PARARI CONFERENCE

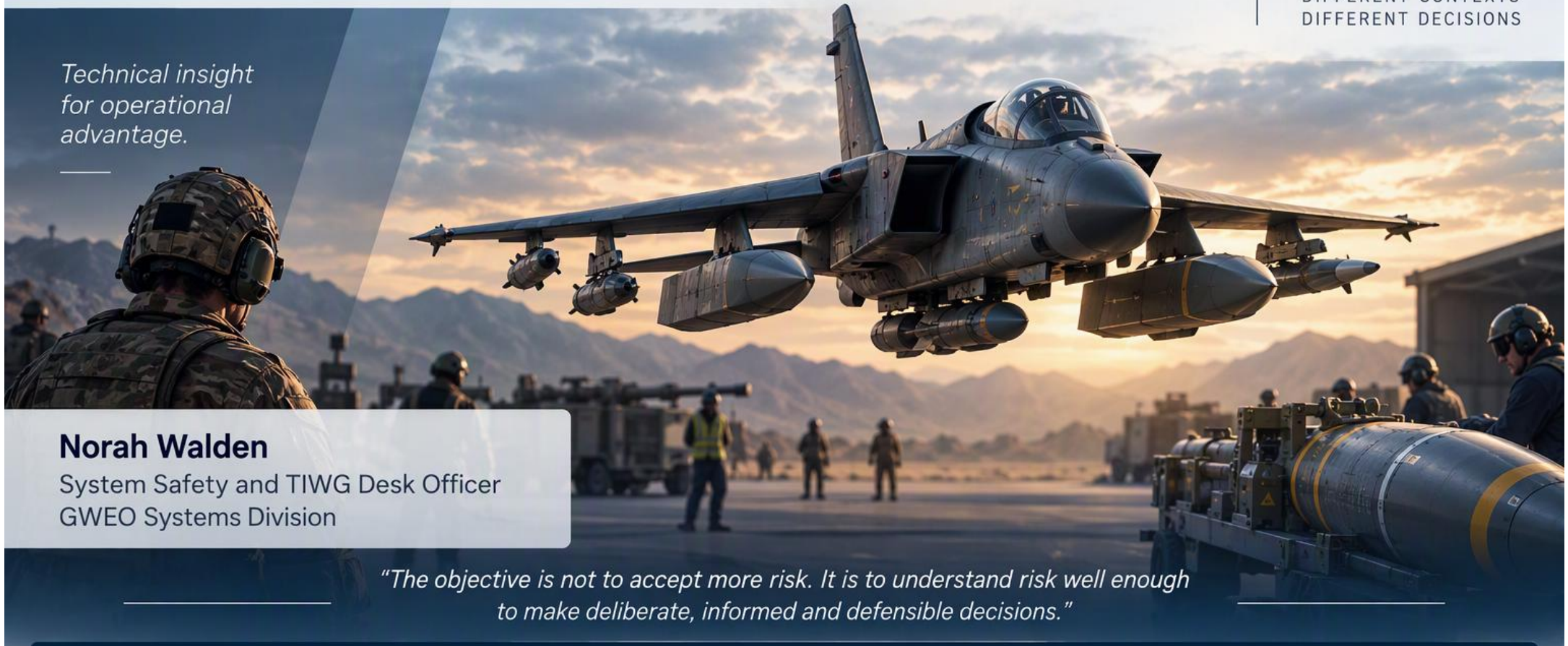
Enabling Proportional Safety in Conflict Through Adaptive Explosive Materiel Limits

Lessons from Flight Test and Armoured Vehicle Practice

UNDERSTAND
ASSESS
DECIDE
ADAPT
DELIVER

SAME HAZARDS
DIFFERENT CONTEXTS
DIFFERENT DECISIONS

Technical insight for operational advantage.



Norah Walden
System Safety and TIWG Desk Officer
GWEO Systems Division

"The objective is not to accept more risk. It is to understand risk well enough to make deliberate, informed and defensible decisions."

PROPORTIONAL SAFETY ENABLES

SAFE PEOPLE • CAPABLE FORCES • OPERATIONAL EFFECT

2. Why This Matters

From Competition to Conflict

The operating environment changes – and so does the balance between risk, safety and operational necessity.



