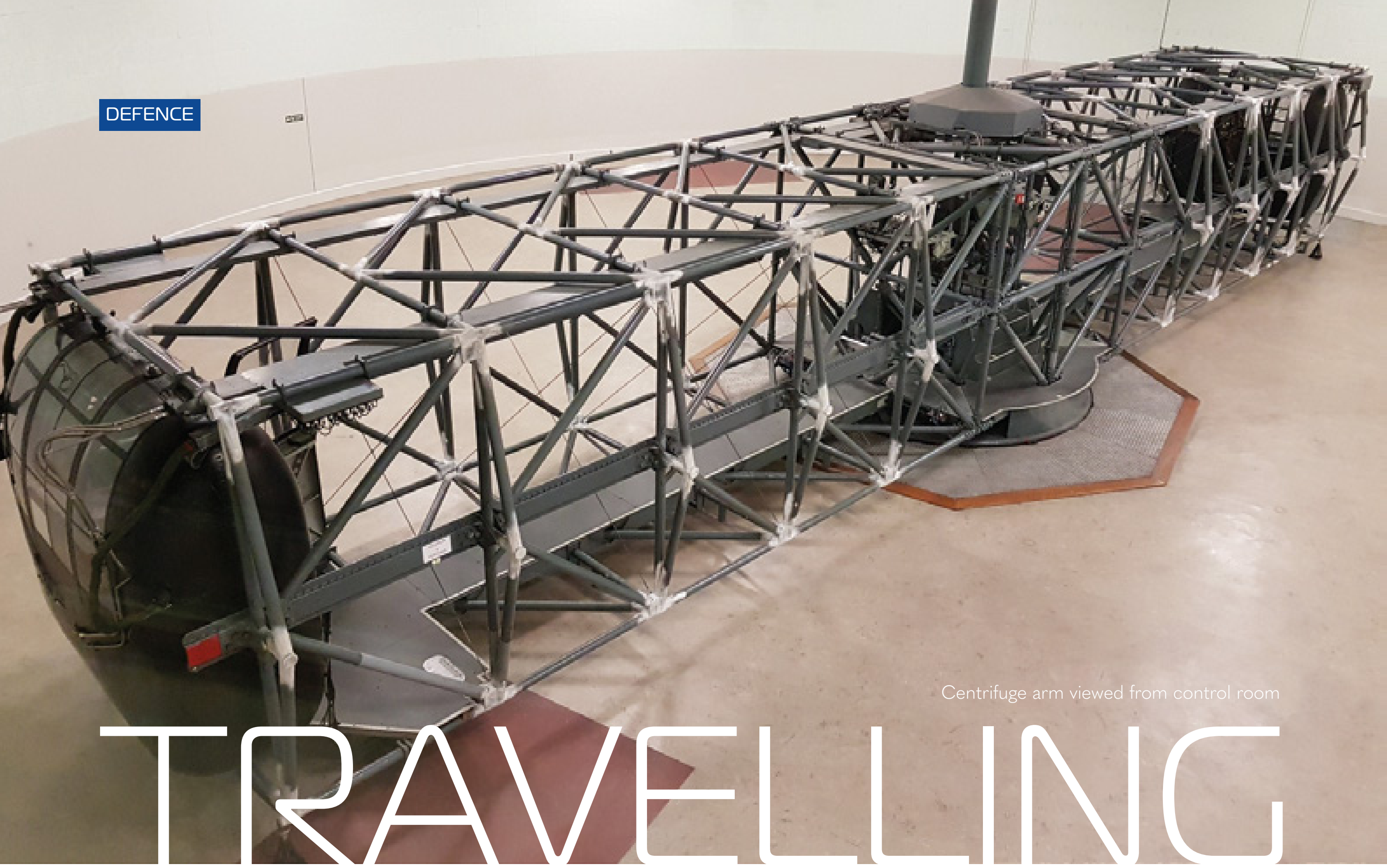
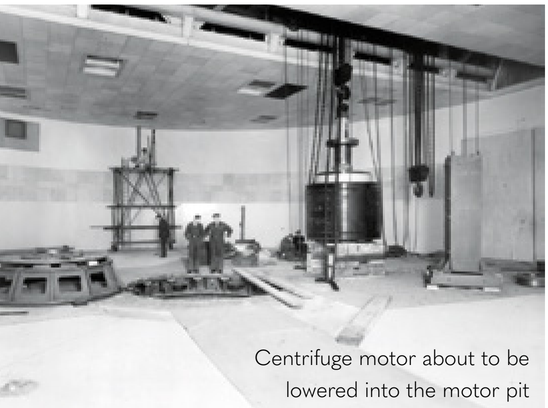


