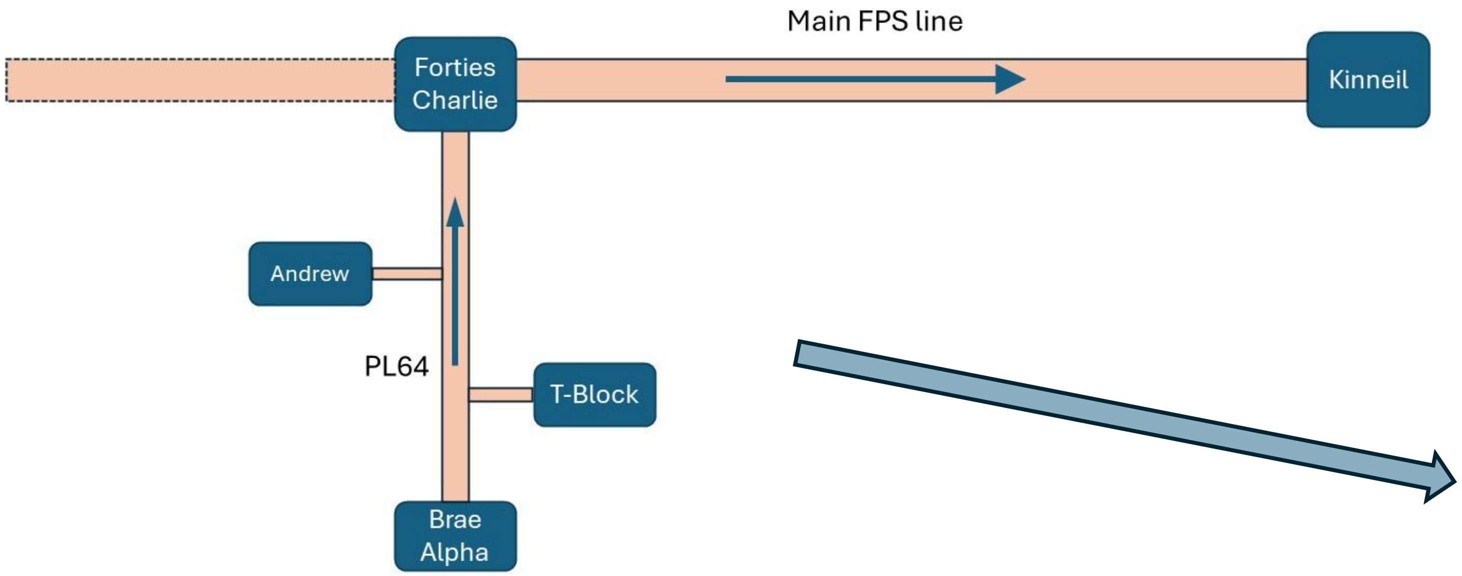
- How is this accounted for – manual adjustment or automatic?
  - Brent Pipeline System was a manual process.
  - Pipeline entrants would advise flush water volumes and Pipeline Operator would manually adjust stock to reflect this.

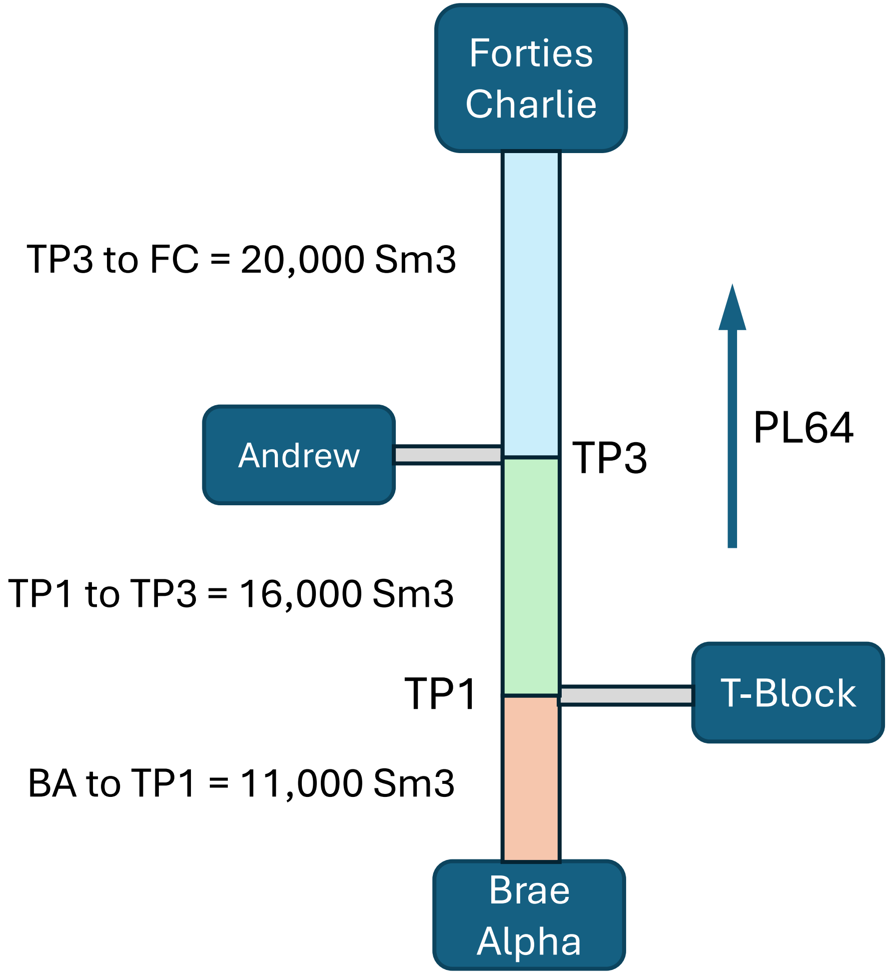
- Forties Pipeline System is automatic.
  - Pipeline stock is a dynamic calculation based on recent production.

