Electro-explosive Hazards in the ADF

Addressing the Quiet Threat of Organisational Memory Loss

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AIM

- Creating ongoing awareness about Electro-explosive Hazards (EEH) and the need for a multi-pronged approach to ongoing training.

SCOPE

- EEH – an easily ignored ‘black magic’ hazard.
- Organisational Memory Loss (OML) & reasons therefore.
- OML as a contributor to EEH risks.
- Dealing with a dynamic & evolving EEH environment.
- The risks associated with EEH.
- Training initiatives – historic viewpoint.
- Proposed training initiatives going forward.

Why this matters now

- EEH knowledge resides in a small specialist community.
- Future GWEO capability will operate in more complex EM environments.

- The question is not whether EEH exists. The question is whether Defence can grow and retain the expertise needed to manage it.

What is EEH?

- The ADF employs a wide variety of EO, and a large number of these items are initiated using electro-explosive devices (EEDs).
- An EED is an explosive or pyrotechnic component that initiates an explosive, burning, electrical, or mechanical train and is activated by the application of electrical energy.
- An Electro-Explosive Hazard is a hazard that may result in the inadvertent functioning of an EED due to the uncommanded transfer of electrical energy to that device.
- An EED cannot distinguish between energy supplied by its firing circuit, static electricity, lightning, nor RF energy.

EEH: The ‘Black Magic’ Hazard

- EEH is driven by invisible electromagnetic energy from natural and man-made sources.
- Because hazards are not readily observable, they are vulnerable to neglect in routine operations and safety discussions.
- Loss of specialist expertise can reinforce perceptions of EEH as ‘*black magic’* rather than sound engineering.
- Advancing technology has the ability to outpace the institutional mechanisms required to sustain EEH knowledge.
- Sustaining organisational memory is critical to maintaining competence and effective hazard management.

What is Organisational Memory Loss (OML)?

- Gradual erosion of institutional knowledge due to:
  - Retirement
  - Staff turnover
  - Posting cycles
  - Restructuring
  - Workforce growth
  - Over-reliance on informal, experience-based knowledge transfer.
  - Insufficient depth of training.
  - Limited exposure, in general, to EEH matters.

How OML creates EEH risk

Staff turnover

Loss of expertise

Reduced EEH Understanding

Control Failure

EEH Incident

The Evolving EEH Environment

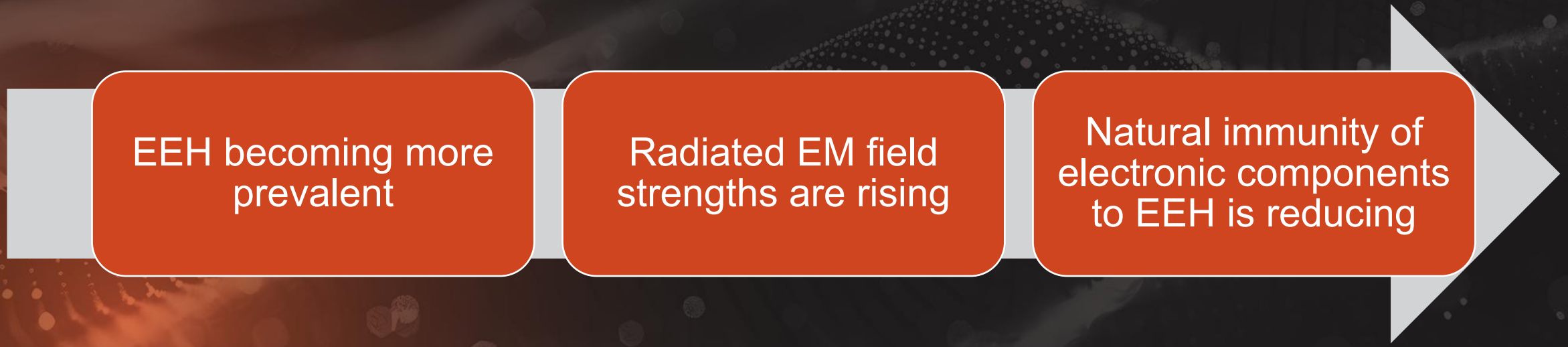
- Network Centric Warfare – the dream of the 90s is here!
- Every platform is increasingly networked and digitised resulting in a more congested EM Spectrum (EMS).
  - Previously this level of connectivity was limited to advanced air and maritime platforms
- Legacy EO has been characterised against legacy systems with limited EMS profiles.



