ATS AS4825 Working Group

POSITION PAPER 1

ACHIEVING, DEMONSTRATING AND ACCEPTING APPROPRIATE FIRE SAFETY IN AUSTRALIAN TUNNELS

5TH AUGUST 2025

DRAFTING HISTORY			
No.	**Date**	**Comment**	**Signed**
1	17 April 2025	Committee review version	
2	28 May 2025	Proposed issue for general comment from WG and elsewhere	
3	5 August 2025	Simplified. Ready to issue for discussion	

EXECUTIVE SUMMARY – POSITION PAPER 1

Achieving, Demonstrating & Accepting Appropriate Fire Safety in Australian Tunnels

The Australian Tunnelling Society (ATS) Working Group is revising **AS 4825 – Tunnel Fire Safety**. Because the way we decide what is *"safe enough"* underpins every clause of the new standard, the Group has produced this stand-alone position paper. It concentrates solely on the framework for establishing the sufficiency of safety measures and for accepting the residual risk. Engineering specifics (e.g. ventilation type or lane width) are outside its scope.

The paper distils a four-hour public workshop held on 11th October 2024 that was attended by designers, operators, proponents, fire-service and government officers, advisers and recognised international experts, plus subsequent written input. The resulting consensus is summarised below.

Key positions

1. **SFAIRP is mandatory**

   Australian work-health-and-safety and rail-safety legislation require that risk be reduced *so far as is reasonably practicable* (SFAIRP). Any tunnel-fire-safety approach must start and finish with that test.

2. **The Acceptor of Risk is the project proponent**

   Responsibility for accepting residual risk, and for balancing cost, benefit and community expectation, always rests with the relevant State agency or government-owned corporation. Designers, contractors, operators and emergency services make recommendations; they do not adjudicate.

3. **Deterministic modelling is a planning aid, not a decision rule**

   Scenario-based calculations help emergency services and operators plan responses, but the wide range of plausible inputs could "prove" a tunnel either perfectly safe or unacceptably dangerous. Deterministic analysis therefore cannot be the primary yardstick for societal risk acceptance under SFAIRP.

4. **Emergency service input is essential but not prescriptive**

   Fire agencies have statutory duties to eliminate harm, yet no responsibility for project cost. They inform cost-benefit discussions; they cannot determine the final balance. Government accepts the residual risk if a requested measure is not adopted.

5. **Where consensus exists, the new AS 4825 should be prescriptive**

   Agreed requirements, including elements of risk demonstration and acceptance, should be stated outright to save projects time and money. The Working Group will

prescribe only where any reasonable reading shows that the clause already meets the SFAIRP assessment.

6. **Australia is not yet ready to delegate acceptance to QRA**

   Quantitative risk analysis, widely used overseas, depends on agreed criteria or a reference tunnel. Australia presently has neither; until it does, QRA can inform design but cannot, by itself, legitimise it.

These principles will guide the drafting of the revised **AS 4825**, ensuring that tunnel-fire-safety decisions in Australia are legally robust, technically sound and publicly defensible.

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1 INTRODUCTION

The Australian Tunnelling Society (ATS) has convened a Working Group (WG) to produce a full revision of **AS 4825 — Tunnel Fire Safety**. Recognising that the way Australia decides, demonstrates and accepts "safe enough" is the linchpin of every technical clause, the WG held a four-hour public workshop on **11 October 2024** and, as a first output, prioritised this topic-specific position paper. The paper distils that workshop and subsequent industry correspondence; it does **not** address engineering particulars (e.g. ventilation schemes or lane widths). Its sole purpose is to set a nationally consistent decision framework.

Once public review comments are resolved and WG consensus is clear, the paper will be recommended to the ATS Executive for adoption as a formal ATS position. That endorsement will then guide the drafting of the corresponding sections in the new AS 4825.

Why a fresh approach is needed

AS 4825:2011 was conceived as a **guideline** to support 'performance-based' design and drew heavily on building fire engineering practice. That orientation limited its usefulness for complex tunnel infrastructure. The revision will be tailored to public infrastructure projects, acknowledging the organisational, contractual and staging complexities of such projects, as well as the role of the State, and seeking to be more a standard than a guideline.

An open, consensus-building process

The WG deliberately replaced closed committee deliberations with public workshops. This open forum allows practitioners, operators, emergency services, government officers and international experts to challenge one another's views in real time and to forge an industry consensus that is both transparent and durable, even if the process takes longer than a traditional standards committee.