TIME AVAILABLE FOR DECISION-MAKING

More time to analyse, test and certify.

UNCERTAINTY

Greater predictability and known conditions.

RISK APPETITE

Conservative, with large safety margins.

TIME AVAILABLE FOR DECISION-MAKING

Compressed timelines and urgent operational needs.

UNCERTAINTY

Increased ambiguity and rapidly changing conditions.

RISK APPETITE

May increase to achieve operational success.

The question is not whether limitations should exist,
but how they should be interpreted and managed when operational imperatives demand flexibility.

3. The Problem

Are Limitations Rules or Risk Controls?

Over time, many limitations become disconnected from their origins.

THE NUMBER REMAINS

A LIMITATION ON PAPER

TECHNICAL ORDER TO-1A-123

MAXIMUM CARRIAGE LIFE
180 DAYS

4.2 OPERATING LIMITATIONS

Carriage life shall not exceed 180 days from date of installation.

BUT WHAT IS IT PROTECTING?

FROM A NUMBER TO AN UNDERSTANDING OF RISK

THE HAZARD REMAINS

REAL CONSEQUENCES IN THE REAL WORLD

PEOPLE
Injury or loss of life

PLATFORMS
Damage or loss

CAPABILITY
Reduced effectiveness

OPERATIONAL OUTCOMES
Mission failure



The challenge is not to blindly comply with a number,
but to **understand the hazard, consequences and intent behind the limitation.**

4. Understanding Limitation Lineage

From Hazard to Limitation

A limitation is rarely an isolated number. It is the final step in a chain of reasoning.

UNDERSTAND
THE JOURNEY
BEHIND THE NUMBER



HAZARD
What could happen?

e.g. Structural overload

POTENTIAL CONSEQUENCE
What are the impacts?

e.g. Aircraft loss and potential loss of life

RISK ASSESSMENT
How likely and how severe?

e.g. Engineering analysis, test evidence, modelling and safety factors

CONTROL MEASURE
How is the risk managed?

e.g. Load management, structural design, operational controls

LIMITATION
How is the control expressed?

e.g. Maximum approved g-limit

The limitation is not the thing being protected.
It is the user-facing expression of a much larger body of technical evidence and risk analysis.

5. Viewing Limitations Through a Bowtie

Viewing Limitations Through a Bowtie

What is the limitation actually protecting?

UNDERSTAND THE HAZARD NOT JUST THE LIMIT

"Exceeding a limitation does not create a new hazard. It changes the effectiveness of the controls managing that hazard."



TRADITIONAL VIEW
FOCUS ON THE LIMIT

- **Captive carriage life exceeded** — Limit breached
- **Limitation breached** — Non-compliant
- **Weapon unavailable** — Removed from service
- **Restore compliance** — Maintenance or removal of weapon
- **Return to service** — When within limit

FOCUS: THE LIMIT

PREVENTION
Reduce the likelihood of the top event

HAZARD AND TOP EVENT
What are we trying to prevent?

MITIGATION
Reduce the consequences if the top event occurs

THREATS (What could cause it?)	PREVENTIVE CONTROLS (What stops it happening?)	MITIGATIVE CONTROLS (What reduces the consequences?)	CONSEQUENCES (What could happen?)
Environmental exposure (temperature, humidity, salt)	Maximum approved captive carriage life	Pre-use checks and BIT (system health verification)	Reduced weapon effectiveness
Vibration and flight loads	Environmental controls (shelter, covers, handling)	Employment restrictions (envelope, targets, conditions)	Reduced accuracy
Thermal cycling	Inspection requirements (visual and functional)	Targeting constraints (target set, collateral control)	Failure to achieve mission effect
Extended captive carriage duration	Carriage-life tracking (records and alerts)	Technical assessment (engineering advice)	In-flight malfunction (e.g. loss of control)
Maintenance and handling factors	Maintenance procedures (storage, handling, fit)	Crew procedures (training, checklists, abort)	Unintended release
			Risk to aircraft or personnel

HAZARD
Guided weapon degradation

TOP EVENT
Weapon exceeds approved captive carriage life

HAZARD-BASED VIEW
FOCUS ON THE RISK

- **Captive carriage life exceeded** — Trigger for assessment
- **Hazard assessed** — What could happen and why
- **Consequences understood** — Likelihood and severity
- **Controls reviewed** — What remains effective
- **Technical advice sought** — Consult technical authority
- **Risk decision informed** — Deliberate and documented

FOCUS: THE HAZARD

KEY INSIGHT

The carriage-life limitation is only one control within a broader risk management system.

