THE EVOLUTION OF AVIATION MEDICINE AND AVIATION PSYCHOLOGY IN THE REPUBLIC OF SINGAPORE AIR FORCE

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Ramstein Aerospace Medicine Summit 2019

Scope of Presentation

- Introduction
- Milestones of RSAF Aeromedical Centre
- Functions of the RSAF Aeromedical Centre
  - Advancements in Aviation Physiology Training
  - Performance Maximisation Research and Translation
  - Aeromedical Standards and Force Health
  - Aircrew Selection Systems and Aviation Psychology
- Conclusion

Introduction

SINGAPORE

Introduction

Singapore Air Defence Command 1968

Hawker Hunter Squadron 1970

- Republic of Singapore Air Force (RSAF) was born on 1 Sep 1968
- Exponential growth of the RSAF following the early years
- Need for deep expertise in Aviation Medicine and Aviation Psychology
- Concept of the RSAF Aeromedical Centre

"If the proposed centre's core functions of aeromedical training, research and clinical services prevented just one aircraft accident, the savings in cost, not to mention the pilot's life, would more than pay for the entire investment"

Dr Lim Meng Kin

Milestones of RSAF Aeromedical Centre

- In 1981, the concept of Aeromedical Centre was approved
- In 1982, the Aeromedical Centre was established next to the Medical Centre within Paya Lebar Air Base
- Focussed on pilot selection and medical screening

1982

1982


Pilot Selection


Aptitude Test


Medical


Medical


Mark III Chamber

Milestones of RSAF Aeromedical Centre

- In 1987, new building was required to house new equipment to conduct Aviation Physiology Training
  - Vertifuge
  - Night Vision Trainer
  - Ejection Seat Trainer
  - Oxygen Systems Trainer
  - Hypobaric Environmental Chamber


Chamber

Vertifuge

1987

"Singapore is at the cross-road of international air travel and has considerable civil aviation activities. So, the Aeromedical Centre could serve us as a national resource catering to both military and civilian needs."

Yeo Ning Hong
Second Minister for Defence (Policy)
23 Jan 1987

Milestones of RSAF Aeromedical Centre

- In 1994, an extension to the building was required to house the Centrifuge
- The G-Flight Environment Trainer (G-FET) was commissioned on 18 Nov 1996 by Deputy Minister for Defence Dr Tony Tan


Laying the foundation for G-FET

Installation of the G-FET


Dr Tony Tan


Commissioning of G-FET

G-FET


G-FET Control Station


G-FET Cockpit

Milestones of RSAF Aeromedical Centre

- Reorganized the Air Force Medical Service
- Commercialization of Routine Aeromedical Services in 1997

- Focus on new areas of growth
  - Development of Innovative Aviation Physiology Training and Review of Aircrew Safety Equipment
  - Human Performance Research and Development
  - Develop Medical Doctrines and Aeromedical Standards
  - Development of New Aircrew Selection Systems