- In either scenario – how does your production reporting deal with pipeline stock changes?
  - Potential to cause issues with production/financial forecasting and reporting.
  - OK, so production has stopped but possibly still significant value in pipeline stock.

Cessation of Production

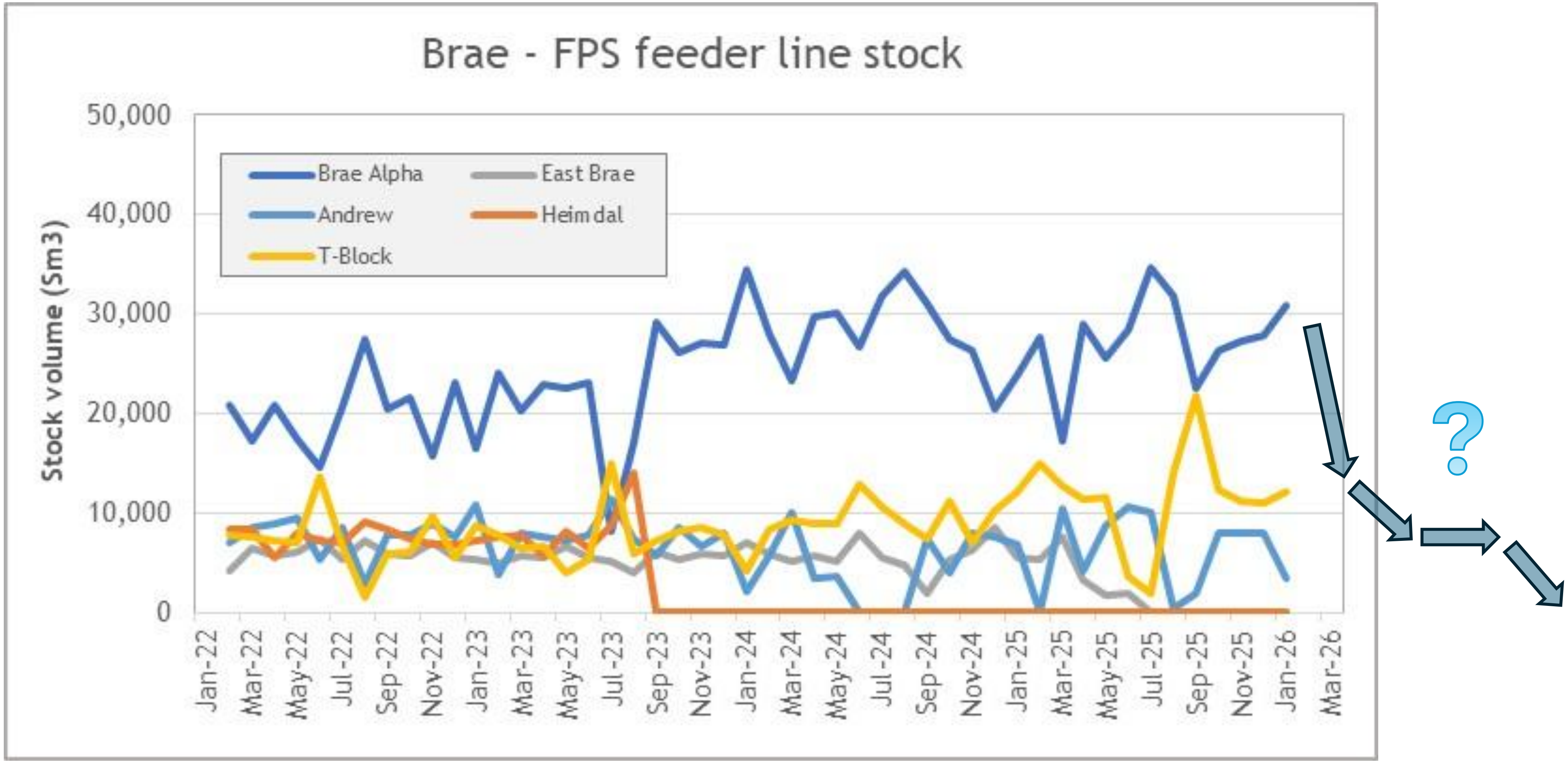
- Pipeline stock





Cessation of Production

- Pipeline stock



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Beyond allocation – Subsurface abandonment

- Background and key requirements

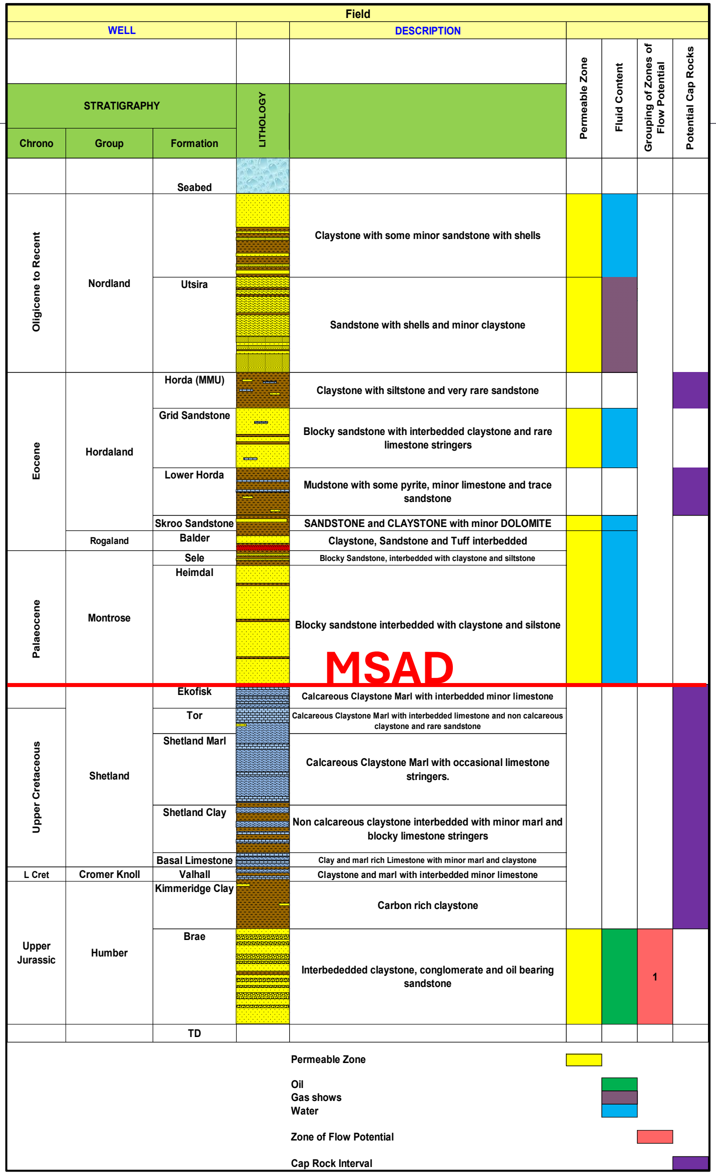
❑ Following (or in parallel to) CoP, the focus turns to well abandonment.

  - Plug and abandon (P&A) wells.
  - Make safe for the very long-term future (100,000s of years).

❑ Key areas impacted by HCA data:

  - Pore pressure predictions
    - What pressure will the wells be at when re-entered?
    - Safety and equipment pressure rating implications.
  - Calculating Minimum Safe Abandonment Depth (MSAD)
    - How far below seabed does the cement plug need to be?
    - Deeper plugs are usually more expensive and complex
    - Too shallow = higher risk of leaks.
  - Cross flow / leak modelling
    - If MSAD cannot be reached, will fluids flow through overburden and find a route to surface?
  - Disposal wells suitability

❑ Issues have been dominated by gas volume uncertainty.



