



Source to Sink Lessons

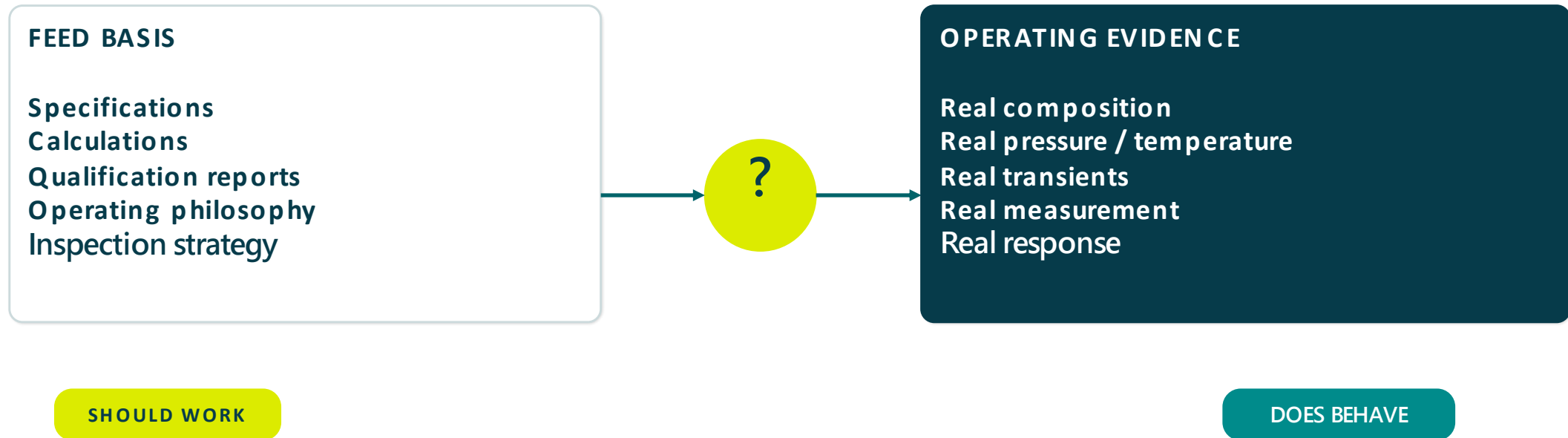
Managing CO₂ integrity risks
before first injection

Ivan Gutierrez · OGC Energy

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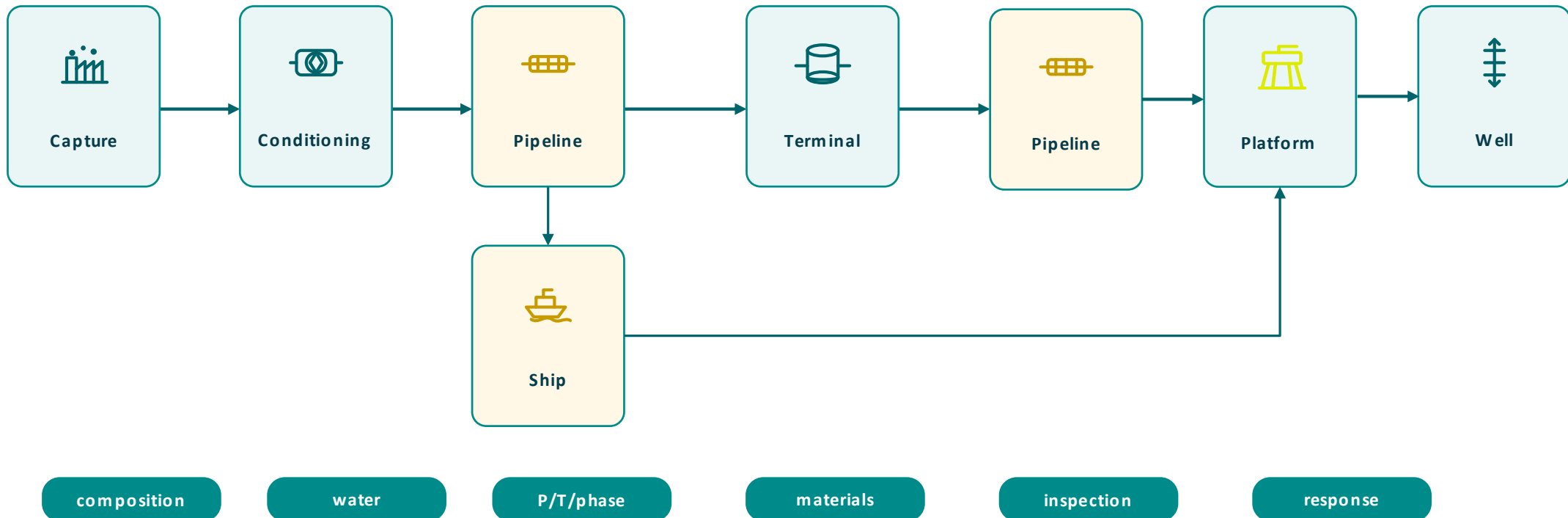


FEED proves the design should work. First injection starts proving behaviour.