Air Force Medical Service

Aeromedical Centre

Aviation Physiology Training

- Aviation Physiology Training - New Generation Equipment since 2010

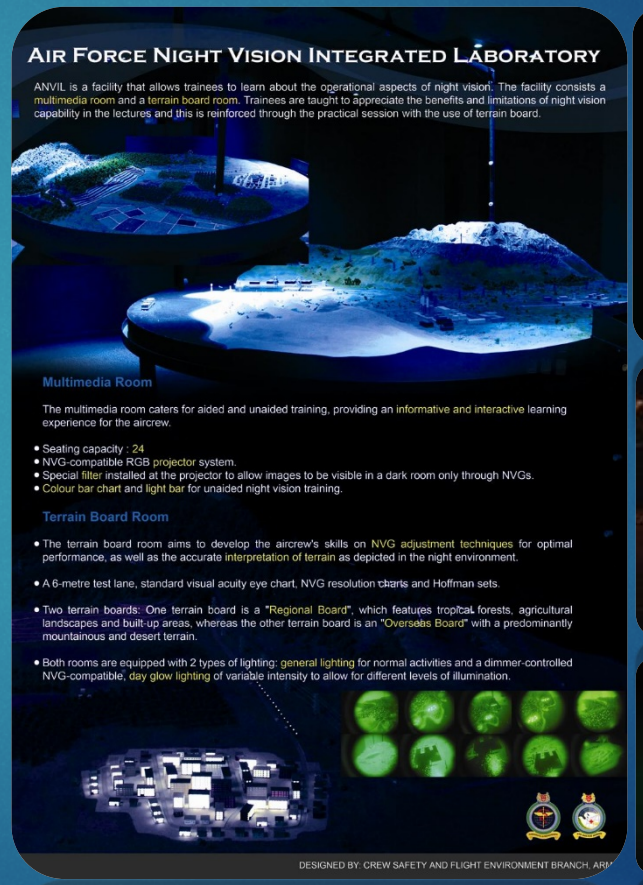
Ejection Seat Trainer

Human Training Centrifuge

Aviation Physiology Training

- Aviation Physiology Training - New Generation Equipment since 2010

Spatial Disorientation Trainer



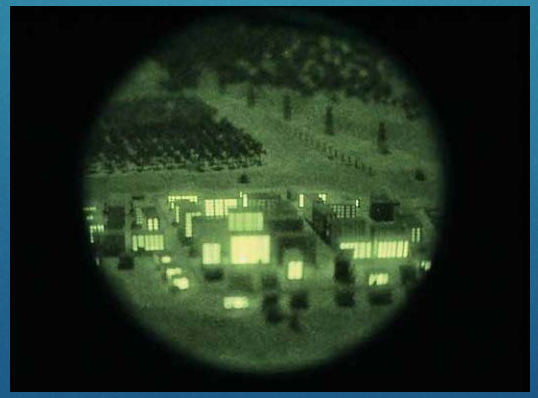
Airforce Night Vision Laboratory (ANVIL)

Aviation Physiology Training

Hypobaric Chamber

Aviation Physiology Training

Training Pedagogy?



Aviation Physiology Training

- Conducted every 3 yearly for all RSAF aircrew
- Since 2015, progressed to include 40-hour online learning module for trained aircrew
- Increased practical training on the equipment
- Classroom discussion of aircraft accidents and incidents resulting from physiological hazards
- Transformation from a didactic download of information to real world application of Aviation Medicine principles

Case Discussions

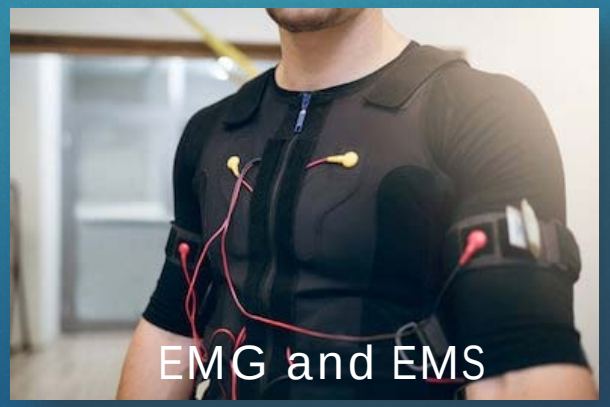
Aviation Physiology Training

- New and Exciting Training Pedagogies Rolled Out in 2019
  - Dynamic Flight Simulation – Yearly Operational G Assessment for Centrifuge Training
  - Breathing Quality Air (BQA) profile for Hypoxia Training

Aviation Physiology Training

- Future Potential Training Modalities
  - Hypoxia Training in Night Environment
  - Electromyography (EMG) and Electric Muscle Stimulation (EMS) for Centrifuge Training
  - Virtual Terrain Board for NVG Training