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The Evolving EEH Environment

- The EM environment is becoming increasingly ‘crowded’.
- Mobility of platforms and associated RF emitters.
- Inevitably, there are hazards to ordnance in the modern battlefield.



The Risks of EEH

- Rare, high consequence
  - ➢ Loss of life, mission failure, platform degradation
- A few HERO incidents are briefly detailed in the slides that follow.

Warhead with Carbon-bridge Detonator

- Unverified but widely cited HERO-related fatality (Israel, approximately 1991).
- A carbon-bridge detonator reportedly initiated during a warhead experiment in the presence of a handheld radio, causing six fatalities.
- Primary-source investigation details have not yet been located.

- *Source: E3 and Spectrum Supportability for Acquisition Professionals, DISA*

Cable Cutter Cartridge – SH-60 Seahawk

- Inadvertent firing of Mk 23 Mod 0 impulse cartridge as SH-60 aircraft approached a CG47 class ship
- The Mk 23 Mod 0 was involved in several such incidents, and was subsequently selected for testing of inductive coupling protective components to improve its RF susceptibility

Source: Applying Analog Integrated Circuits for HERO Protection, Willis, Kenneth, 1994

Inadvertent firing of CIWS Round

- 10 Jan 1988 - USS Chandler (DDG-996), Arabian Gulf. One 20 mm Mk 149 Mod 1 round was inadvertently discharged from aft Phalanx CIWS Mount 22 while on routine patrol.
- The projectile exited the muzzle and fell harmlessly into the sea.
- The brief incident report does not identify a cause, although the event was later cited within HERO-related incident compilations.
- No injuries or damage were reported.

Source: Electro-explosive Hazards Assessment - Study Into Defence Requirements

What happens when EEH controls fail?

- Although individual causes remain debated, these incidents continue to feature in discussions because they highlight the potential consequences of EEH

EEH Current State

- Informal knowledge transfer
  - Reliant on ‘On-the-Job-Training’
  - Not formalised or structured
- Small community of experts
- Limited awareness across broader Defence
- Workforce turnover