Getting the decision-maker right

Risk tolerability differs across stakeholders:

- **State (Project Proponent)** – ultimately responsible for balancing community benefit, cost and residual risk.
- **Emergency Services** – statutorily obliged to minimise harm but have **no cost responsibility**; their acceptable risk threshold is therefore lower. They do not adjudicate final acceptability.
- **Designers, Contractors, Operators** – recommend measures, but also do not adjudicate final acceptability.

Accordingly, the *Acceptor of Risk* must always be the State (or its delegated agency). If that role is ceded to an emergency service organisation, more conservative and costlier solutions will inevitably result. Clarifying the Acceptor of Risk at project inception is therefore essential to timely, defensible decisions.

Best practice vs common practice

The paper aims to describe **best practice**. Widespread habits are not automatically best practice; where better examples exist, domestically or overseas, the standard will reflect them.

Note to reviewers – Questions raised during the workshop on documentation burden, data-collection requirements, stakeholder-agreement "lock-in" and competency definitions are flagged for later chapters or annexes of the revised standard. They are acknowledged here but not debated in this introductory section.

2 LEGAL CONTEXT

2.1 Legal context - who may accept tunnel fire risk?

This section reflects legal advice provided by barrister Professor Arnold Dix, whose schedule prevented him from speaking at the October 2024 workshop.

2.2 Residual risk and the Acceptor of Risk

- Every tunnel retains some **residual operational risk**; that risk must sit **below the level tolerated by the relevant State**.
- Tolerability is a **societal decision** and therefore varies by State, by time and by tunnel type.
    - Example – society expects railways to be safer than roads; New South Wales historically tolerates less transport risk than Western Australia.
- Emergency service agencies, created by statute to minimise harm, almost always hold a **lower risk target** than the government of the day.
- **Therefore, at project inception, the entity that will accept the residual risk must be named.**
    - If that role is delegated to an emergency-service agency, the design will, by definition, be more conservative (and costly) than if retained by the State; both outcomes can still be "safe enough".

Recommendation 1 – Identify the **Acceptor of Risk** before design starts and acknowledge that reasonable parties may differ.

2.3 Road tunnels

- Road authorities derive their powers, duties and liabilities from a patchwork of statutes; some States may soon codify explicit tunnel responsibilities.
- Statute and case law grant road authorities partial shields from civil liability, recognising both public utility and inherent risk.
- Those shields do **not** remove the twin legal tests that road-authority decisions must be:
    - **reasonable** (within statutory powers) and
    - **non-negligent** (not causing foreseeable harm).
- A road authority **need not** be the final design decision-maker, but it may refuse to **operate** a tunnel it deems unsafe under its own statute.
- Emergency services, lacking cost responsibility, are usually the most conservative voice; their advice informs but does not overrule.

2.4 Bus tunnels

Busways are legally “roads”; all points in § 2.2 therefore apply directly to bus tunnels.

2.5 Rail tunnels

- Rail authorities operate under State statutes **and** the **Rail Safety National Law (RSNL)**, regulated by the Office of the National Rail Safety Regulator (ONRSR).
- Gaining ONRSR accreditation requires documented due process whenever a project proponent and emergency services disagree on safety measures.
- Society’s risk tolerance for rail transport is lower than for road; designs must reflect that higher bar.

2.6 Ancillary buildings

- Surface control rooms, ventilation buildings and electrical substations are **critical infrastructure**: losing one can shut a tunnel as surely as a lining failure.
- Basic Building Code of Australia (BCA) “deemed-to-satisfy” provisions cover occupant life safety but **not** business-continuity risk.
- New AS 4825 clauses will therefore specify **robustness and redundancy** requirements for these structures (e.g. geographically separate hot-standby control rooms) in each mode-specific part of the standard.

In short, tunnel-fire–risk acceptance is a legal act. The revised AS 4825 will clarify who must make that act and how technical stakeholders can supply the evidence needed for an informed, defensible decision.

3 RISK METHODS

3.1 Risk assessment methods

Every tunnel fire design method contains an implicit or explicit view of risk. The revised AS 4825 will make that view transparent and, where possible, prescriptive.