Night Hypoxia Training


EMG and EMS


Virtual Terrain Board

Aviation Physiology Training Accreditation

UNITED STATES AIR FORCE

Certificate of Recognition

to the

Republic of Singapore Air Force

Aerospace Physiology and Centrifuge Training Programs

For the period 1 December 2015 through 30 November 2020

DAVID A. WELGE
Lt Col, USAF, BSC, CAsP
Chief, Physiology Programs Branch

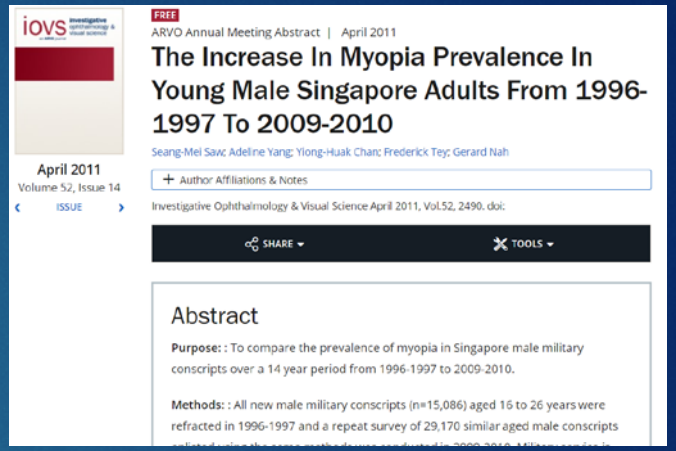
JOHN A. CHERREY
Brigadier General, USAF
Director of Intelligence, Operations
and Nuclear Integration

Aviation Physiology Training
Translation of Research

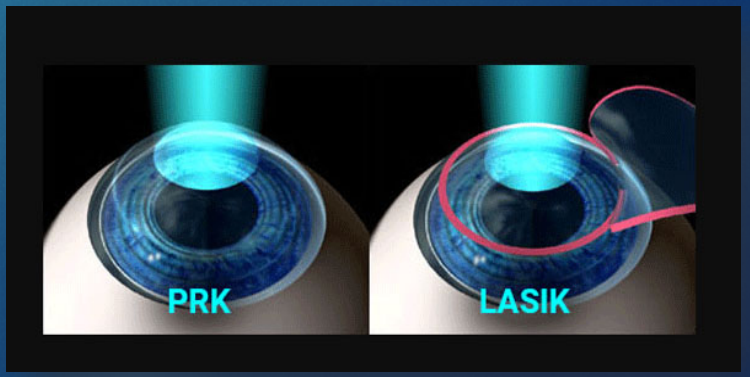
- Early centrifuge trials conducted at ARMC in 2002 showed that the Full Coverage Anti-G Trousers offered +1G to +1.5G more protection
- Explored possibility to use Full Coverage Anti-G Trousers for current fighter platforms
- Verification and certification for use on existing RSAF platforms
- In 2015, operationalized Full Coverage Anti-G Trousers, used in conjunction with Combat Edge, across all fighter platforms in the RSAF

Performance Maximization Corneal Refractive Surgery

- Myopia affects more than 80% of the population
- Study on the safety and efficacy of Corneal Refractive Surgery in early 2000s - Photorefractive Keratectomy (PRK)
- RSAF Corneal Refractive Surgery program in 2005
- Surgical protocols which minimized corneal scarring
- Included LASIK and increased the myopia cut-off from 500 to 600 degrees in 2015
- Performed CRS for hundreds of pilot applicants with no complications

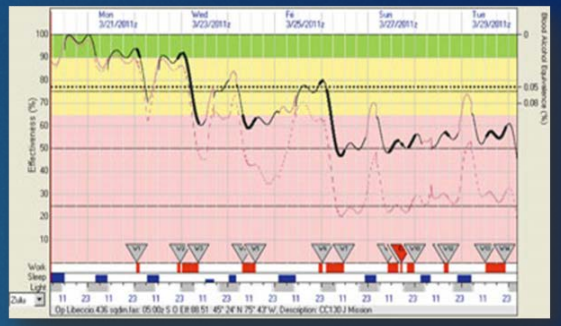


IOVS Apr 2011



Performance Maximization
Fatigue Research

- Fatigue research started since 2000, looking into novel ways of prevention, detection and intervention modalities for fatigue
- Prevention: Adopted the FAST® (Fatigue Avoidance Scheduling Tool) modelling as the basis for aircrew flight scheduling
- Detection: Trialed a few equipment to detect physiological measures of fatigue (eye saccades, balance, reaction time)
- Intervention: Zolpidem, Zaleplon, Caffeine, Modafinil