Training - Historic Viewpoint

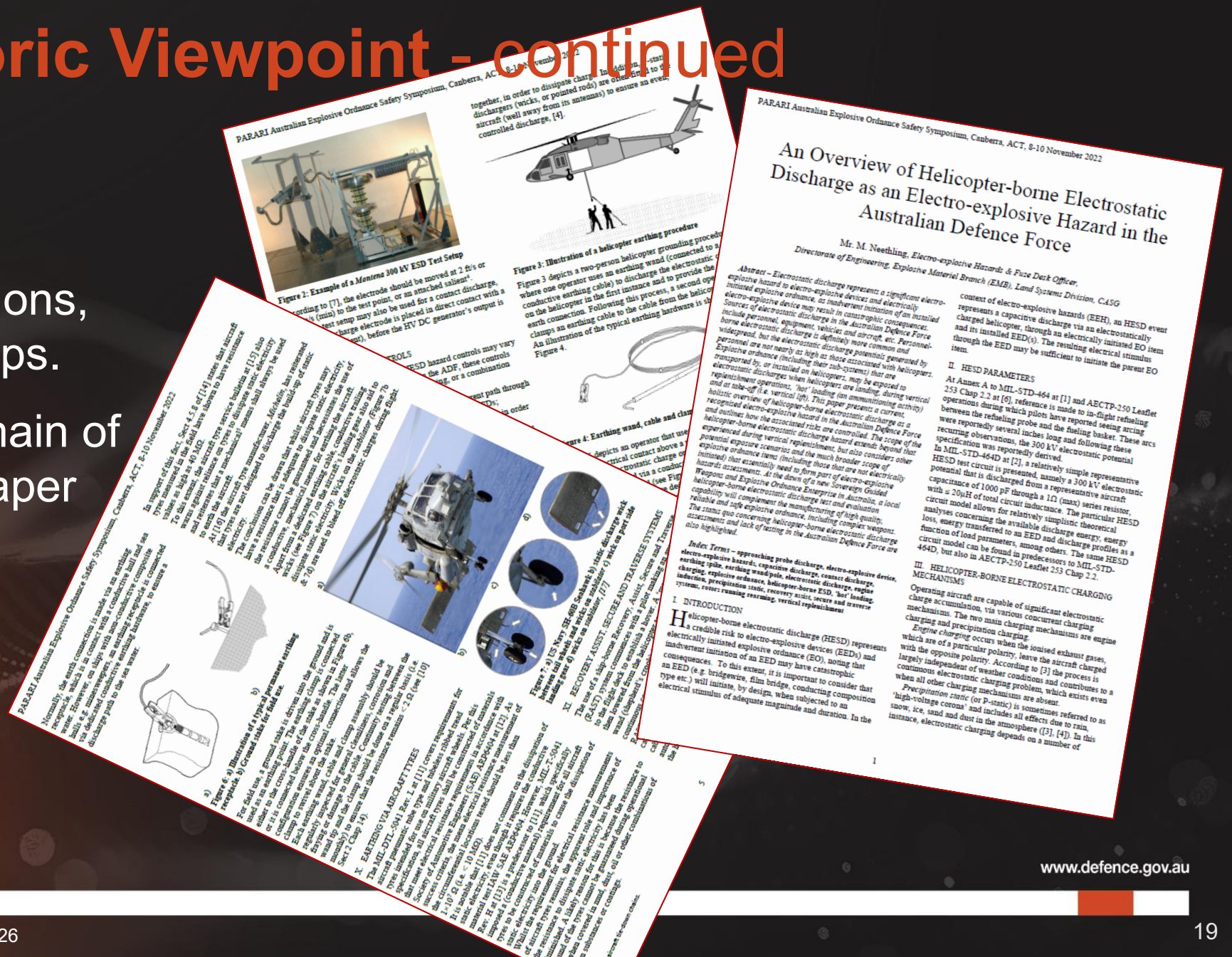
- EEH Continuation Training (CT) occurred on a fairly ad-hoc basis.
  - Always competing with other CT timeslots.
- Site-specific & tailored EEH training occurred on an ad-hoc basis.
- University Courses
  - Locally – Master of Explosive Ordnance (MEO), UNSW
  - Abroad – MSc Explosive Ordnance Engineering (EOE) delivered through Cranfield University at the Defence Academy of the UK (Shrivenham)
  - Provides supporting EO engineering knowledge that strengthens EEH practice (to some extent).

Training - Historic Viewpoint - continued

- Joint Electromagnetic Environmental Effects (E3) – Community of Practice (CoP)
  - Active mid 2019 to mid 2020.
  - Representation from Directorate of Ordnance Safety (DOS), RAAF Air Warfare Engineering Squadron, DST Weapons and Combat Systems Division, Naval Technical Bureau, Land Engineering Agency and Explosive Materiel Branch.
  - Allowed for regular engagement and knowledge-sharing with different E3 Specialists.
  - Nice idea! Never gained traction due to **'other priorities'.**
  - Formal endorsement / establishment could not be achieved.

Training - Historic Viewpoint - continued

- PARARI EO Safety Symposium
  - ➢ Papers/presentations, tutorials, workshops.
  - ➢ Some papers remain of use e.g. HESD paper

