Saving Lives and Sustaining Life: An Australian perspective on the Program Management of Aeronautical Life Support Equipment in Defence.

David Bywater, Australian Defence Department.

Abstract

Introdcution and Aim: The acquisition and sustainment of Australian Defence Force common Aeronautical Life Support Equipment (ALSE) for 19 fixed wing and rotary wing platforms across the Army, Navy and Air Force is centrally managed by the Capability Acquisition and Sustainment Group (CASG). In a rapidly changing strategic environment for national Defence, the program management of ALSE must keep pace in order to meet the evolving safety and mission needs of our aviator community. This brief will overview the Australian approach to ALSE requirements setting, acquisiiton and sustainment; focusing on the key challenges and opportunities facing the program now and across the next decade.

Technical Outline: Placed at the interface between human and machine, Australian ALSE capability provides a vital contribution to military aviation operations. Australia juggles competing priorities and demands from three very different services, with a limited ability to fund and resource transitions to contemporary, best pratice equipment. Optimisation of the Australian approach to ALSE program management is necessary to deliver the best capability and safety outcomes possible. Three pillars underpin our strategy to deliver improved outcomes to our warfighters:

a. **ALSE Capability Roadmap**. A reformed program management framework needs to deliver and fund a prioritised investment program for ALSE replacements. Across a 10 year roadmap, fleet replacements and technology refresh activities will be bundled and phased in an optimised manner to increase speed to capability and reduce costs.

b. **Requirements setting and design standards**. Australian Defence operates across American and European aviation platforms, and sits at the end of a global supply chain with minimal sovereign ALSE manufacturing capability. Our prescribed standards must reflect international best practice, without restricting procurement options to one country or another. We will take a less prescriptive and more outcomes based approach to design standards promulgation to promote flexibility. We will also work with international partners to influence the development of standards and specifications.

c. **International engagement and partnerships.** The Australian ALSE program is small in material scale but complex in its application across multiple platforms and operating roles. Opportunities exist to engage and collaborate with international Defence procurement, sustainment and science and technology partners through joint development efforts, knowledge sharing and test and evaluation support.

Cconclusions: Australian Defence aviators deserve contemporary ALSE solutions that deliver exemplary safety performance and mission enhancing capabilities. The ADF ALSE Program is intent on executing a strategy that will deliver this outcome via a 10 year ALSE Capability Roadmap, the optimisation of requirements setting and leveraging international relationships.

Biography

Mr David Bywater CSC MIEAust CPEng is the Deputy Director for ALSLMU located within CASG for the Australian Defence Department. David is appointed as the Delegate of the

Defence Aviation Safety Authority for ALSE, and is responsible for the prescription of ADF ALSE design standards.

Prior to his career as a civil servant, David was a commissioned Aerospace Engineering Officer in the RAAF and remains an active reservist with RAAF HQ Air Command. David's service experience spans operational experience with C-130J and F/A-18 Hornet, military instruction, acquisition and sustainment. David is a Chartered and Registered Professional Engineer with Engineers Australia, holding a Bachelor of Mechanical Engineering with Honours from the University of Technology, Sydney, and a Masters of Business with Honours from the University of New South Wales. In 2020, David was honoured by the Governer General of Australia with a Conspicious Service Cross for his services to ADF Aeronautical Life Support reform, acquisition and sustainment. David is married to Melissa and has two sons, Hudson (9) and Lincoln (3). In his spare time, David enjoys camping, travel, only the best coffee and devoting his energy to his boys.

G-induced alterations of consciousness in UK military aviation

Dr Michael Jones (Sqn Ldr), Royal Air Force, Kings College London

Abstract

BACKGROUND: Despite improvements to G training and countermeasures, G-induced alterations of consciousness continue to cause military aircraft incidents. A previous survey of Royal Air Force aircrew completed in 2012 reported that 37.2% had experienced at least one A-LOC or G-LOC episode. This study aimed to assess whether the introduction of updated centrifuge training and improved training aircraft countermeasures has reduced reports of these incidents.

METHODS: An anonymous survey of UK Armed Forces pilots was carried out to re-assess the prevalence of G-induced alterations of consciousness. Further questions aimed to examine perceptions of G-related risk factors and mitigations in pilots exposed to the high G environment.