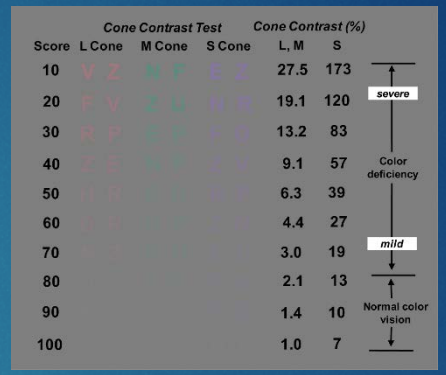
Performance Maximization
Fatigue Research

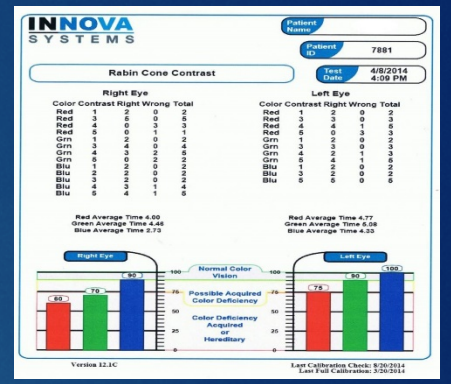
- Deploy the use of Readiband™ in operations
- Ongoing efforts to study and validate in-house developed psychomotor test on handheld phone platform

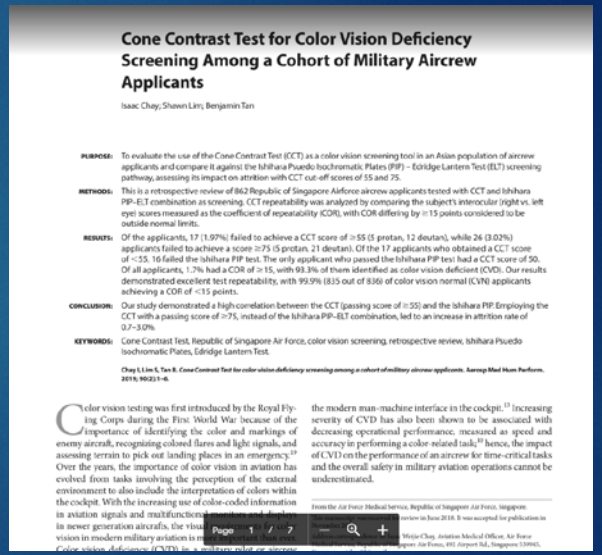
- Studied and operationalized the use of blue-enriched white lights in 24/7 units to enhance alertness

Aeromedical Standards
Color Vision Testing

- Ishihara Pseudoisochromatic Plates
- Lantern Test (Edridge Green / FALANT)
- Studied the feasibility of computerized color vision testing
  - Better quantify and classify color deficit
  - Inability for subjects to memorize
- Rolled out Cone Contrast Test in 2016 as the only color vision test for pilot and aircrew selection
  - Cut off at score of 75







Cone Contrast Test for Color Vision Deficiency Screening Among a Cohort of Military Aircrew Applicants

Isaac Chay; Shawn Lim; Benjamin Tan

PURPOSE: To evaluate the use of the Cone Contrast Test (CCT) as a color vision screening tool in an Asian population of aircrew applicants and compare it against the Ishihara Pseudo Isochromatic Plates (PIP) - Edridge Lantern Test (ELT) screening pathway, assessing its impact on attrition with CCT cut-off scores of 55 and 75.

METHODS: This is a retrospective review of 862 Republic of Singapore Airforce aircrew applicants tested with CCT and Ishihara PIP–ELT combination as screening. CCT repeatability was analyzed by comparing the subject's interocular (right vs. left eye) scores measured as the coefficient of repeatability (COR), with COR differing by ≥ 15 points considered to be outside normal limits.