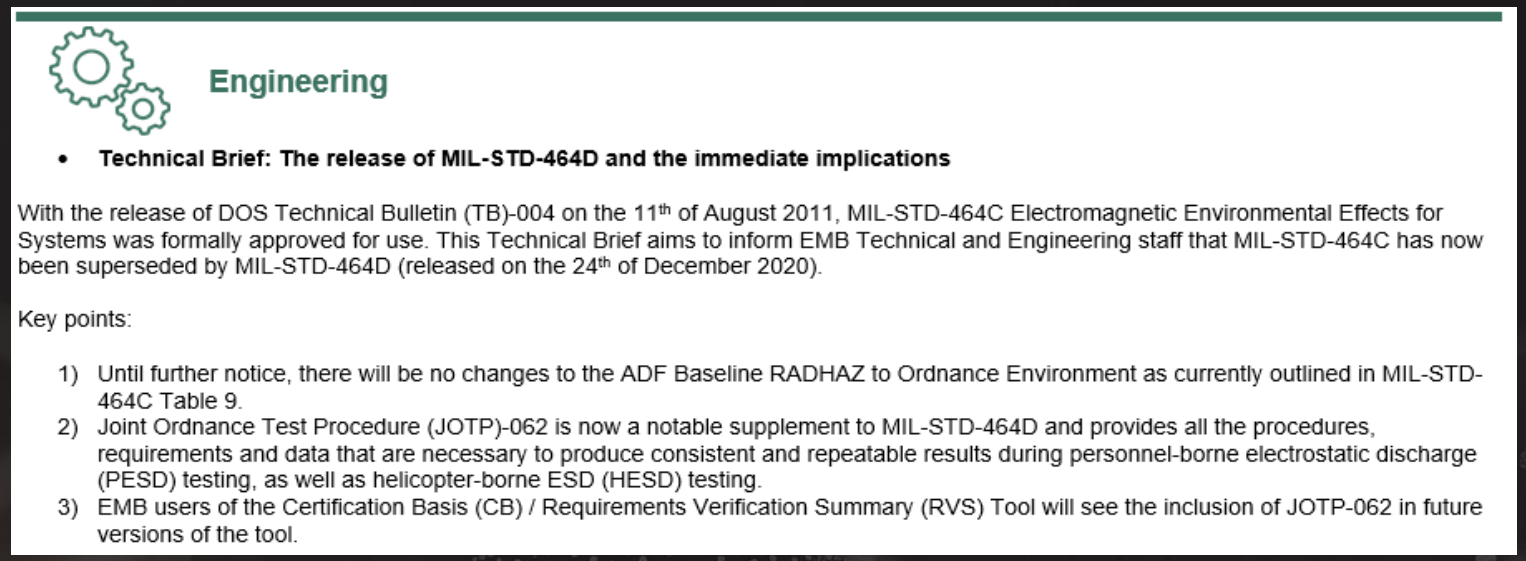


Training - Historic Viewpoint - continued

- Defence Explosive Ordnance Training School (DEOTS)
  - EO Engineering / Armament Officer's course (formerly)
  - Explosive Chemistry Weapon Design Fundamentals course (currently)
    - limited EEH content (≈ 90 min)

Training - Historic Viewpoint - continued

- Technical Briefs
  - ➢ sent out as part of Explosive Materiel Branch (EMB) Weekly Broadcasts, Sep 2021 to Aug 2022