RESULTS: 403 pilots responded to the survey with the response rate estimated at 11.9%. 21.6% of pilots reported at least one G-induced alteration of consciousness incident. A higher proportion of incidents was reported by frontline fast jet pilots compared to previous surveys. Common risk factors reported included failure to carry out an effective AGSM, pre-flight fatigue and lack of recent exposure to the high G environment. Recency of high G exposure was rated as the most important risk factor for G-induced incidents across all pilots surveyed.

DISCUSSION: Whilst an overall reduction in prevalence of G-induced alterations of consciousness incidents was observed, the high G environment remains a relevant flight safety hazard in UK military aviation. Despite aviation medicine training, trainee pilots need to be reminded to carry out an AGSM. Additional risk assessment for the G-layoff effect may be beneficial for frontline fast jet pilots.

Biography

Dr Michael Jones MB BChir MA MSc DAvMed DOccMed MRCP MRAeS RAF

Squadron Leader Michael Jones is a Royal Air Force Medical Officer. He completed his training as a General Practitioner in 2016 and has worked at RAF Brize Norton, RAF Akrotiri and the Centre of Aerospace Medicine at RAF Henlow, as well as deployments to the Middle East. He was responsible for High G Centrifuge training development and delivery at the RAF's new High G Training and Test Facility from 2019 to 2020 followed by completing MSc studies in Aerospace Medicine with King's College London. He is currently working at the Regional Occupational Medicine Department at RAF Brize Norton and is training to become a military Consultant in Occupational Medicine. When he isn't working or kept busy by two young children, he enjoys recreational flying with the RAF Brize Norton Flying Club.

Development of a novel brain injury criteria for aircrew helmets

Dr Alasdair Mackay, Centre of Aerpsoace Medicine, UK MOD, Kings College London

Abstract

Introduction: Aircrew helmets mitigate the risk of head impacts by reducing the forces acting on the head. The assessment of aircrew helmet impact performance is typically carried out on a drop rig. A helmeted dummy headform is dropped from a defined height onto a rigid surface such as an anvil. The choice of anvil, the impact location and speed of impact is determined by the relevant impact standard.

Internationally, aircrew helmets are required to pass an injury threshold based on the peak translational acceleration (PTA) measured at the headform. Translational acceleration is closely associated with localised pathologies such as skull fracture but the link between PTA and brain injury is less well established. This research proposes alternative injury thresholds for use in aircrew helmet certification.

Technical outline: There is a growing body of evidence that most brain injury pathology is caused by mechanical strain resulting from brain deformation. Pathologies such as diffuse axonal injury and loss of consciousness are closely associated with increases in brain strain. Loss of consciousness, although classed as a minor traumatic brain injury (mTBI) is of particular concern for aircrew. Incapacitation for even a short duration can be potentially fatal due to post-crash fires or escape and evasion considerations. A review of UK fast jet ejections from 1972-2023 identified loss of consciousness as the most prevalent brain injury sustained (76%).

A database of 82 live reconstructed sporting head impact cases were used to load a finite element method (FEM) brain model. The database included the head kinematics of cases with and without a loss of consciousness. Strain and strain rate was measured in the nuclei of the brainstem known to be associated with arousal. Multiple linear regression was carried out to generate tissue injury risk functions for loss of consciousness.

FEM models of the brain are highly biofidelic, with strain and strain rate calculated to a high degree of accuracy, however they are computationally intensive techniques and so are not currently suitable for use in helmet certification. Tissue injury risk functions were therefore converted to kinematic injury risk curves by using logistic regression techniques. Injury risk curves for peak rotational acceleration (PRA) and peak rotational velocity (PRV) were generated. These kinematic based injury risk curves allow simple triaxial test data collected on the drop test rig to predict the risk of loss of consciousness.

Conclusions and recommendations: Internationally, PTA is the sole pass-fail injury threshold used for certification of aircrew helmets. This research recommends the inclusion of rotational kinematic thresholds in addition to PTA. Injury risk curves have been developed to quantify the risks of loss of consciousness for rotational kinematics; these enable future helmet impact standards to set the maximum acceptable risk of loss of consciousness for a specified helmet impact test scenario.

Biography

Squadron Leader Alasdair Mackay is a Specialty Registrar in Aviation and Space Medicine (ASM) at the Centre of Aerospace Medicine, Royal Air Force Henlow. Prior to reading Medicine, he completed a BSc in Biology and an MRes in Bioinformatics. Alasdair worked as a General Practitioner prior to commencing ASM training and has subsequently completed the Diploma in Aviation Medicine. Alasdair's interests are in aircraft accident investigation and the injury biomechanics of fast jet ejections and aircraft crashes. He sits on the BSI Head Protection and Applied Ergonomics committees as a technical expert and is a member of the Royal Aeronautical Society. Alasdair is an active member of the Military Aircrew Helmet Impact Standard (MAHIS) working group. He is currently a PhD candidate at the Imperial College London HEAD lab, and his research title is Aircrew Head Injury Protection.

