

Why Commissioning Must Be Recognised in Safety Planning

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Abstract

Commissioning—the process of testing, calibrating, and verifying engineered systems before operational handover—represents a critical yet underexamined phase in safety planning. This paper argues that commissioning constitutes a distinct safety environment characterised by five intersecting features: system uncertainty, acute time pressure, professional identity negotiation, informal learning mechanisms, and organisational boundary complexity. These characteristics reshape risk in ways that conventional safety frameworks fail to address. Current safety planning models devote extensive attention to design, construction, and operations, while commissioning remains structurally marginalised in both academic research and organisational practice. This gap has consequences: engineers work in high-hazard conditions without adequate learning structures or psychological safety provisions. This paper proposes three foundational interventions: explicit recognition of commissioning as a standalone safety environment, implementation of structured learning mechanisms, and establishment of psychologically safe communication practices. Integrating commissioning into safety planning frameworks is both overdue and essential.

Keywords: Commissioning; safety planning; informal learning; psychological safety; engineering practice; socio-technical system

Highlights

- Commissioning is absent from most safety planning frameworks despite high risk
- Five features distinguish commissioning: uncertainty, time, identity, learning, and boundaries
- Informal learning during commissioning can propagate unsafe norms
- Psychological safety is a prerequisite for safe commissioning work
- Dedicated safety structures are needed for the commissioning phase

Commissioning is one of the most safety-critical phases of engineering work yet paradoxically remains structurally absent from most safety planning frameworks, academic research, and organisational learning models. While design, construction, and operations attract extensive safety protocols, commissioning—the regime of checks, calibrations, energisations, and verifications that move systems from theoretical performance to live operation—exists in a conceptual blind spot. This omission impairs safety management, constrains learning, and leaves a high-risk environment without the reflective infrastructure it demands. Modern safety science emphasises understanding work-as-done rather than work-as-imagined (Dekker, 2019; Hollnagel, 2014), yet commissioning remains structurally absent from this discourse.

This short paper argues that commissioning should be explicitly recognised as a distinct domain of safety planning. Commissioning is not a routine extension of construction. It is a fundamentally different form of work characterised by uncertainty, latent faults, system interactions, time pressure, identity strain, and accelerated informal learning. These features reshape risk in ways that standard safety frameworks fail to capture.

First, commissioning work involves unique uncertainty. Systems behave unpredictably as they are energised, tested, or integrated. Unexpected alarms, instrumentation drift, incompatible interfaces, or cascading failures require rapid interpretation and improvisation. These emergent behaviours reflect the complex interactions characteristic of tightly coupled socio-technical systems (Leveson, 2011). Safety planning that assumes stability or predictable task sequences is misaligned with this reality. Commissioning requires dynamic risk assessment, adaptive expertise, and flexible decision-making capacities that are not easily codified in prescriptive safety procedures.

Second, commissioning compresses time. Project deadlines, contractual obligations, stakeholder scrutiny, and commercial penalties converge, intensifying pressure on engineers. Research demonstrates that time pressure systematically degrades safety performance by increasing error rates, reducing hazard awareness, and diminishing speaking-up behaviours (Beus et al., 2016). Commissioning amplifies these behaviors: teams "push through" issues to maintain timelines, often at the cost of reflective learning and risk awareness.

Third, commissioning is a high-identity environment. Engineers, especially early-career engineers or those from underrepresented groups, must rapidly negotiate credibility to gain access to tasks or influence decisions. Research on professional identity formation shows this involves active negotiation of competence and standing within engineering work communities (Tonso, 2014; Trevelyan, 2019). This credibility negotiation affects safety by determining who speaks up, who is heard, and whose interpretations shape team actions. A commissioning environment that privileges confidence over accuracy, or dominance over expertise, fosters silence and risky deference.

Fourth, commissioning relies heavily on informal learning. Knowledge transfer occurs through observation, storytelling, trial-and-error, and shadowing—forms of situated

learning within communities of practice (Johri & Olds, 2011; Tynjälä, 2013)—not formal training. This creates variability in how engineers understand hazards, interpret system behaviour, and internalise safe practices. When informal learning becomes the primary safety mechanism, it also becomes a vulnerability: if senior engineers normalise risk, overwork, or speed-driven behaviours, these norms propagate. Figure 1 illustrates how these five characteristics intersect to define commissioning as a distinct safety environment.