The test before first injection is not whether each report exists.
It is whether the assumptions, limits, measurements and responses agree.

One integrity basis must survive every interface



Each variable is carried through the chain. If one changes, the downstream integrity basis may change.

A small composition change can affect the stability of the whole mixture

Canadian crude pipeline case

A Canadian pipeline proceeding considered whether butane blending could affect crude-oil stability and lead to asphaltene precipitation.

The mechanism was technically plausible, but whether it occurred in this particular pipeline was disputed.

All impurities within specification

1

Butane blending changed the fluid composition

The technical question was whether additional butane could shift the crude's solvency balance sufficiently to destabilise asphaltenes.

2

Asphaltene precipitation was the concern

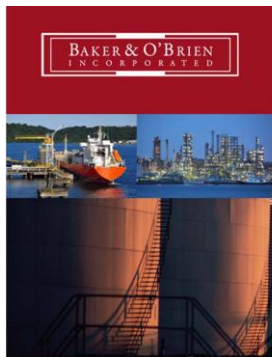
For susceptible crude compositions, the change in solvency can cause asphaltene precipitation, deposition and potential fouling.

3

Applicability to Westspur was disputed

The operator's expert argued that the transported crudes were not sufficiently asphaltic and reported that asphaltene precipitation had not been experienced in the pipeline.

CCS lesson: Composition limits cannot always be assessed independently. Interactions between impurities can change phase stability and generate secondary liquid or solid phases.



Request:

(a) Can Mr. Falkner please confirm that every crude oil has butane in it and yet not every crude has propensity to drop asphaltenes as asphaltene precipitation is a very complex process that can be influenced by many factors including but not limited to, types of crudes being mixed, volumetric ratios of these crude types, aromatic contents, paraffinic content etc?

(b) Can Mr. Falkner please specify a level of butane in various crude grades emanating from Canadian Western Sedimentary Basin where asphaltene precipitation may be of higher risk?

(c) Can Mr. Falkner provide details of the 'chronic apportionment' on the Enbridge pipelines transporting light crude types such as those being injected by Westspur?

RESPONSE:

(a)-(b) Confirmed. Prior to the addition of NGLs/LPGs being deliberately blended or "spiked" into crude (direct injection), every crude oil contains butane, as it is naturally occurring and an expected component in the crude conditioning or stabilization process. Every crude will eventually precipitate asphaltenes if excessive blending of butane or other paraffinic materials or solvents are blended into the crude. However, asphaltene precipitation is just one of many issues that occur when excessive butane is blended into crude. Please refer to Question 6, page 7 of Mr. Falkner's expert evidence.

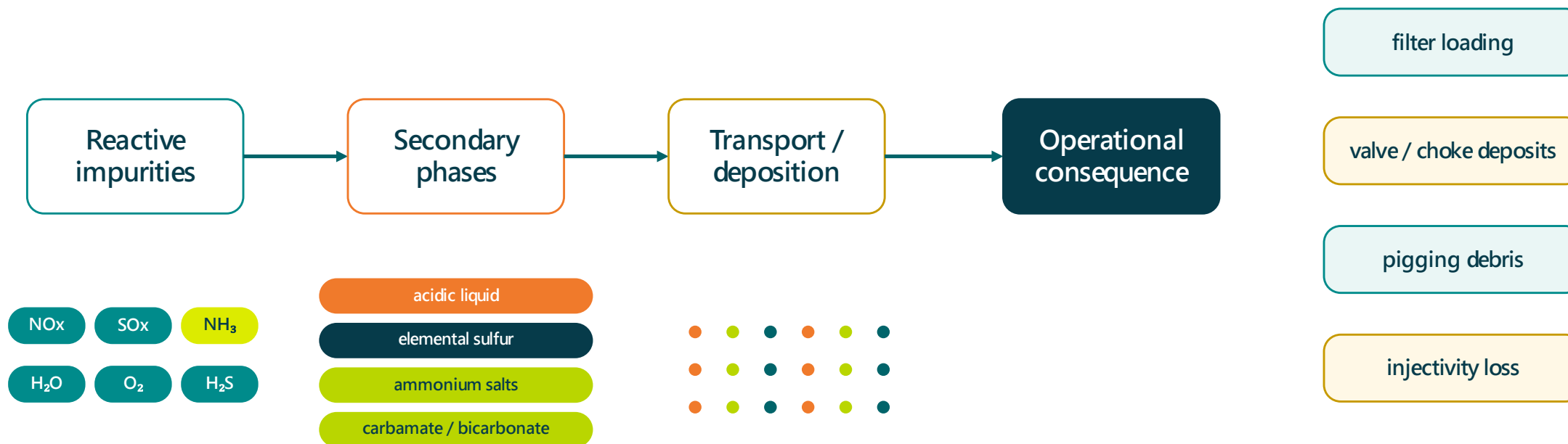
Prepared by:
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National Energy Board
Hearing Order RHW-002-017