Example Lithology Column

Beyond allocation – Subsurface abandonment

- HCA impact – pore pressure predictions

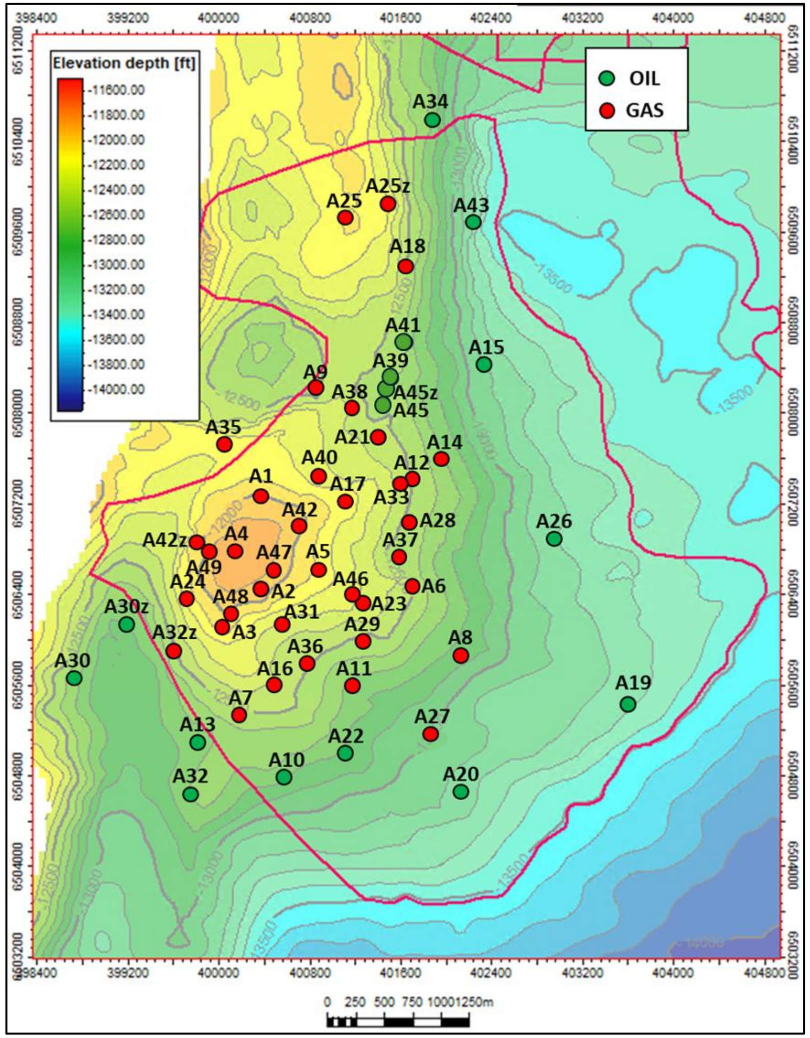
- Pore pressure predictions (re-entry pressure)
  - What pressure will the Wells Team encounter when they re-enter the well for abandonment?
  - Wells may be shut-in for some time before well entry.
  - Easy to predict pressure for wells that produced recently, not so for wells shut-in years ago.
- If no recent data for a well, hopefully we can find an "analogue" well
  - i.e. a similar well produced from the same reservoir layer/zone at the same time which has recent data.
- Does the HCA/production data include well production layer/zone information?
  - Having this data reduces the uncertainty in pressure predictions.
  - No data forces a conservative, and perhaps a more expensive, approach (higher pressure equipment).

	Well	Reservoir Zone	Block	Oil Factor	Gas Factor	Water Factor	From Date	To Date
	CN-CN-CN-33	Broom	42	0.2100	0.2100	0.2100	23/Nov/2019	
	CN-CN-CN-33	Etive	42	0.6800	0.6800	0.6800	23/Nov/2019	
	CN-CN-CN-33	Rannoch	42	0.1100	0.1100	0.1100	23/Nov/2019	
	CN-CN-CN-33	Broom	42	0.1500	0.1500	0.1500	01/Jun/2012	01/Jun/2012
	CN-CN-CN-33	Etive	42	0.2400	0.2400	0.2400	01/Jun/2012	01/Jun/2012
	CN-CN-CN-33	Lower Ness	42	0.1000	0.1000	0.1000	01/Jun/2012	01/Jun/2012
	CN-CN-CN-33	Rannoch	42	0.1500	0.1500	0.1500	01/Jun/2012	01/Jun/2012
	CN-CN-CN-33	Upper Ness	42	0.3600	0.3600	0.3600	01/Jun/2012	01/Jun/2012