- Hazard remains unchanged
- Weapon degradation remains the concern
- Controls remain relevant
- The decision process changes

The key question is not "Was the limit exceeded?"

The key question is "How has the risk changed?"

SAFE PEOPLE
CAPABLE FORCES
OPERATIONAL EFFECT

6. Not All Limits Are Equal

Failure Cliffs vs Progressive Degradation

Exceeding different limitations produces very different risk outcomes.

UNDERSTAND
THE CONSEQUENCE
BEFORE
THE NUMBER

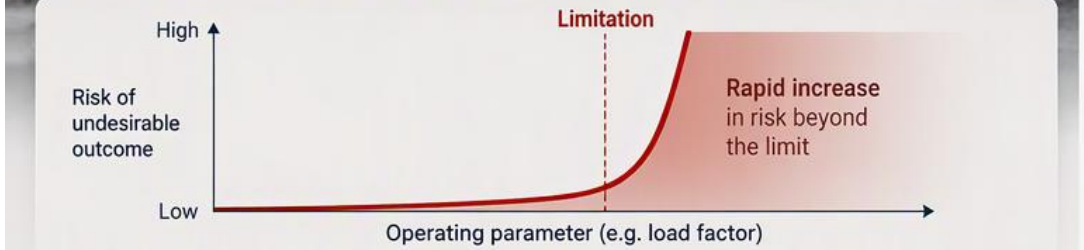
FAILURE CLIFFS

A RAPID TRANSITION FROM SAFE TO UNACCEPTABLE



Once the limit is exceeded, consequences can occur rapidly and with little warning, often resulting in catastrophic outcomes.

"There is often a direct and immediate relationship between exceedance and the hazard."



TYPICAL EXAMPLES

- **Structural limits** (e.g. g-limits)
- **Separation limits** (e.g. explosive ordnance)
- **Flight envelopes** (e.g. angle of attack)

LOW TOLERANCE FOR EXCEEDANCE | HIGH CONSEQUENCE

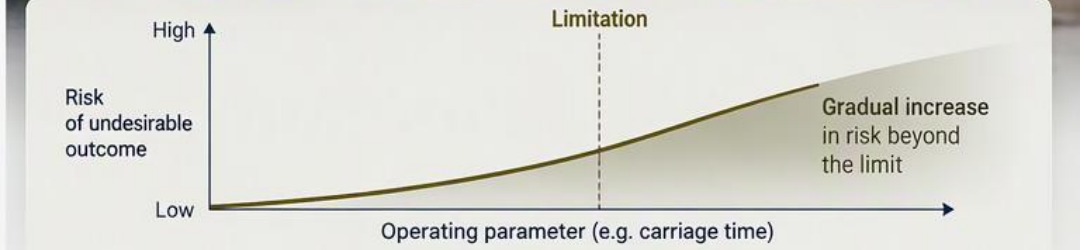
PROGRESSIVE DEGRADATION

A GRADUAL INCREASE IN RISK AND UNCERTAINTY



Exceeding the limit typically does not result in immediate failure, but increases uncertainty and reduces confidence in performance over time.

"Exceedance may reduce future capability rather than cause an immediate catastrophic outcome."



TYPICAL EXAMPLES

- **Captive carriage life** (guided weapons)
- **Shelf life** (explosive materiel)
- **Component ageing** (mechanical systems)
- **Reliability margins** (avionics / electronics)

GREATER OPPORTUNITY FOR INFORMED RISK ACCEPTANCE | OFTEN LOWER IMMEDIATE CONSEQUENCE

Not every limitation represents a binary transition from safe to unsafe.