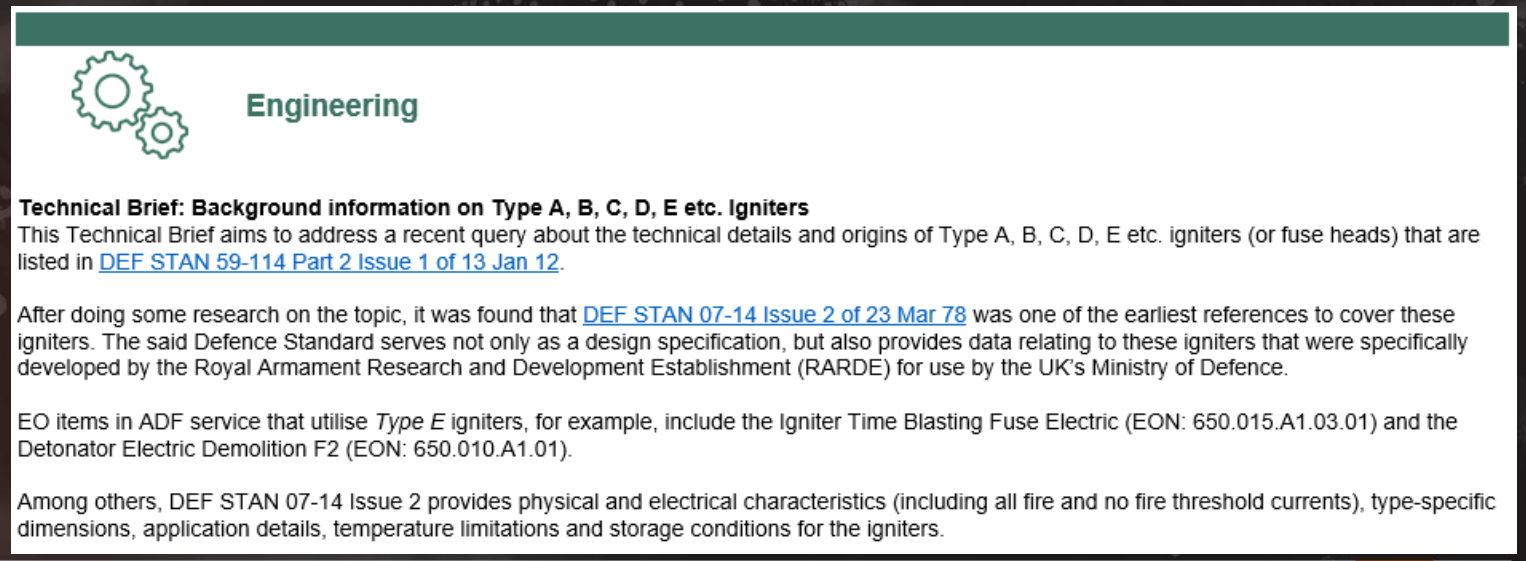
Engineering

- **Technical Brief: The release of MIL-STD-464D and the immediate implications**

With the release of DOS Technical Bulletin (TB)-004 on the 11th of August 2011, MIL-STD-464C Electromagnetic Environmental Effects for Systems was formally approved for use. This Technical Brief aims to inform EMB Technical and Engineering staff that MIL-STD-464C has now been superseded by MIL-STD-464D (released on the 24th of December 2020).

Key points:

1) Until further notice, there will be no changes to the ADF Baseline RADHAZ to Ordnance Environment as currently outlined in MIL-STD-464C Table 9.
2) Joint Ordnance Test Procedure (JOTP)-062 is now a notable supplement to MIL-STD-464D and provides all the procedures, requirements and data that are necessary to produce consistent and repeatable results during personnel-borne electrostatic discharge (PESD) testing, as well as helicopter-borne ESD (HESD) testing.
3) EMB users of the Certification Basis (CB) / Requirements Verification Summary (RVS) Tool will see the inclusion of JOTP-062 in future versions of the tool.



Engineering

Technical Brief: Background information on Type A, B, C, D, E etc. Igniters

This Technical Brief aims to address a recent query about the technical details and origins of Type A, B, C, D, E etc. igniters (or fuse heads) that are listed in DEF STAN 59-114 Part 2 Issue 1 of 13 Jan 12.

After doing some research on the topic, it was found that DEF STAN 07-14 Issue 2 of 23 Mar 78 was one of the earliest references to cover these igniters. The said Defence Standard serves not only as a design specification, but also provides data relating to these igniters that were specifically developed by the Royal Armament Research and Development Establishment (RARDE) for use by the UK's Ministry of Defence.

EO items in ADF service that utilise *Type E* igniters, for example, include the Igniter Time Blasting Fuse Electric (EON: 650.015.A1.03.01) and the Detonator Electric Demolition F2 (EON: 650.010.A1.01).

Among others, DEF STAN 07-14 Issue 2 provides physical and electrical characteristics (including all fire and no fire threshold currents), type-specific dimensions, application details, temperature limitations and storage conditions for the igniters.

EEH Training

We have done a lot!

However, momentum has been lost.

GWEO Engineering and Technical Professionalisation

- GWEO is undergoing a major uplift to its technical competence framework.
- This provides an opportunity to formalise EEH as a key enabling capability.