Beyond allocation – Subsurface abandonment

- HCA impact – MSAD calculation

- ❑ Minimum Safe Abandonment Depth (MSAD) is the minimum depth required for an abandonment plug
- ❑ Free gas in reservoir requires deeper (more expensive) plugs than oil/water (geomechanics!).
  - o Abandonment plugs must be set at the depth of a rock strong enough to withstand long term pressure.
  - o This can differ significantly for each well in a reservoir were both oil and gas are present.
  - o Often more difficult and expensive for well engineers to set the deeper plugs.
- ❑ Poor historical allocation of produced (and injected) gas volumes?
  - o Produced gas allocation from oil fields is often lower quality than oil allocation, especially at well allocation level.
  - o Uncertainty in total volume of gas produced increases the uncertainty of the volume of gas remaining in the reservoir.



Example gas or oil long term fluid gradient

Beyond allocation – Subsurface abandonment

- HCA impact – Cross flow / leak path modelling

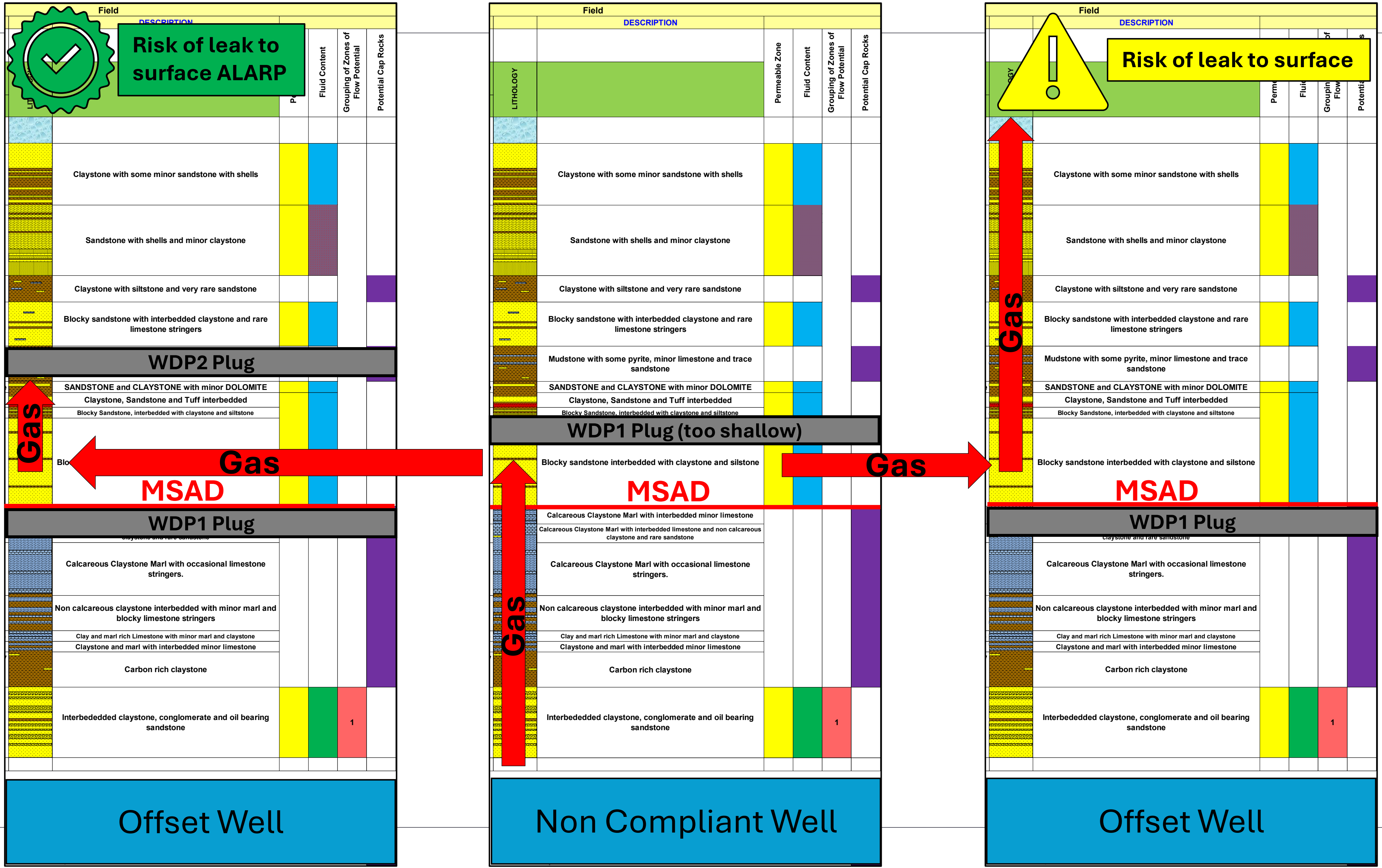
- In some cases, it may not be possible to reach Minimum Safe Abandonment Depth (MSAD) for plugging (poor well condition).