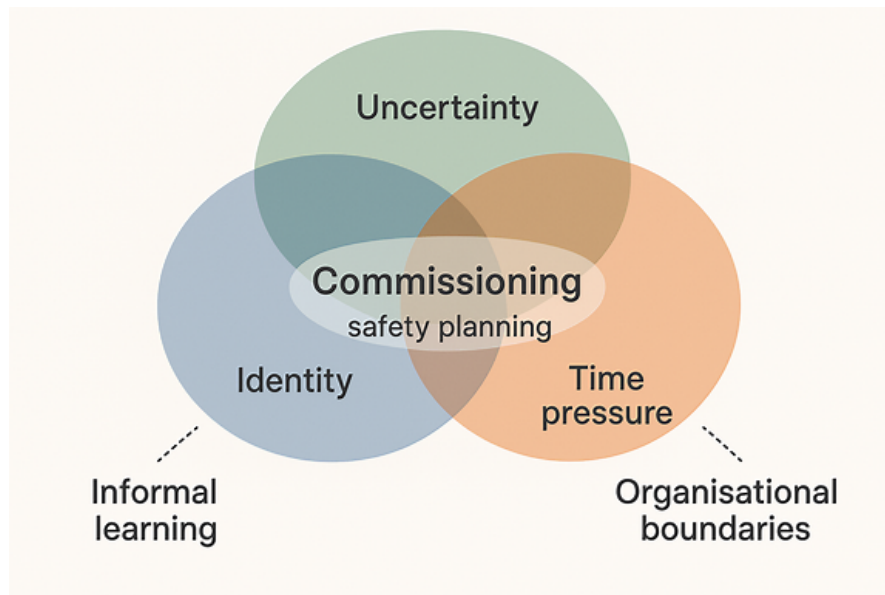


Figure 1. The commissioning safety environment emerges at the intersection of five characteristics: uncertainty in system behaviour, acute time pressure, professional identity negotiation, informal learning mechanisms, and organisational boundary complexity. These features interact to create distinctive safety challenges requiring dedicated planning approaches.

Finally, commissioning sits at the intersection of multiple organisational boundaries—design, construction, operations, vendors—which complicates accountability and communication. Safety roles are often unclear. Teams navigate conflicting priorities and inconsistent expectations, increasing the likelihood that hazards fall between organisational cracks.

Given these realities, commissioning cannot be treated as an afterthought in safety planning. It requires a formalised learning-safety model that integrates technical, behavioural, and organisational dimensions. This short paper proposes three foundational steps.

First, commissioning must be recognised as a standalone safety environment requiring dedicated learning structures. Organisations should include commissioning explicitly in safety management systems, risk registers, onboarding processes, and competency

frameworks. This reframing acknowledges that commissioning work is not a temporary deviation from normal operations but a distinct risk regime.

Second, commissioning teams need structured learning mechanisms. These include pre-commissioning briefings that embed learning in authentic work contexts (Johri & Olds, 2011), "safe mistake" opportunities for early-career engineers, reflective debriefs after energisations, and transparent sharing of decision rationales. Leaders should make tacit knowledge visible rather than gatekept.

Third, credibility-safe communication practices must be embedded. Junior engineers and under-represented groups require assurance that raising concerns, asking questions, or challenging interpretations will not harm their standing. Psychological safety—the shared belief that speaking up is welcomed and valued (Frazier et al., 2017)—is not optional in commissioning; it is a prerequisite for safe system activation.

Practical Applications

The framework presented has immediate applications for engineering organisations. Safety management systems should incorporate commissioning-specific risk assessment protocols. Onboarding programs should prepare engineers for the distinct challenges of commissioning. Project planning should allocate time for pre-commissioning briefings and post-energisation debriefs. Human resources policies should protect junior engineers who raise safety concerns during high-pressure commissioning periods. Competency frameworks should recognise commissioning expertise as distinct from construction or operational competencies.

Commissioning is where systems reveal their truth. It is where design assumptions meet operational reality, where hidden failures emerge (Leveson, 2011), and where learning accelerates or collapses. Treating commissioning as merely a technical milestone obscures the socio-technical complexity that makes it one of the most dangerous and learning-intensive environments in engineering.

Safety planning that fails to recognise commissioning's unique learning demands leaves engineers—and systems—exposed. Integrating commissioning explicitly into organisational safety frameworks is both overdue and essential.

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