A limit is only as important as the consequence it is intended to prevent.

7. Mission Context Changes Risk Appetite

Risk Appetite Across the Capability Lifecycle

The acceptable level of risk is not fixed — it changes depending on context, purpose and need.

SAME HAZARDS
DIFFERENT MISSIONS
DIFFERENT DECISIONS



Build knowledge and reduce uncertainty.	Conservative risk appetite to ensure safety and compliance.	Defined limits to protect capability and personnel.	Balanced approach to risk and efficiency.	Increased risk acceptance due to operational necessity.	A wider range of risk postures depending on the mission, context and consequences.

Risk appetite is influenced by context, mission objectives and operational necessity.

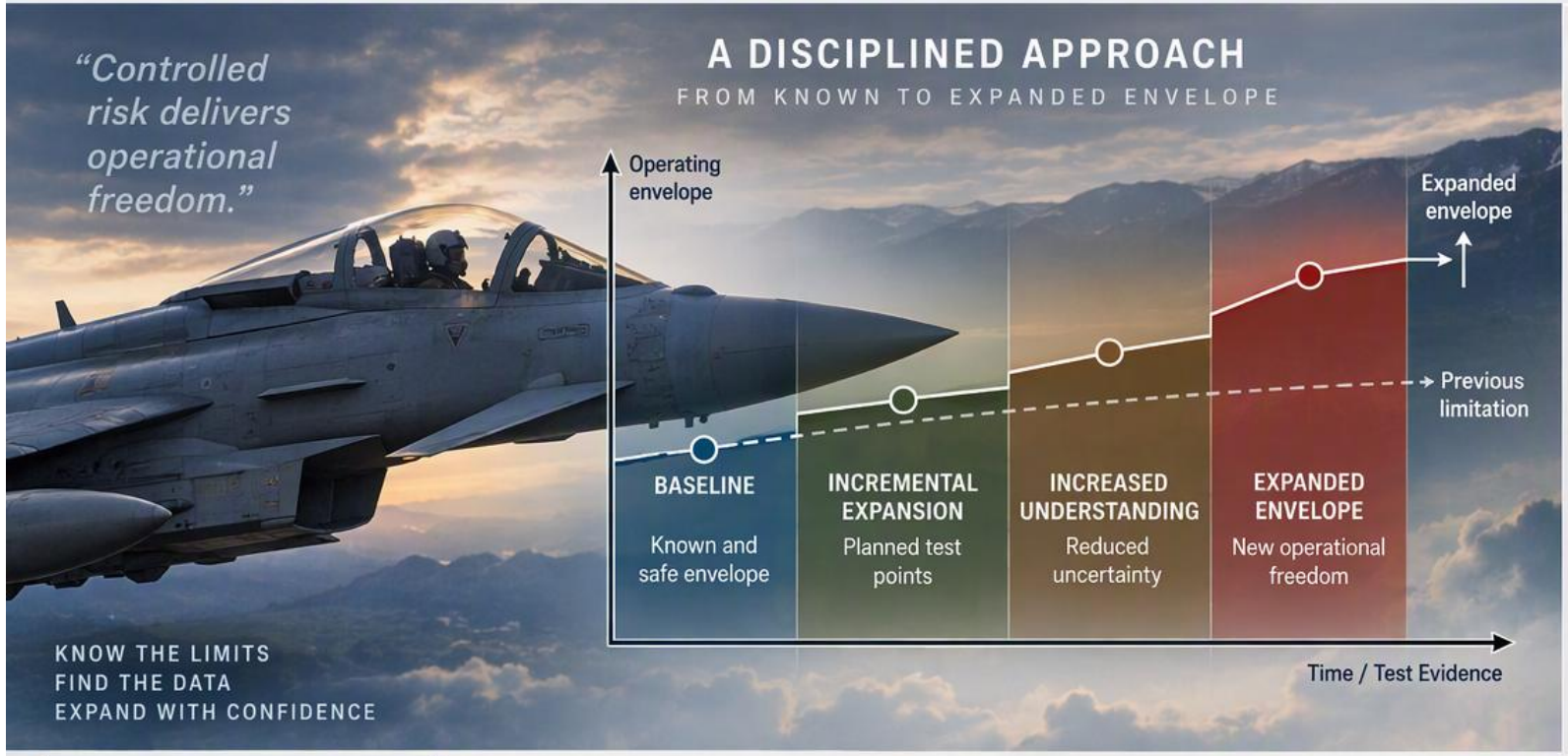
Conflict does not create a single risk posture; it expands the range of risk decisions that may be required.