- This could lead to crossflow from reservoir to permeable overburden.
  - Hydrocarbons have the potential to flow through into permeable overburden layers through wells where the plugs are too shallow
  - Can reach other well bores above main WDP1 plugs, thus providing a potential route to surface.
  - May require additional WDP2 plugs on offset wells (can be expensive).
  - Crossflow modelling informs which wells have the highest risk of crossflow.

- Gas is significantly more mobile than oil.
  - Uncertainty in the gas cap volume can lead to overly conservative assumptions in cross flow modelling (i.e. large free gas volumes) and requirement for WDP2 plugs in potentially more wells than required.
  - Back to HCA data – historical produced and injected gas allocation.

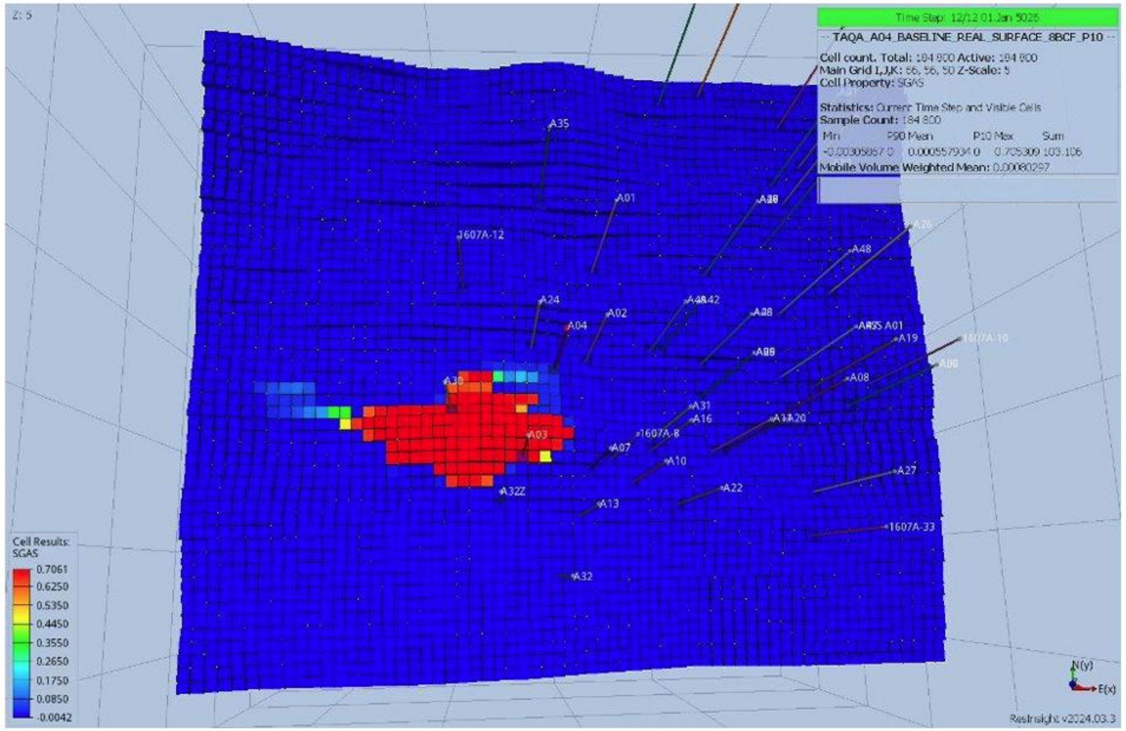
Beyond allocation – Subsurface abandonment