Hypoxia impairs reaction time but not visual scanning of helmet mounted display symbology.

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Abstract

Introduction: In military aviation, helicopter pilots increasingly rely on helmet mounted displays (HMD) to maintain awareness of aircraft systems and the environment. During flight, pilots actively scan HMD symbology and focus their attention on the various symbols to perceive the information displayed. This requires good functioning of the visual system, which can be impaired by hypoxia. We investigated the effect of hypoxia on the reaction time (RT) and response accuracy of pilots performing a visual choice reaction task that corresponded to the scanning of HMD symbology.

Method: Eighteen male military pilots performed the task in a hypobaric chamber at two simulated altitudes (300 ft and 15,000 ft) in a single-blinded repeated measures and counter-balanced design. The visual stimuli were displayed in low and high contrast and at a 30- and 50-degree field of view (FoV). We measured the pilots' RT and response accuracy. Using an eye tracker, we measured the pilot's glance time at each stimulus location. Finally, we collected subjective ratings of alertness.

Results: The results show that hypoxia increased the RT and glance time. Contrary to our expectation, this effect on RT was not exacerbated by decreasing stimulus contrast or increasing stimulus FoV. Lowering the stimulus contrast and increasing the FoV further increased the RT, independent of hypoxia. RT correlated positively with glance time. There was no significant difference in response accuracy between the two altitude conditions, but pilots corrected significantly more responses during the hypoxia condition than during the baseline condition. Finally, the sleepiness ratings indicated that alertness was significantly lower during the hypoxia condition than during the baseline condition.

Discussion: Our findings provide no evidence for hypoxia-induced changes in visual contrast sensitivity or visual field. Instead, hypoxia seemed to affect RT and glance time by reducing alertness. It appears that pilots maintained their accuracy on the visual task by trading response speed for greater response accuracy. Our results suggest that visual scanning of HMD symbology may be resistant to the effects of acute hypoxia.

Biography

Yuval Steinman joined the Centre for Man in Aviation of the Royal Netherlands Airforce in 2007 during his Masters Degree's work placement in sports exercise (Maastricht university). Yuval's research concentrates in two areas 1) influence of hypoxia exposure on pilots flight performance, 2) testing and evaluation of the effect of current and new flight equipment might have on aircrew performance and safety.

F-35 Post Ejection Survival Training

Matthew Parkinson, Martin-Baker Aircraft Company Ltd

Abstract

Introduction: Post Ejection Survival Training (PEST) is a training course delivered by Martin-Baker Human Engineering technical instructors to air force survival training instructors responsible for F-35 pilot training. This course has been developed and rolled out to a number of F-35 operators over the past 10+ years.

Objectives and user requirements: This paper will discuss the objectives of PEST, as well as how unique user requirements feed into the equipment developed, and the training methods taught.

Training equipment: The paper will discuss some of the common training equipment used for F-35 PEST to enable all aspects of post ejection procedures to be taught and trained specific to the platform and equipment used on F-35. Some of the more bespoke equipment designed, tested, and available for more unique user requirements will be discussed.

Benefits and future potential: The paper will conclude with the benefits seen by end user groups in developing and implementing equipment specific PEST for their aircrew, and the potential to expand PEST across other platforms.

Biography

Matthew leads the Survival Systems team within the Human Engineering Department at Martin-Baker Aircraft Company Ltd. Matthew began his career at Martin-Baker in 2010, moving into the Human Engineering Department in 2013. Matthew is responsible for all aspects of survival equipment fitted to Martin-Baker ejection seats, as well as Post Ejection Survival Training.

FireDragon – A Solidified Ethanol Based Fuel

Katie Reichwald, BCB International

Abstract

Introduction: Combusting fuels such as hexamine, charcoal and wood when used indoors can prove life-threatening due to the emissions that are released and subsequently inhaled. In conjunction, these harmful emissions are often greenhouse gases which have detrimental effects on our environment. The concept of FireDragon, our solidified ethanol based eco-fuel, aims to confront both of these majorly pressing issues, and was conceptualised in 2013 after hexamine fuel was used in tents by the armed forces, sadly leading to a detrimental outcome for those involved.