8. Flight Test Lesson

Expanding the Envelope Safely

Flight test shows how limitations can be adapted through evidence, discipline and risk management.

TEST
UNDERSTAND
INCREMENTALLY
ADAPT



KEY FLIGHT TEST PRINCIPLES

EVIDENCE-BASED DECISIONS
Test, analyse and understand the data.

INCREMENTAL EXPANSION
Make small, controlled steps into new operating space.

CONTROLLED UNCERTAINTY
Manage and reduce uncertainty through testing and analysis.

EXPLICIT RISK OWNERSHIP
Clear authority, governance and acceptance of risk.

THE RESULT

GREATER CAPABILITY
WITH MANAGED RISK

- EXPANDED OPERATIONAL UTILITY
- MAINTAINED SAFETY MARGINS
- DEFENSIBLE RISK ACCEPTANCE
- INFORMED DECISIONS IN COMPLEX ENVIRONMENTS

The flight test mindset provides a proven model for adapting limitations.
The same principles can – and should – inform explosive materiel management.

9. Case Study – Operation TELIC

Storm Shadow and Adaptive Limitation Management

Delivering capability through informed, evidence-based risk management.

OPERATIONAL NEED DRIVES ADAPTIVE DECISIONS



FROM INTEGRATION AND TEST...

Tornado GR4 releasing a Storm Shadow during trials.

"Operational necessity did not remove risk. It changed the question to a practical one: what risk is acceptable, and how do we manage it?"



...TO OPERATIONAL EFFECT

Tornado GR4 with full Storm Shadow load out.

ORIGINAL OBJECTIVE	OPERATIONAL DEMAND	TARGETED TESTING	RESTRICTED CLEARANCE	COMBAT EMPLOYMENT
Full certification to peacetime standards.	Urgent requirement for capability in TELIC.	Focused, evidence-based test programme.	Approval with defined limitations and controls.	Capability delivered and used operationally.
Comprehensive testing, analysis and clearance.	Time constraints and evolving threat environment.	Address critical risks and generate decision-quality evidence.	Managed risk through operational restrictions (e.g. carriage life, release conditions).	Effective employment in TELIC with acceptable and managed risk.

The question was not whether all uncertainty could be removed,
but whether sufficient understanding existed to employ the capability responsibly.

10. Prevention vs Informed Risk Acceptance

Prevention vs Informed Risk Acceptance

The hazard remains unchanged. The decision-making process changes.

UNDERSTAND
THE HAZARD
INFORM
THE DECISION
MANAGE
THE RISK

"The interlock prevents firing — and the patrol cannot engage."

A safe system, but at what cost?



HAZARD IDENTIFIED
Risk to People, Platform or Capability
(e.g. unintended launch / unsafe firing / collateral damage)

LIMITATION ESTABLISHED
Technical control introduced
(e.g. safety interlock / firing conditions)

TRADITIONAL COMPLIANCE APPROACH

Prevent exceedance of the limitation.

- **Technical Control Applied** (Interlock active)
- **Override Prevented** — System blocks firing
- **Compliance Required** — Adhere to established conditions
- **Risk Minimised** — Reduced likelihood of hazardous event
- **Reduced Operational Flexibility** — Capability may not be employed

FOCUS: PREVENT EXCEEDANCE

SAME HAZARD
SAME LIMITATION
SAME TECHNICAL CONTROL

ONLY THE DECISION-MAKING PROCESS CHANGES

ADAPTIVE RISK-BASED APPROACH

Understand and manage the residual risk.