- HCA impact – Cross flow / leak path modelling

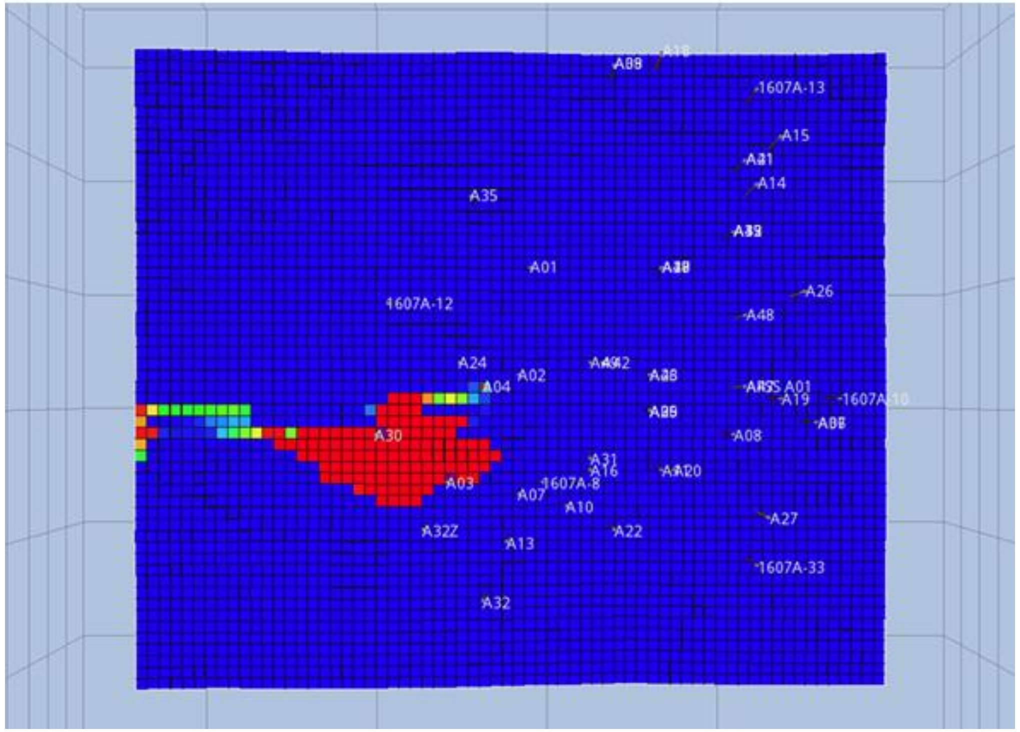


Beyond allocation – Subsurface abandonment

- HCA impact – Cross flow / leak path modelling



Smaller gas volume - no flow of gas to West



Larger gas volume - flow to the West and larger area of permeable overburden affected

Beyond allocation – Subsurface abandonment

- HCA impact – Gas in reservoir

- ❑ In cases of sudden gas break through, a well may have been shut in at short notice.
- ❑ Typically, given the timescales of these events, there would be no well test taken showing this gas production.
  - As well allocation is typically pro-rata on basis of well tests…no record of gas production at that well.
- ❑ Later, at abandonment phase, when trying to work out what volume of gas remains in the reservoir it won't have been recorded in HCA / production system (and OFM), as not relevant to production.
- ❑ Recommended to create a "dummy" well test at least, in order to highlight the late gas breakthrough.

Beyond allocation – Subsurface abandonment

- Water injection and scaling

- Disposal wells are used to store byproduct fluids (waste water, drilling fluids, etc.).
  - Lower cost than returning and disposing topside.
  - Requires suitable wells to inject these fluids into.
- Past water injection can affect this:
  - Reservoir or sea water for injection?
  - Affects scaling potential in wells.
- Is this data recorded, volumes and samples?
  - The same rigour as applied to production volumes is not always applied to disposal fluids.

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Even longer term requirements

- Key Issues

- ❑ System / application retention
  - o How long do you need to keep systems available?
- ❑ Data retention
  - o How long do you need to keep data?
- ❑ What are the drivers for these requirements?

Even longer term requirements

- Retention drivers

- Legal/Regulatory
  - Government requirements.
    - 5 years for measurement or allocation data?
  - UK Emissions Trading Scheme.
    - 10 years since last annual submission. Covers reported data and data required to recalculate if necessary.
- Commercial
  - Pipeline, transportation, processing or cost-sharing agreements?
- Corporate policy
  - Appetite for risk?
  - Is it more or less risky to have data than not have it?

