

The Pathway to Licensing: Selecting and Scaling Safety Analysis in Advanced Reactor Development

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Licensing strategy is a scaling problem.

The right safety case depends on what you are building, why you are building it, and who is authorizing it.

1

Dominant drivers:
facility type,
mission, regulatory
authority

2

Mistake to avoid:
one document trying to
satisfy all pathways

3

Things to preserve:
technical knowledge +
regulator feedback

WHY THIS MATTERS? Advanced reactor licensing is rarely linear

- Rapid deployment pressure pulls teams toward early criticality.
- Design, fuel, site, and mission can all change while analysis is underway.
- The same reactor technology may support a test, prototype, demonstration, or commercial plant.
- The safety case must stay aligned with the decision being made now.

Main point

Do not scale analysis to an assumed future end state. Scale it to the facility mission and authorization decision in front of you.

Each pathway starts from a different question

DOE authorization

Starts by asking:

What work is being performed, what hazards exist, and what controls are needed?

Analysis emphasis:

Hazard analysis, accident analysis, controls, readiness

NRC commercial

Starts by asking:

What licensing basis supports lifecycle operation of a power plant?

Analysis emphasis:

Design criteria, event classes, SSC classification, risk-informed basis

NRC research / test

Starts by asking:

Is the mission experimental or non-power, and what safety basis supports it?

Analysis emphasis:

Non-power reactor application and emergency planning guidance

High-level philosophies are compatible. Document structures are not interchangeable.

Here is how that played out for Aalo.

AALO CASE STUDY

The program moved from broad commercial framing to a narrower first mission

Parallel NRC engagement remained useful for familiarization and future planning - but the actual near-term authorization basis needed to be **singular and explicit**.

Commercial pod concept

multi-unit long-term vision



Hybrid package friction

more analysis, less decision clarity



DOE demo as bridge

near-term deployment while preserving NRC continuity

Low-power test mission

clearer DOE safety-basis alignment

LESSON 1 Analytical volume is not the same as decision clarity

What happened

- DOE submittal framed with future NRC concepts
- More deterministic, hazard, and PRA-like material than needed
- Still not organized as a future NRC application
- Cost: rework, schedule expansion, documentation churn

————→
translate,
do not
merge

Better framing

- Keep one explicit near-term authorization basis
- Reuse technical knowledge across pathways
- Translate the licensing narrative only when the decision changes
- Separate near-term demonstration from commercial licensing

Preserve the science and engineering; tailor the safety-case narrative to the mission and regulator.

LESSON 2 Mission definition controls analysis depth

Fit-for-purpose analysis is not minimalism. It is discipline.