Established risk-evaluation approaches

Insight from European practice	Relevance to AS 4825
EC Directive 2004/54/EC kept minimum prescriptive measures **and** introduced compulsory risk assessment.	A hybrid model, prescription plus risk analysis, works in mature jurisdictions and will shape our own.
Clear governance is critical: the **Administrative Authority** (usually Government) takes the final decision.	Mirrors our Acceptor-of-Risk model (§ 2).
Both prescriptive and risk-based tools are used; neither is "second-class."	The standard will accommodate both, provided SFAIRP is met.
"Willingness-to-pay" and "value of life" are used to justify measures.	Unacceptable in Australia, as tunnels already start from a high safety baseline.
Quantification clarifies which parameters drive risk, but numbers are **fuzzy** and need expert interpretation.	QRA can inform, but must never be treated as plug-and-play.
Absolute-risk criteria and a reference tunnel are prerequisites for QRA gatekeeping.	Australia has neither, so QRA cannot yet be the pass/fail test.
Comparative (relative) risk is more flexible; it connects prescriptive and risk-based worlds.	A viable interim path—if a tunnel meets today's prescription it could serve as the local benchmark.
Risk must be holistic: reducing fire risk alone can raise total risk (e.g. by increasing collision exposure).	AS 4825 will note the interface but confine itself to fire; other hazards remain under parallel standards.

ATS position

Australia should adopt best-practice tools available **today**, while leaving the door open for a future Australasian QRA framework.

3.2 Deterministic (scenario) analysis

Definition – Calculates smoke movement, evacuation timing and tenability for a **single set** of fire and response assumptions.

- Valuable for **emergency-response planning** and for designing specific design details.
- **Not suitable for design acceptance**: by adjusting inputs plausibly you can "prove" either zero casualties or mass fatalities.
- When used as a gate, input selection becomes a contract negotiation, not a safety exercise, and the resulting report can mask rather than reveal risk.

ATS stance – Deterministic (scenario) analysis is a supporting tool. It may illustrate consequences, but it cannot determine societal risk acceptability.

3.3 Consequence analysis

Fire agencies need to understand *how* incidents could unfold; deterministic runs across a sensible range of scenarios provide that picture. Consequence results therefore:

- aid response planning,
- help identify infrastructure tweaks,
- inform, but do not replace, holistic SFAIRP judgements.

3.4 SFAIRP and professional negligence

- SFAIRP is a statutory duty under WHS Acts and the Rail Safety National Law. It is **not optional**.
- It requires explicit acceptance that **residual risk is never zero** and must be weighed against feasibility, cost and technology.
- Courts apply a disproportionality test (loosely based on *Edwards v National Coal Board* (cost must be **grossly** disproportionate to the benefit before safety measures are rejected).
- Government, as the public's representative, makes the final SFAIRP call, after hearing expert evidence.

3.5 Failure modes and redundancy

Compliance with SFAIRP also demands a systematic look at:

- failure probabilities for each safety-critical subsystem (ventilation, suppression, egress),
- redundancy or diversity to maintain function after a fault, and
- cascading effects, ensuring that one failure does not disable multiple layers of defence.

3.6 Standardisation opportunities

Where the industry already agrees (e.g. critical-velocity formulae, water-mist densities), AS 4825 should *state the rule*. Doing so:

- cuts project variability,
- streamlines SFAIRP demonstrations, and
- strengthens legal defensibility.

Unique project circumstances may still justify departures, but the burden of proof then rests with the proponent.

3.7 Other risk engineering tools

Method	Use with caution because…
HIPAP (NSW Hazardous-Industry PAPs)	Provides structure but no acceptance criteria.
LOPA (Layer of Protection Analysis)	Helpful for scenario probability weightings; still needs tunnel-specific data.
Imported QRA packages	Europe leads, but without Australian criteria they remain advisory only.

Guidance: adapt proven overseas tunnel-related tools rather than inventing new ones, but apply them transparently within an SFAIRP framework.

3.8 Summary

The revised AS 4825 will:

- embed SFAIRP as the non-negotiable baseline,
- permit deterministic studies for *insight*, not acceptance,
- encourage comparative risk where useful,
- prescribe methods wherever consensus already exists, and
- acknowledge that full QRA gatekeeping awaits national criteria.

Applied together, these measures deliver tunnel-fire safety that is technically sound, legally robust and aligned with community expectations.

4 ACCEPTOR OF RISK

4.1 Accepting residual risk - who signs off?

Residual risk never disappears; someone must own it. Past projects have sometimes treated a deterministic model showing "zero fatalities with a safety factor" as proof of acceptability, but that simply hides the real decision: **choosing the inputs already chooses the risk**. Acceptance is always explicit, whether acknowledged or not. The question, therefore, is *who has legal and financial authority to say "safe enough"?*

European Directive 2004/54/EC resolved this by naming an **Administrative Authority**. AS 4825 will do the same through the **Acceptor-of-Risk (AoR)** role. Without a clearly appointed AoR, projects stall, costs climb and accountability blurs.

4.2 Contractor / designer

- Must produce a documented **SFAIRP safety argument**.
- Selects reasonable methods and parameters **but** must respond to stakeholder comments.
- Cannot resolve cost-risk disputes: authority rests with the AoR.