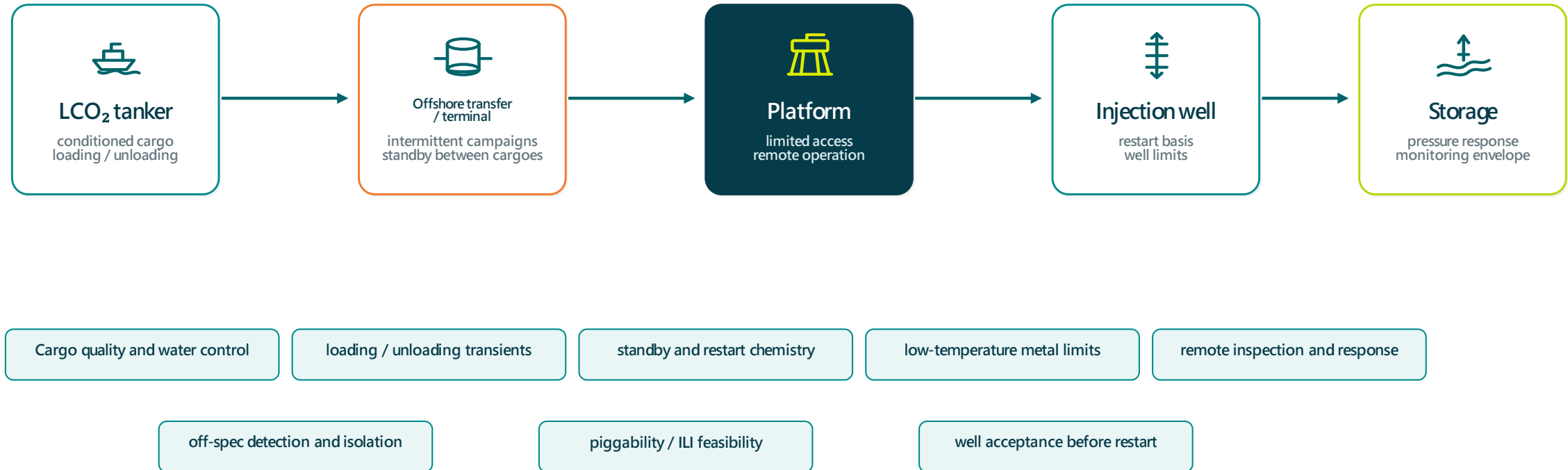
TEML WESTSPUR PIPELINES LIMITED
COMPLAINT BY CRESCENT POINT
RESOURCES PARTNERSHIP

"Acid dropout" may be the wrong first question



Question for operation: where do secondary phases form, move, settle and accumulate?

LCO₂ ship-to-injection changes the governing cases



At concept / pre-FEED, the operating pattern is already creating the integrity cases that must close before first injection.

Repurposing is an evidence problem, not a shortcut

1	Asset records	material, seam, welds, original design basis
2	Condition evidence	corrosion history, defects, anomaly growth
3	Fracture evidence	toughness, decompression, crack arrest
4	Inspectability	MFL / EMAT capability, detection and sizing
5	Operating response	limits, intervals, repair and restart basis

ILI capability is not the same as CCS evidence

- What threat is being inspected?
- Can the tool detect and size it?
- Can it repeat and trend growth?
- What action follows a finding?

MFL / EMAT: technology exists.
The strategy still has to fit the threat.

For repurposing, the decision is only as strong as the weakest evidence link.