RESULTS: Of the applicants, 17 (1.97%) failed to achieve a CCT score of ≥55 (5 protan, 12 deutan), while 26 (3.02%) applicants failed to achieve a score ≥75 (5 protan, 21 deutan). Of the 17 applicants who obtained a CCT score of <55, 16 failed the Ishihara PIP test. The only applicant who passed the Ishihara PIP test had a CCT score of 50. Of all applicants, 1.7% had a COR of ≥ 15, with 93.3% of them identified as color vision deficient (CVD). Our results demonstrated excellent test repeatability, with 99.9% (835 out of 836) of color vision normal (CVN) applicants achieving a COR of <15 points.

CONCLUSION: Our study demonstrated a high correlation between the CCT (passing score of ≥55) and the Ishihara PIP. Employing the CCT with a passing score of ≥75, instead of the Ishihara PIP–ELT combination, led to an increase in attrition rate of 0.7–3.0%.

KEYWORDS: Cone Contrast Test, Republic of Singapore Air Force, color vision screening, retrospective review, Ishihara Psuedo Isochromatic Plates, Edridge Lantern Test.

Chay I, Lim S, Tan B. *Cone Contrast Test for color vision deficiency screening among a cohort of military aircrew applicants.* Aerosp Med Hum Perform. 2019; 90(2):1–6.

Color vision testing was first introduced by the Royal Flying Corps during the First World War because of the importance of identifying the color and markings of enemy aircraft, recognizing colored flares and light signals, and assessing terrain to pick out landing places in an emergency.[1] Over the years, the importance of color vision in aviation has evolved from tasks involving the perception of the external environment to also include the interpretation of colors within the cockpit. With the increasing use of color-coded information in aviation signals and multifunctional monitors and displays in newer generation aircrafts, the visual [illegible] vision in modern military aviation is [illegible] the modern man–machine interface in the cockpit.[13] Increasing severity of CVD has also been shown to be associated with decreasing operational performance, measured as speed and accuracy in performing a color-related task;[10] hence, the impact of CVD on the performance of an aircrew for time-critical tasks and the overall safety in military aviation operations cannot be underestimated.

From the Air Force Medical Service, Republic of Singapore Air Force, Singapore. [illegible] review in June 2018. It was accepted for publication in [illegible]

Weijie Chay, Aviation Medical Officer, Air Force [illegible] Singapore Air Force, 491 Airport Rd., Singapore 539965;

Published in Aerospace Medicine and Human Performance Feb 19

Aeromedical Standards
Allergic Rhinitis (AR)

- Prevalence in Singapore is 25%
- Clinical assessment is based on a novel scoring technique - ACEG score
- Risk stratify into mild, moderate and severe AR
- Novel use of the hypobaric chamber as a practical tool to assess susceptibility for barotrauma in candidates with moderate allergic rhinitis
- Also used to assess applicants with suspected eustachian tube dysfunction

Aeromedical Standards
Cardiology

- Increased array of cardiac assessments and screening modalities have gone mainstream
  - Coronary Artery Calcium Score
  - CT Angiography

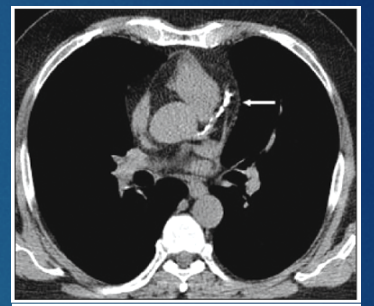


Fig. 1 - Calcification of the anterior descending artery detected on ultrafast tomography in an asymptomatic man (arrow).

- With the inclusion of some of these tests into the cardiac screening protocols and workflow in the military, it was pertinent to establish new guidelines based on medical literature

Aeromedical Standards
Chronic Hepatitis B

- Chronic Hepatitis B - endemic in Southeast Asia
- Started to pick up operational pilots who developed immune-CHB which required long-term suppression treatment
- Started evaluating pilots who received treatment (Lamivdine/Entecavir), monitoring them over a period of time while receiving treatment
- Returned 7 military pilots to flying duties from 2006-2014 while receiving treatment

Returning Aircrew with Chronic Hepatitis B Back to Flying While on Nucleos(t)ide Analogues

Dominic Tan; Clarence Kwan; Benjamin B. C. Tan; Wee Hoe Gan

BACKGROUND: Chronic Hepatitis B (CHB) remains a major cause of morbidity in several parts of the world. Aircrew with immune-active hepatitis are unfit for flying duties due to the risk of acute hepatic decompensation; those who have begun on treatment are generally also disqualified from flying duties due to the potential side effects of antiviral treatment. As treatment endpoints for nucleos(t)ide analogues (NUC) are typically achieved after prolonged therapy, aircrew treated for CHB may be subjected to an extended period of flying restriction.