4.3 Building certifier

- Works for normal buildings via BCA "deemed-to-satisfy" or performance pathways.
- **Not** the AoR for tunnels:
  - no BCA tunnel classification,
  - BCA ignores SFAIRP and Rail Safety National Law requirements,
  - cannot authorise extra State expenditure for further risk reduction.
- Still involved via State development or building legislation, but addresses the high-level requirements, relying on the project fire engineer and others.

4.4 Fire services

- Statutorily obliged to minimise harm and protect their crews.
- Carry **zero project cost responsibility**; therefore cannot weigh cost vs. community benefit.
- Focus on response, not probability; societal-risk acceptance lies outside their mandate.
- Under legislation such as the NSW Roads Act, approval authority sits with the owner/operator, not the brigade.
- The Project Proponent, typically the transport authority, must undertake early and extensive engagement with stakeholders (particularly fire services) prior to confirming project requirements.

- This engagement should have the aim of confirming fire safety related requirements prior to contract award such that fire safety related delivery risk is mitigated.

4.5 Government (project proponent)

- Transport authority, government-owned corporation or similar.
- Holds the purse strings, public mandate and legal power, and is **therefore the AoR by default**.

4.6 Operator

- Responsible for day-to-day safety once the tunnel opens (for rail tunnels, the Operator is often both the Rail Infrastructure Manager and Rolling-Stock Operator under Rail Safety National Law).
- Must confirm, *before handover,* that the tunnel is operable within their safety case.
- Does not usually replace the State as AoR, but monitors ongoing compliance on its behalf.
- Early operator involvement is essential; tender-stage "probity firewalls" must not block safety dialogue.

Key takeaway – Every project must name a single **Acceptor of Risk (AoR),** normally the Government entity funding or enabling the tunnel, and the AoR must be made known to project parties. All other parties advise; none can unilaterally declare the design "safe enough."

5 CONTRACT REQUIREMENTS

5.1 Contract framework - embedding risk acceptance in the specification

Project contracts are the practical bridge between a State's **Acceptor-of-Risk (AoR)** decision and the physical tunnel. Poorly drafted clauses can push responsibility onto the wrong party, distort cost-risk trade-offs and derail schedules. The revised AS 4825 will set out the following principles.

5.2 State specification - pre-approved safety case

- The specification issued by (or for) the State **is** the AoR's statement that the design, as written, meets SFAIRP.
- Tenderers may therefore assume the listed measures are already accepted; their bids should not be burdened with re-justifying them.
- In some jurisdictions, entities that seek to provide self-assured engineering and asset services to Transport agencies are required to become a Technically Assured Organisation (TAO). Transport Agencies may undertake self-assured engineering though concept design phases, but may be reliant on industry through detail design phases.
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5.3 Avoid open-ended "to the satisfaction of the fire service" clauses

Two acceptable formulations exist – and one that must be avoided:

Clause type	Effect	ATS position
Principal pays – Government will fund any extra measures the fire service requests.	Cost risk stays with the AoR (appropriate).	Acceptable.
Fixed scope – Fire-service input already resolved; no further obligation.	De-risked for bidders (ideal).	Acceptable.
Contractor at risk – "Design to fire-service satisfaction" without cost cover.		

AS 4825 will deem the third formulation invalid.

5.4 Post-tender fire service requests

- New fire-service requirements raised **after** tender award are legitimate but **must be funded by the specification issuer**, not by the contractor.

- The fire service must persuade the AoR, who controls the purse, of the SFAIRP case for extra scope.
- The AoR should mitigate the need for additional post tender fire service requests by undertaking detailed engagement before contract execution.

5.5 Reference design & tender documentation

- Meeting an issued project specification should be able to be taken as also providing an accepted safety outcome.
- Requiring bidders to restart fire-engineering documentation from a blank page puts them behind a "probity firewall", forces guesswork and yields paperwork of little value.
- AS 4825 will state that once the AoR has endorsed a specification, or perhaps a reference design, only **design changes** (scope extensions, new technologies, site-specific constraints) need fresh risk acceptance.

5.6 Final safety case and operator sign-off

- At practical completion, the contractor must deliver an **as-built safety case** that consolidates the original safety case / specification requirements, or reference design, and all approved changes.
- The Operator must review and accept this document **before** taking charge. Early operator involvement is therefore mandatory (see § 4.5).

Bottom line: Clear allocation of cost and decision authority prevents late-stage disputes, keeps the safety conversation focused on SFAIRP and lets contractors price with confidence. All of this improves the chances of good design outcomes. The revised AS 4825 will mandate that clarity.