Shipping is not pipeline CO₂ on a boat

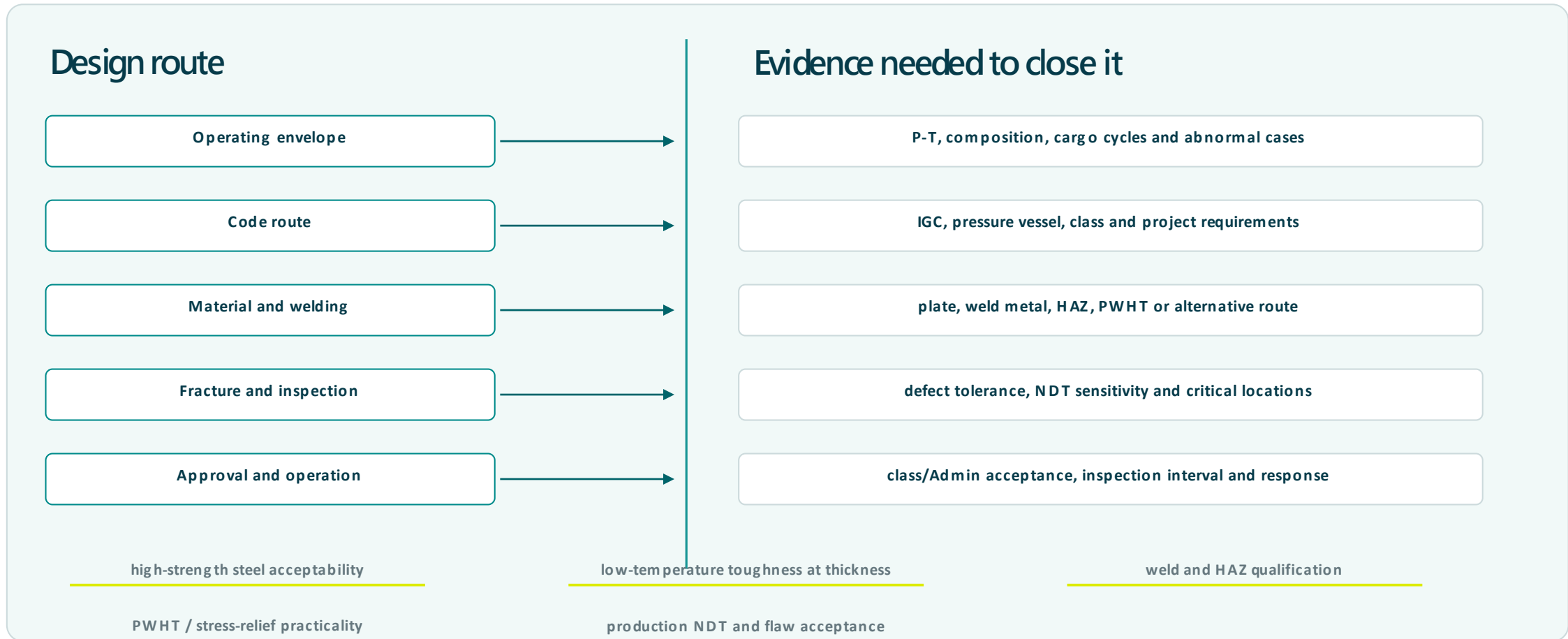
The existing frameworks

- IGC Code / gas carrier safety
- cargo containment and ship type
- pressure-vessel rules
- class and Administration acceptance
- instrumentation and operations

Where CCS makes it hard

- low-temperature envelope
- impurity / water behaviour at ship P-T
- weld and HAZ toughness
- PWHT, NDT and defect tolerance
- loading / unloading fatigue duty

A technically attractive route still has to be approvable



The route closes only when material, weld, inspection and approval assumptions agree.

What operating actions are actually implemented?

Trigger	Immediate action	Integrity check	Restart basis
Off-spec water	stop / divert receipt	isolate affected section	dry or flush before restart
Reactive impurities	confirm sample method	filter / trap solids	clean and reassess ΔP trend
Low-temperature event	control depressurisation path	hold above metal limit	inspect if limit exceeded
Water ingress after opening	nitrogen preserve	verify dew point	restart only to defined criterion
ILI finding	fitness-for-service screen	repair / derate if required	update inspection interval
Well shut-in / flowback	apply shut-in chemistry case	monitor corrosion / pressure	restart with well limits confirmed

If a limit has no owner, no detection method and no action, it is not yet an operating control.

First injection is the beginning of evidence.

Gaps still to close

- **CO₂ specification** - excursions & deviations; solids / deposits; acid drop-out and reactive phases
- **Pipeline integrity** - ductile running fracture; repurposing evidence; inspection / ILI feasibility
- **Liquid CO₂ shipping** - material compliance; welding / HAZ toughness; IGC + class requirements; cyclic duty
- **Well & storage** - formation-water flowback; thermal transients; salt / hydrate risk; injectivity and pressure
- **Operations** - detection, isolation, cleaning / drying, restart criteria and responsibility

Not the end of assurance.

FEED proves the design should work.

First injection starts proving whether the complete system behaves as assumed.

Turn every gap into a limit, a measurement and an action.

Thank you