System/data retention

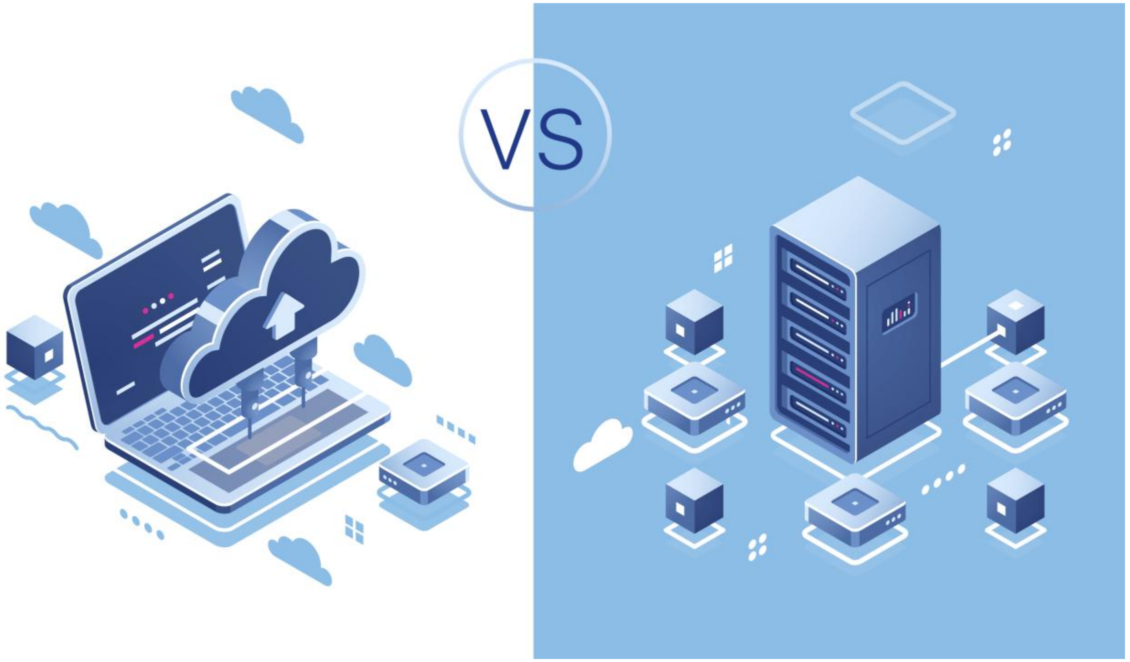
- Keep systems with data

❑ What type of system?

- In-house custom build.
- 3rd party vendor, local hosting.
- 3rd party vendor, cloud-based (i.e. EnergySys).

❑ Factors

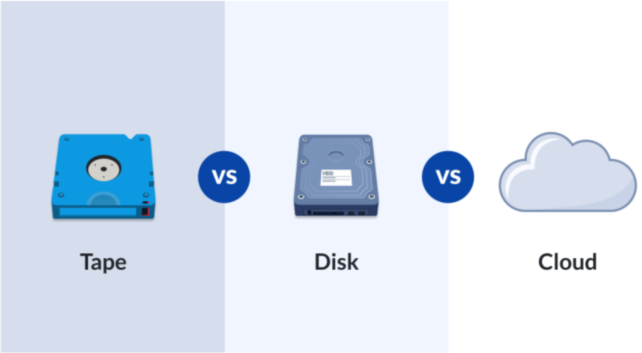
- Cost of storage or hosting.
- Data security.
- Longevity (of system, vendor, servers, etc.)
- Back-up / disaster recovery.



System/data retention

- Decommission systems but export and retain data?

- ❑ Why?
  - o Remove license costs.
  - o Consider there is no need to re-run any calculation or reporting processes.
- ❑ How?
  - o Data export format? Vendor may have a default method.
  - o Longevity of data?
    - Excel. 10 yrs OK, what about 25 or 50 years (more a Subsurface issue)?
    - PDF. Our IT dept suggest this has a longer life span, but only useful for viewing data.
  - o Physical format? (Hard drive, DVDs, tape/film?)



System/data retention

- Accessing and using data

- ❑ What happens if there is a need to access/review data?
- ❑ Who's going to do it?
  - o Anyone left in the Operator company?
  - o Service company contract in place?
    - Familiarity / training required?
- ❑ How will the data be accessed?
  - o Reinstate original system?
  - o License original system (cloud based)?
  - o Manual (Excel again!) calcs?

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Awareness and planning ahead

- Who, how and when

- ❑ Lots of longer-term issues to consider
- ❑ Who should be planning for this and how?
  - o Multi-disciplinary problem.
  - o HCA, Subsurface, IT, Legal & Commercial
- ❑ When?
  - o Yesterday would be best!
  - o Today is the next best option.
  - o Recommend not leaving it until the end...
- ❑ Time and money spent now will pay off in the long term.

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System issue and changes required

- Who, how and when

- ❑ Evaluate if current systems will provide the data and information required.
- ❑ Again, multi-disciplinary problem.
  - HCA, Subsurface, IT, Legal & Commercial
- ❑ When?
  - As before, yesterday would be best. May be too late for many Operators/fields, especially UK.
  - Norway still developing new fields and tie-backs, so opportunities to plan ahead.

THANK YOU