6 FIRE SERVICES CONSULTATION

6.1 Fire-service consultation

Early, structured dialogue with fire agencies is essential, but the role and limits of that dialogue must be clear.

6.2 Purpose of early engagement

- Capture operational requirements while design changes are still cheap.
- Confirm that infrastructure (e.g. hydrant couplings, appliance access, communication links) supports the response level society expects.
- Avoid "late-surprise" incompatibilities that drive cost and schedule blow-outs.

6.3 Scope of fire service input

Issue type	Decision owner	Notes
Tactical hardware (hydrant thread, radio band)	Fire service	They specify; designer incorporates.
Response choreography (staging points, entry routes)	Fire service & Operator	Joint workshops; documented in operating procedures.
Societal-risk balance	AoR (Government)	Fire service contributes views; final call is not theirs.

6.4 No veto on analysis method

- Analysis approaches stand or fall on evidence, not on any single stakeholder's preference.
- Disagreements are escalated, like any other design issue, to the **Acceptor of Risk** for a fact-based ruling.

6.5 One-way door principle

- Fire services should state their position **once, early and in writing**.
- New demands after tender award are addressed, but the **Principal funds them** (see § 5.2).
- Designers keep the agency informed of material design changes that could warrant a revised view.

6.6 Common causes of friction

1. **Unclear AoR** → fire service fills the vacuum.
2. Contract clauses granting implicit veto rights (now barred by AS 4825).
3. Late engagement that forces the brigade to say “no” because options are closed.

Sound governance, and the clarity in §§ 2-5, eliminates most of these problems.

7 OTHER 'PROCESS' DOCUMENTS

7.1 AFEG / IFEG

- **What it is** – The *Australian Fire Engineering Guidelines* (AFEG) is a building-fire document developed in Australia.
- **Why it falls short for tunnels**
  - Written for buildings; never widely applied to transport infrastructure.
  - Covers process and roles, but the revised **AS 4825** will address those topics in tunnel-specific depth.
  - Does not deal with SFAIRP obligations unique to major linear infrastructure.
- **AS 4825 stance** – All tunnel-relevant process, role and documentation requirements will be self-contained in the new standard. Referencing AFEG/IFEG would add no value and may confuse users, so AS 4825 will **not cite it for normative guidance** (see explanatory Appendix for background only).

7.2 Austroads Guide to Tunnels

- A helpful **introductory primer** for newcomers to the sector.
- Not written as a performance or prescriptive **standard**; contains no enforceable requirements.
- **Therefore** it should *not* be referenced in contracts or in AS 4825 itself.

8 APPENDIX A - WORKSHOP ATTENDANCE

For the record, the attendance at the workshop on 11th October 2024 is recorded below.

Workshop Chair: Nigel Casey

Rapporteurs: Diane Mather
Nick Agnew

Workshop panel: Bernhard Kohl, ILF, Austria
Michael Beecroft, AFAC, QFES
Craig Hiscock, Tactix Sener
Amer Magrabi, Society of Fire Safety
David Radcliffe, Advisor, SRLA
Ingo Riess, Riess Ingenieur-GmbH, Switzerland
Conrad Stacey, Stacey Agnew

In-room attendees:

Alexander Rogan
Andy Wong
Annalena Chapman
Ben Tuckwell
Bruce Hateley
Cass Nason
Charles MacDonald
Dave Absalom
Dean Pramualphol
Edward Wright
Erik van der Horst
Gordon Stacey
Hal David
Jaime Cadena Gomez
Kevin Stewart
Lee Brown
Leigh Clark
Marlon Arthur
Matthew Rowley
Michael Beyer
Michael Meissner
Natalija Beslic
Nick Jays
Peter Gehrke
Raymond Donato
Steven Hayes
Taksh
Tom Sheppard
Wendy Luo

Online attendees (more than 80% attendance):

Adrian Lee
Andrea Paradiso
Andrew Purchase
Anggraini Nitiwalujo
Bamshad Naghibi
Blake Bambridge
Colin Rose
Cristian Biotto
Dennis Licuanan
Hamid Akbarzadeh
Harriet Peel
Haydn Lewis
He-in Cheong
Henry Brammer
Ingo Riess
Kjetil Pedersen
Lachlan Kaaden
Matthew Taylor
Micael Lundqvist
Nazia Nawshin
Peter Johnson
Peter Kroon
Prakash Sabapathy
Rahul Patel
Richard Lau
Rick Fox
Syed Zaidi
Teresa Sandum
Terry McGavin
Thomas Starling