Commercial plant

More interaction, more operating states, more need for PRA

Lifecycle licensing basis + PRA-informed event selection + SSC classification

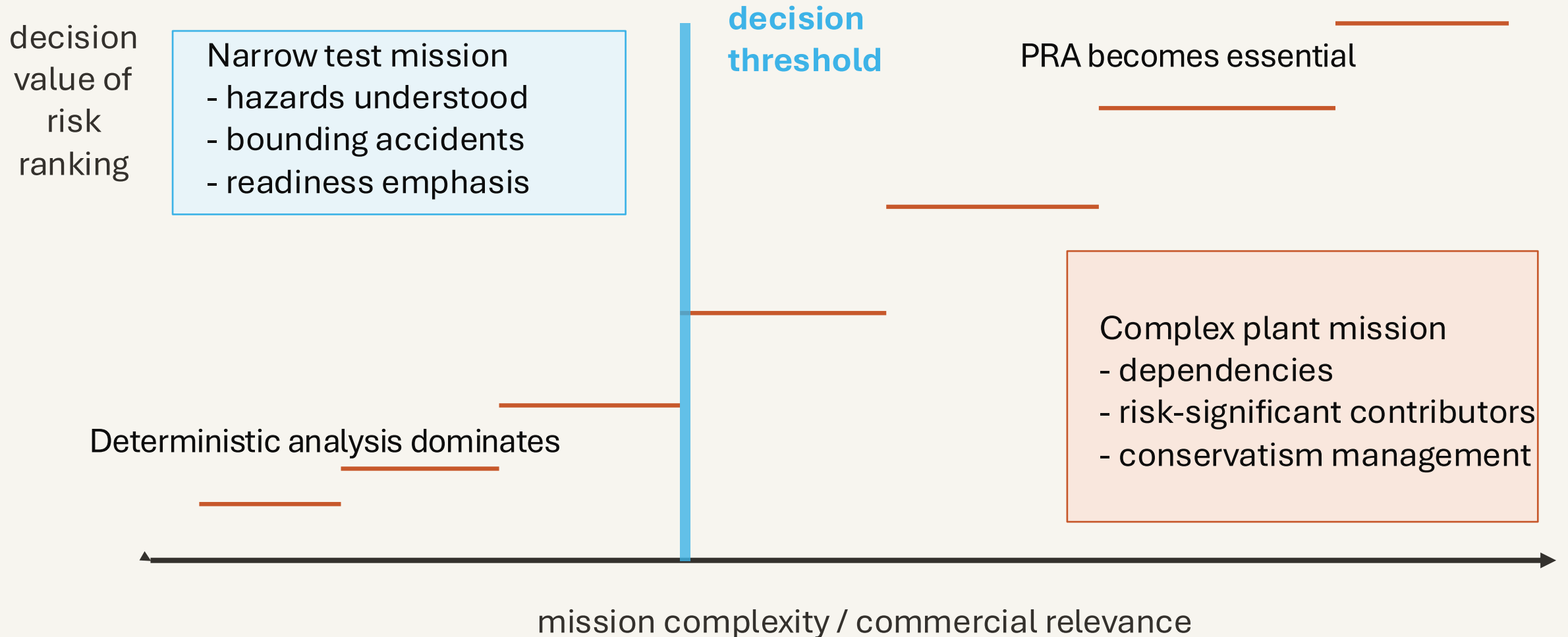
Integrated prototype

Broader accident set + control strategy + targeted reliability inputs

Low-power test

Hazard analysis + bounding deterministic accidents + readiness

LESSON 2 — ROLE OF PRA PRA should enter when it changes decisions

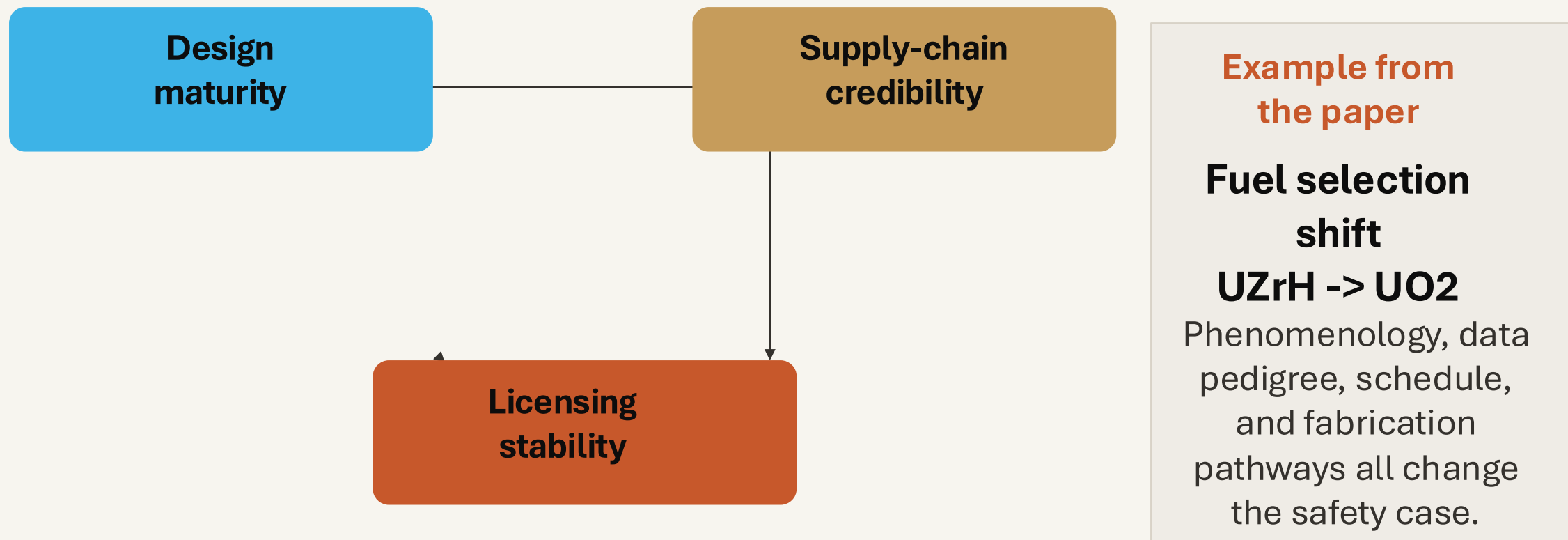


LESSON 3 Frequent feedback right-sizes the safety case



Staged documents are not redundant drafts - each stage should answer a different question.

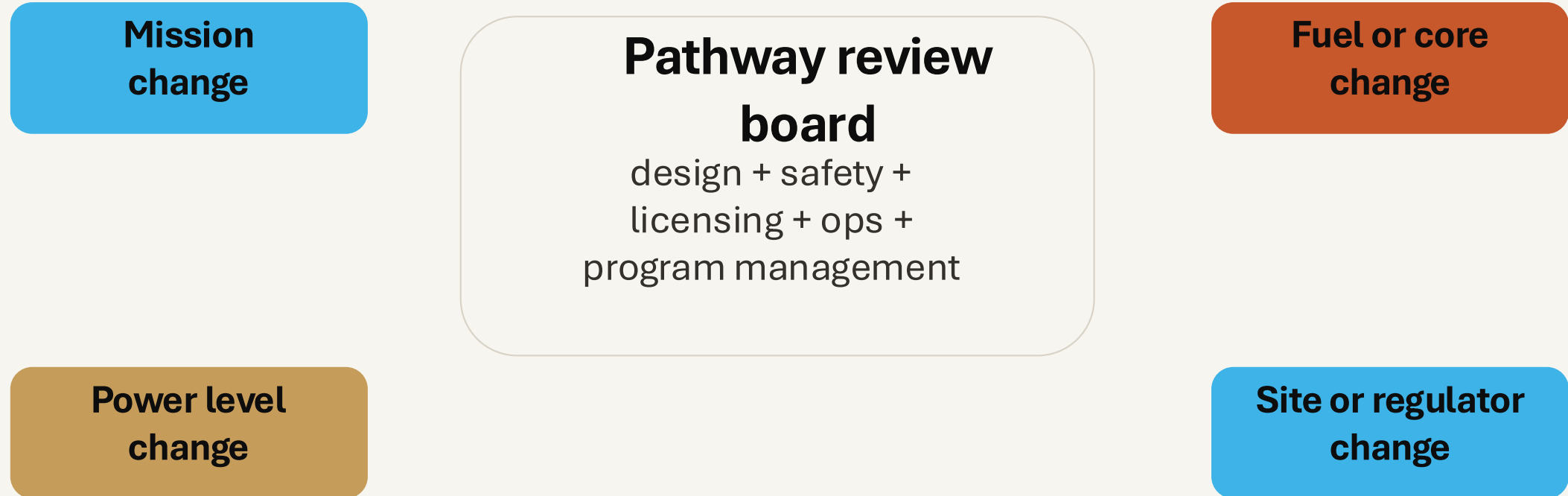
LESSON 4 Licensing strategy must reflect what can actually be built



A technically attractive design basis can become unstable if it is not achievable on the project timeline.

RECOMMENDATIONS

Govern licensing strategy at decision points



At each gate: Is the hazard basis, accident set, regulator interface, and use of PRA still appropriately scaled?

Five takeaways

- Scale analysis to facility mission, not an assumed future end state.
- Keep the near-term authorization basis singular and explicit.
- Reuse technical inputs, but translate the licensing narrative.
- Use PRA where it improves decision quality and manages conservatism.
- Revisit strategy when mission, fuel, power level, site, or regulator changes.

Questions?

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