Aim: BCB International aims to provide a clean, safe and efficient alternative to other fuels that is functional in extreme conditions. Made with bioethanol, FireDragon is the innovative way of ensuring sustainability and quality in all recreational and survival settings. This abstract aims to highlight key data in support of FireDragon compared to other common fuels, highlighting its potential in arctic survival.

Technical Outline: Hexamine, one of the most commonly used fuels, combusts with the simplified equation (assuming complete combustion). Meanwhile, ethanol (FireDragon) combusts with the simplified equation (assuming complete combustion).

Per mole of fuel, less carbon dioxide is emitted from FireDragon, along with a significant reduction in other harmful gases such as nitrous oxides and ammonia. Furthermore, the energy released from FireDragon is around 9% higher than that of hexamine.

FireDragon has also been tested in Arctic conditions in Norway, with low temperatures around -11°C. It was found, using a 27g block of FireDragon was sufficient to boil 500ml of water in 9 minutes, and it was never blown out by the arctic winds.

Conclusion: FireDragon is significantly less harmful to the environment and when inhaled during combustion than most other available fuels. Reduction in particulate matter; volume and type of emitted gases during combustion makes it safer for use in confined spaces. The efficient energy release and transfer enables FireDragon to be used in nearly all survival and recreational settings, including extreme cold. Preliminary trials have estimated effective heat transfer of ~1.9kW for 3kg of FireDragon designed for arctic survival. This is sufficient to boil and maintain boil (4 gallons of water) for at least 25 minutes (starting temperature ~14ºC). Moreover, FireDragon is functional and can ignite even in damp and extreme cold conditions. The trials in Norway demonstrate the immense capabilities of our solidified ethanol fuel in the Arctic.

Biography

Having studied at Cardiff University and graduating with a degree in Biomedical Sciences (BSc) in 2021, Katie gained a strong understanding of experimental design, data handling and a broad grasp of multiple areas of the biological sciences. She started her career working as a pharmaceutical analyst shortly after, beginning her journey into the world of chemistry. This progressed into working in several quality control laboratories, specialising in ion-exchange resins and various forms of chemical analysis, along with some minor experiences working in electrolysis. The combination of this experience led to a strong understanding of formulation processes, various analytical techniques and GMP coherence, with a large focus on data collection, handling and therefore experiment design also. Now working as BCB Internationals

R&D Chemist, she is focusing on the innovation and development of new products, such as FireDragon, aiding in their goal of safe, efficient and quality products tailored towards survival, applying all previously learned skills in the process.

Finding the needle in the haystack: Using AI to provide highly accurate person overboard detection and tracking

Andy Tipping, Co-founder, Zelim

Abstract

Finding a person who has fallen overboard is often a game of luck, at a ships deck level or from a SAR helicopter or drone you are trying to spot an object no larger than a football from several hundred metres. Even once spotted, a person drifts quickly in currents and is often obscured by waves, light glare and sea spray so they can quickly become lost. Add to this, the random motion of water, weather and reflected light combine to create a chaotic environment where the human eye and vision systems can become confused, leading to misidentification or worse, failed sightings.

Zelim have developed ZOE, an AI enabled person in water (PIW) detection solution which brings order to the chaos, detecting, alerting and tracking PIWs in daylight, night time, storm, mist or fog. Developed in collaboration with the US Coastguard, ZOE's AI models have been built on a dataset of over 4.5 million labelled maritime rescue images across a wide range of ocean conditions. Powered by this dataset, ZOE provides a greater probability of detection and a consistent level of detection performance, whatever the weather.

Hear from Zelim co-founder Andy Tipping for an insight into how AI can be used to improve the chances of finding and tracking people in distress.

Outcomes: Attendees will learn about:

- The application of AI to detect and track a person or multiple people who have fallen overboard
- Why AI can deliver exceptionally accurate and consistent detection results in such a challenging environment
- How AI detection can be used to support search operations and sea surface monitoring

Biography

Andy Tipping Co-Founder and Commercial Director of Zelim.

Andy has spent much of his career commercialising novel technologies in the maritime world, spending 8 years in offshore wind, where he founded the industry's first technology accelerator, the Launch Academy, which marries up sector primes with agile innovators developing cutting edge technology. Andy joined Zelim as a co-founder in 2020 and has since been driving the commercialisation of Zelim's search and rescue technologies, taking them from idea on a page to commercial reality.