METHODS: We present a retrospective case series of seven aircrew who were returned to flying duties while on varying combinations of NUC for the treatment of CHB. All seven aircrew were comanaged by the flight surgeon and hepatologist, reviewed by a panel of flight surgeons, and had achieved normalized liver function tests prior to resumption of flying duties; two out of the seven aircrew had detectable serum Hepatitis B virus (HBV) DNA when reinstated back to flying duties. Only one aircrew member experienced side effects from the NUC treatment. This was promptly evaluated and managed prior to resumption of flying duties to ensure flight safety.

DISCUSSION: Aircrew with CHB infection can be safely allowed back to flying duties, especially when their conditions have been well controlled via treatment with any of the NUC regimes. While there are limited studies evaluating the use of NUC in aircrew performing flight duties, our study has shown that NUC are generally well tolerated and have a good safety profile which is compatible with flying duties.

KEYWORDS: flight safety, aeromedical fitness assessment, anti-viral treatment.

Tan D, Kwan C, Tan BBC, Gan WH. *Returning aircrew with chronic Hepatitis B back to flying while on nucleos(t)ide analogues.* Aerosp Med Hum Perform. 2019; 90(1):37–42.

Chronic Hepatitis B (CHB) is known to cause an increased risk of liver-related complications for those affected by the disease. This condition is not uncommon, affecting over 240 million individuals worldwide, with its prevalence highest in the sub-Saharan Africa and East Asia regions.[18] It is, therefore, not uncommon to encounter aircrew with CHB in South-East Asia.

Currently, treatment options for CHB include pegylated interferon α (PEG-IFN α) or nucleos(t)ide analogues (NUC). The main goal of therapy is to prevent disease progression, and consequently development of hepatocellular carcinoma. Recommendations for CHB treatment endpoints can include any of the following: 1) long-term viral suppression; 2) HBeAg clearance, with or without anti-HBe seroconversion (for HBeAg positive patients); or 3) HBsAg clearance, with or without anti-HBs seroconversion.[5] Patients who have achieved these serologic endpoints may be continued on a period of consolidation therapy of at least 12 mo prior to treatment cessation.[15,16]

The rate of seroconversion with NUC treatment is typically low. For example, a 12-mo course of lamivudine would likely achieve HBeAg seroconversion in approximately 16% of HBeAg-positive individuals on treatment.[4] Studies have shown that the sustained viral suppression rates after NUC discontinuation are less than ideal and long-term NUC treatment may be necessary.[12]

While it is widely accepted that aircrew with acute hepatitis will be considered unfit to perform flying duties due to symptoms such as abdominal pain and fatigue, the aeromedical

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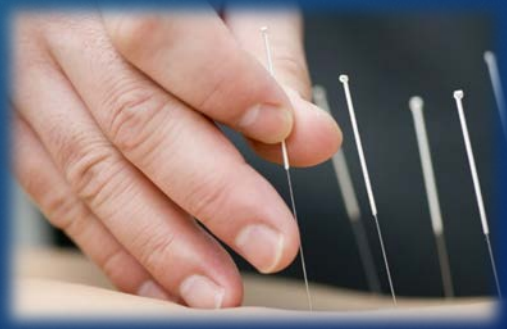
Clinical Services
Musculoskeletal Injury

- Promulgation of ASSET (**A**ircrew **S**ystematic **S**trengthening **E**xercises and **T**est)
  - Build up muscle mass for G performance and endurance
  - Strengthen core muscles for injury prevention

- Integrated Medical Care concept to focus on early intervention
  - Dedicated physiotherapist
  - Acupuncture
  - Optimal pain control