- **Technical Control Applied** (Interlock active)
- **Hazard and Consequences Understood** — What risk is being managed?
- **Authority Established** — Commanders with defined decision rights
- **Authorised Override Considered** — Under defined conditions
- **Deliberate Risk Assessment** — Assess residual risk and available controls
- **Informed Risk Acceptance** — Decision documented and owned
- **Operational Agility Enabled** — Mission can be achieved with managed risk

FOCUS: UNDERSTAND AND MANAGE RESIDUAL RISK

"The commander must weigh the risks — not just the limitation."

Understanding enables options.



ILLUSTRATIVE SCENARIO

An enemy anti-armour team is identified preparing to engage a friendly patrol from a building.
A weapon interlock prevents firing because a required firing condition cannot be automatically verified.
The commander must balance the risk of overriding the interlock against the risk of allowing the threat to remain unengaged.



Adaptive limitation management does not remove controls.
It enables informed decisions when competing risks must be balanced.

SAFE PEOPLE
CAPABLE FORCES
OPERATIONAL EFFECT

Towards Adaptive Limitations

A framework for proportional decision-making.

SAME HAZARD
DIFFERENT CONTEXT
PROPORTIONAL
CONTROLS



Increasing Operational Necessity

Respond and Achieve Effect

Maintain Operational Advantage

Sustain Safe and Effective Operations

Generate Knowledge and Define Limits

CONFLICT
Mission-driven risk acceptance

- Mission-specific authorisations
- Senior decision authority
- Explicit risk acceptance
- Continuous technical reach-back

CONTINGENCY OPERATIONS
Increased flexibility with control

- Tailored operating envelopes
- Additional technical assessment
- Enhanced monitoring and reporting
- Delegated decision authority

ROUTINE OPERATIONS
Operate within established limits

- Approved operating limits
- Standard procedures and controls
- Routine monitoring and compliance
- Defined authority

DESIGN, DEVELOPMENT AND CERTIFICATION
Understand hazards and establish limits

- Hazard identification and analysis
- Testing, modelling and evidence generation
- Limitation development
- Regulatory and governance approval

Increasing Decision Authority

KEY PRINCIPLES

THE HAZARD REMAINS UNCHANGED
Context changes the acceptable level of risk, not the hazard itself.

PROPORTIONAL CONTROLS
Controls adapt to operational context while maintaining intent.

CLEAR RISK OWNERSHIP
Decisions are made by authorised individuals with appropriate expertise.

EVIDENCE-BASED DECISIONS
Use the best available information to understand and manage risk.

INTEGRATED GOVERNANCE
Adaptation strengthens governance — it does not remove it.

Adaptive limitations do not remove governance.
They align governance with operational context.

SAFE PEOPLE
RELIABLE CAPABILITY
OPERATIONAL EFFECT

Technical Authority and Reach-Back

Connecting Operational Decisions with Technical Understanding

KNOW THE HAZARD
UNDERSTAND THE RISK
ENABLE THE DECISION

WITHOUT REACH-BACK

LIMITED CONTEXT. HIGHER RISK.

- Limited technical context and understanding
- Binary compliance decisions
- Slower response to emerging issues
- Reduced operational flexibility

"If the conditions aren't met, we can't do it."

— Compliance-driven decision

OPERATIONAL DECISION

Commanders make informed decisions, with the right technical support, for the operational context.

Hazard understanding | Evidence and data | Assumptions and uncertainty | Consequences and residual risk | Available controls and options

TECHNICAL AUTHORITY
Engineering expertise, qualification and authority.

SAFETY & RISK ADVISORS
Hazard analysis, risk assessment and safety advice.

SYSTEM EXPERTS
Platform and materiel knowledge and technical data.

CAPABILITY OPERATORS
Operational insight, mission context and practical experience.

SHARED UNDERSTANDING → INFORMED DECISIONS → OPERATIONAL EFFECT

WITH REACH-BACK

GREATER UNDERSTANDING. BETTER DECISIONS.

- Hazard-based advice and technical context
- Better understanding of uncertainty and risk
- Tailored risk controls and options
- Faster, more informed decision-making
- Maintained operational flexibility with governance

"We understand the risk, and we can manage it."

— Informed, risk-based decision

KEY PRINCIPLES

Enablers for adaptive limitation management.