EEH Outcomes

- EEH embedded in competency frameworks
- Broader EEH knowledge across EO community – SPOs, end users and operators, Defence Industry
- Accessible training and guidance
- Risks known and actively managed

Fixing EEH capability

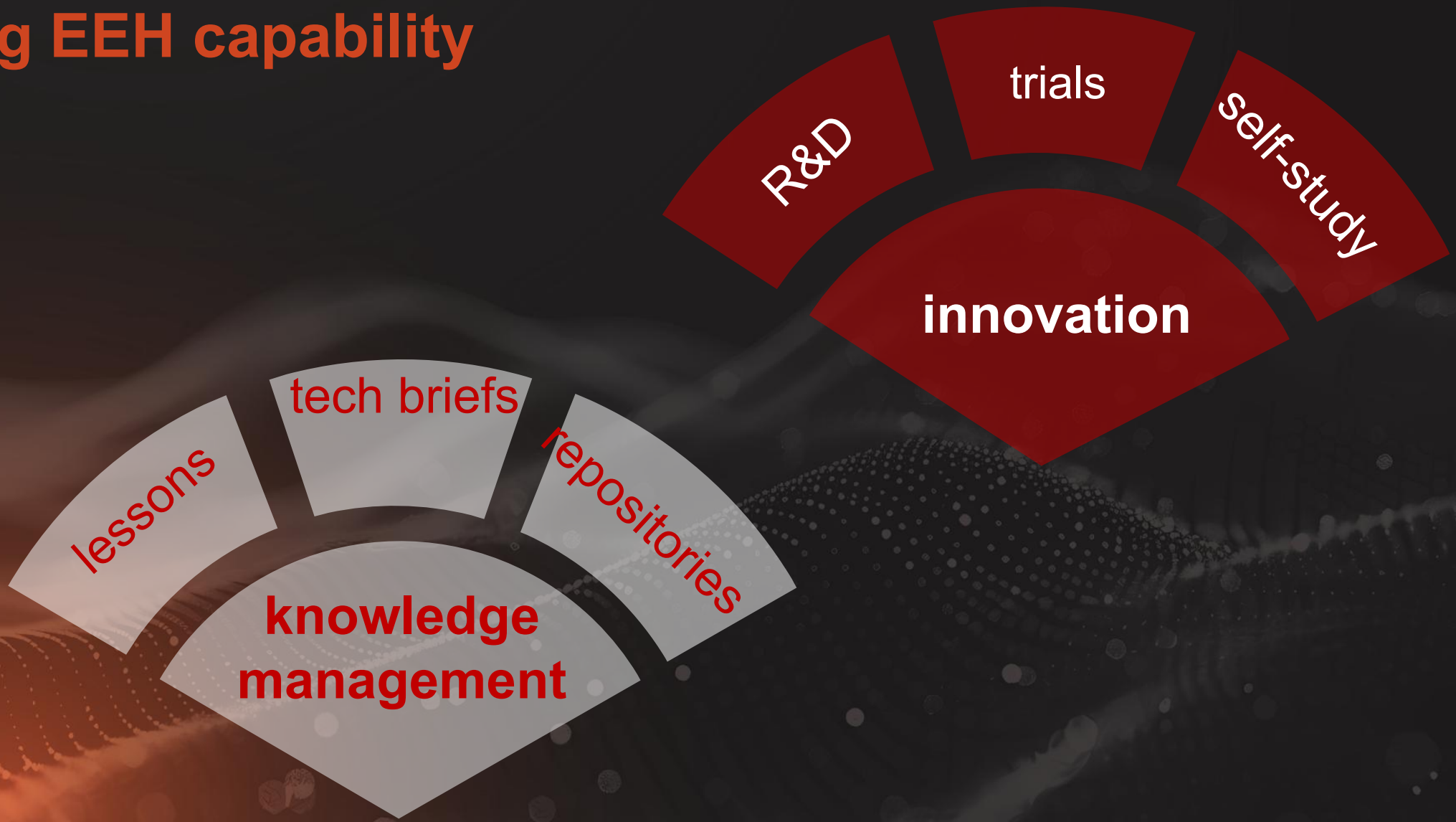


Fixing EEH capability





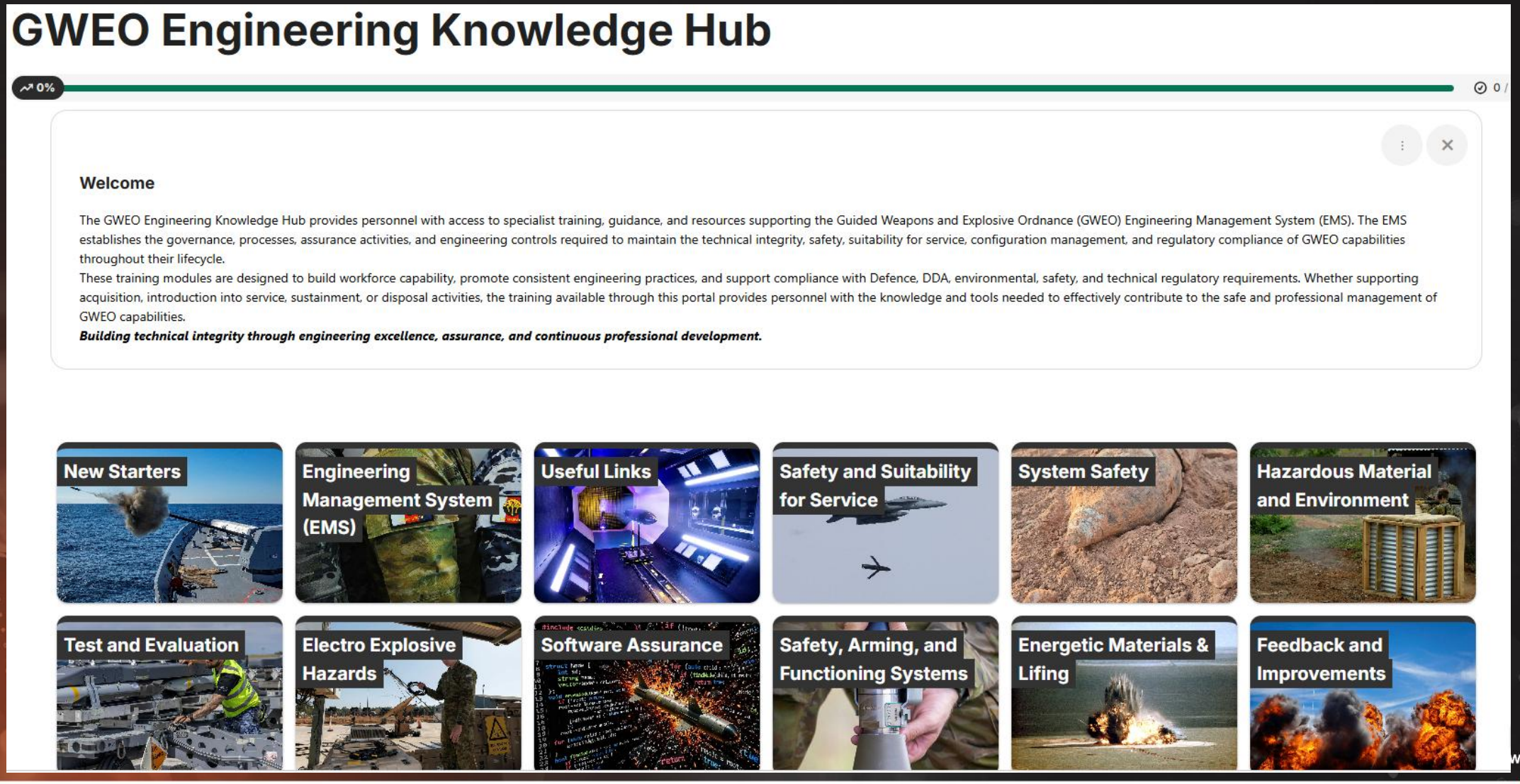
Fixing EEH capability



Fixing EEH Capability

Pillar	Key Enablers
Leadership	sponsorship, resourcing, direction
Experience	on-the-job training, accreditation, mentoring
Training	formal, internal, seminars, conferences
Innovation	research, trials support, self-study
Collaboration	Forums, communities of practice, workshops
Assurance	standards, peer review, certification
Knowledge Management	lessons learned, guidance, repositories

What we're doing



Conclusion

"When expertise fades, invisible hazards become forgotten hazards."

Preserving EEH knowledge ensures that electromagnetic threats remain understood, recognised, and appropriately managed throughout the EO lifecycle.

QUESTIONS

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