Resident Training and Accreditation

- In 2014, Aviation Medicine was recognized as a sub-specialty by the Ministry of Health in Singapore
- RSAF ARMC was accredited to train Aviation Medicine specialists for Singapore
- Re-accreditation was achieved in Jul 18

JCST

Joint Committee on Specialist Training

31 July 2018

Dr Tan Boon Chuan Benjamin
Head of Department
Republic of Singapore Airforce Aeromedical Centre
492 Airport Road
Singapore 539945

Dear Dr Tan

RE: SITE ACCREDITATION AT AVIATION MEDICINE, REPUBLIC OF SINGAPORE AIRFORCE AEROMEDICAL CENTRE

With reference to the site accreditation exercise conducted on 30 July 2018, we are glad to inform that your department has been awarded the following number of accredited training places with effect from 30 July 2018:

Advanced Trainees : 8

Please be informed that the department is accredited for **5 years**. The accreditation status will lapse on **30 July 2023** and the training unit is required to update JCST on annual basis if there are any changes in its training supervision or workload.

To continue providing training for Aviation Medicine trainees, the training unit would need to submit a request for re-accreditation when the accreditation status lapse. Enclosed is the site accreditation report for your reference and necessary actions.

Thank you.

Yours sincerely

A/PROF CHEN FUN GEE
Co-Chairman
Joint Committee on Specialist Training

DR S R E SAYAMPANATHAN
Co-Chairman
Joint Committee on Specialist Training

cc. Dr Jarnail Singh, Chairman, Aviation Medicine Subspecialty Specialist Training Committee (SSTC)
Dr Wong Sheau Hwa, Programme Director, Aviation Medicine Subspecialty Training Programme
Dr Koh Choong Hou, Assistant Programme Director, Aviation Medicine Subspecialty Training Prgramme
Dr Goh Khean Teik, Specialist Accreditation Board, Ministry of Health

Aviation Psychology
Aircrew Selection


1982

- Pilot Aptitude Selection (pen and paper) and Interviews since 1982
- Rolled out Computerized Pilot Aptitude and Selection System (COMPASS) in 1995
- Introduced selection system for Weapon System Officers (Fighter) in 1998 and Air Traffic Controllers in 2005
- Rolled out the selection system for UAV pilots in 2008


COMPASS


UAV

Air Traffic Controllers

Aviation Psychology
Aircrew Selection

- All selection systems are reviewed every 3 yearly, and validated against the training outcomes in the respective training schools
- Many of the selection systems have also been streamlined over the years to cut down test time
  - Pilot selection tests used to take 2 days at its inception but have now been reduced to 4 hours
- Ongoing developments on tests to assess motivational traits and system level integration
- In the near future, Flight Simulators and/or the use of Virtual Reality systems may the way forward for such selection systems

Aviation Psychology
Psychological Support

- Deployment of ground psychologists to support our aircrew
- Implemented the concept of Uncertainty Training to pilots in 2008
- Proliferate resilience training since 2013: Adaptability, Innovativeness, Resilience (AIR)
- Started AIR training with the various training schools
  - Incorporate into the various training syllabi for trainees to build on strong fundamentals but to think out of the box for solutions
  - Enable training to strengthen resilience

Aviation Psychology
Psychological Support

- Rolled out programs across various operational units to redesign training modalities to introduce the AIR concepts for training
  - Briefs and Debriefs
  - Contingency Plans
  - Testing of fundamentals

- Ongoing work to increase the AIR training in various simulators

Conclusion

- The RSAF Aeromedical Centre has evolved significantly over the last 37 years
- Regional Centre of Excellence in Aviation Medicine and Aviation Psychology
- Continued importance and relevance of Aviation Medicine and Aviation Psychology to aviation safety
- Training the next generation of Aviation Medicine doctors and Aviation psychologists remains a key responsibility

Commemorating 50 Years

Singapore Airshow 18


Toa Payoh


Jurong East


Sembawang


Bedok


Marina barrage 18


Punggol


RSAF50 Parade 18

Thank You

RSAF 50
OUR HOME, ABOVE ALL