1. **TECHNICAL AUTHORITY INFORMS DECISIONS**
   Provides engineering knowledge and context.
2. **RISK OWNERSHIP REMAINS VISIBLE**
   Decision makers retain accountability.
3. **EVIDENCE REDUCES UNCERTAINTY**
   Uses the best available information.
4. **REACH-BACK ENABLES AGILITY**
   Access to expertise when it's needed.
5. **GOVERNANCE SUPPORTS ADAPTATION**
   Controls remain proportionate and deliberate.

Adaptive decisions require rapid access to technical expertise, not reduced oversight.

Hazard understanding • Evidence • Authority • Accountability

SAFE PEOPLE
CAPABLE FORCES
OPERATIONAL ADVANTAGE

A Proportional Safety Model

Integrating knowledge, risk and operational need to enable adaptive limitations.

UNDERSTAND
INFORM
ADAPT
DELIVER EFFECT

KEY INPUTS

The information we need to make informed decisions.

Hazard Understanding
What could happen and why it matters.

Technical Evidence
Test data, analysis and operational experience.

Operational Context
Mission objectives, constraints and alternatives.

Risk Appetite
Acceptable risk varies by context and consequence.

CONTINUOUS LEARNING AND IMPROVEMENT

HAZARD & CONSEQUENCE
Understand what we are protecting

EVIDENCE & UNCERTAINTY
Know what we know, what we don't know, and how it affects risk

PROPORTIONAL SAFETY
The right control, for the right context, at the right time.

AUTHORITY & GOVERNANCE
Clear decision rights and accountability

ADAPTIVE CONTROLS
Tailor limitations and mitigations to operational context

CONTINUOUS LEARNING AND IMPROVEMENT

OPERATIONAL OUTCOMES

Maintain safety while enabling effective and agile operations.

Protect People
Reduce the likelihood and severity of harm

Preserve Capability
Maintain operational effectiveness

Enable Operational Agility
Provide flexibility when circumstances demand it

Maintain Trust
Transparent, traceable and defensible decisions

"Better understanding enables better decisions."



DEVELOPMENT & TESTING
Generate knowledge

CERTIFICATION
Establish limits

ROUTINE OPERATIONS
Operate within limits

CONTINGENCY OPERATIONS
Apply tailored controls

CONFLICT
Adapt to mission needs

Proportional safety is not about taking more risk.
It is about understanding risk well enough to make deliberate, informed and effective decisions.

SAFE PEOPLE
CAPABLE FORCES
OPERATIONAL EFFECT

14. Conclusions

From Compliance to Understanding

Better understanding enables safer, more effective decisions in complex environments.

UNDERSTAND
ASSESS
DECIDE
ADAPT
DELIVER

"The issue is not whether we accept more risk, but whether we understand risk well enough to make better decisions."



SAFE PEOPLE
CAPABLE FORCES
OPERATIONAL EFFECT

FIVE KEY TAKEAWAYS

1

LIMITATIONS ARE CONTROLS, NOT OBJECTIVES

Understand the hazard, consequence and purpose behind the limit.



2

NOT ALL LIMITS CARRY EQUAL RISK

Failure cliffs differ from progressive degradation. What happens beyond the limit matters.



3

RISK APPETITE DEPENDS ON CONTEXT

The acceptable level of risk varies across the capability lifecycle and with mission objectives.



4

TECHNICAL EXPERTISE ENABLES AGILITY

Access to technical authority and reach-back provides the context, evidence and advice needed for informed decisions.



5

GOVERNANCE REMAINS ESSENTIAL

Adaptive does not mean uncontrolled. Decisions must be deliberate, traceable and supported by appropriate oversight.



UNDERSTAND Hazards and consequences → **ASSESS** Evidence and uncertainty → **DECIDE** Authority and risk ownership → **ADAPT** Proportional controls → **DELIVER** Operational effect

"The objective is not to accept more risk. The objective is to understand risk well enough to make deliberate, informed and defensible decisions."

PROPORTIONAL SAFETY ENABLES

SAFE PEOPLE • CAPABLE FORCES • OPERATIONAL EFFECT

READINESS TODAY
RESILIENCE TOMORROW
A MORE SECURE AUSTRALIA