Centrifuge arm viewed from control room

TRAVELLING back in time



Centrifuge motor about to be lowered into the motor pit

Jo Davies reports on the Southern Regional Network's recent visit to the RAF centrifuge that was created in the 1950s to help jet pilots survive the rigours of working in high G-force environments

The centrifuge has played a central role in aviation medicine research during its 64-year life. It was used to gain a better understanding of how gravity (G) affects the human body and to develop countermeasures to equip RAF fast jet pilots with essential life support systems. It's thought to be the oldest example of a human centrifuge in the world and the only one manufactured by British engineers.

Problems operating under high G environments were well known and, as World War 2 approached, the need to provide G protection was deemed operationally essential. The lack of ability to replicate the G environment safely led to the commissioning of the centrifuge by the RAF Institute of Aviation Medicine (IAM) in the mid 1940s. It was formally opened by Lord Thurso in 1955 and ran continuously until 2019, by which point it had accomplished 122,133 runs.

Visiting the site

Sue Adcock and her team of volunteers hosted 13 CIEHF members and began with a presentation about the facility and how G forces impact our bodies. Sue has nearly 150 hours in fast jets and has carried out almost 600 runs in the centrifuge so most of the videos that she shared were of her or her late husband, RAF Test Pilot Terry Adcock, and were from personal experience.

G forces occur when the vehicle in which we're travelling rapidly changes speed or direction. The positive G forces cause reduced blood flow to the retina, which results in loss of peripheral vision and greying out. This provides an indication that continued manoeuvring will result in loss of blood pressure in the brain and eventually result in loss of consciousness known as G-LOC.

The pilots are taught anti-G straining manoeuvres that can improve G tolerance by about 4G. These involve tensing muscles in the limbs and abdomen to squeeze the veins and breathing techniques to apply pressure to the air in the lungs to raise arterial blood pressure. This technique has largely been replaced utilising pressure breathing for G protection (PBG) devices. It's not widely known that it was the UK who first invented PBG, which is now used globally for combat aircraft, with all the initial research carried out on the Farnborough Centrifuge in the 70s and 80s.

Anti-G trousers have developed over the years from water-filled bladders to apply pressure to the legs and abdomen – which were uncomfortable and restrictive – to air-filled bladders in which the air is pumped into five spaces in proportion to the amount of G being pulled. This prevents the blood pooling in the lower limbs and increases G tolerance by about 1 to 1.5G.

Full coverage anti-G trousers were designed for the Typhoon fast jet aircraft which have a bladder plus a chest counterpressure vest and increase G tolerance by 2 to 2.5G.

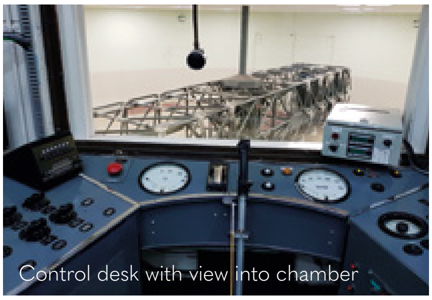
The facility

The centrifuge is a most impressive example of 1950s engineering and remains almost unchanged. It has received an Engineering Heritage Award (above) and Farnborough Air Sciences Trust (FAST) operates tours of the site. We were given access to the control room, the plant room, the gondolas and the central observer station.

The control room

The control room is on the first floor and is approached by an attractive art deco staircase. From here, the Duty Controlling Engineer can control the onset rate of G, the peak G and the sustained time at peak G. This can be carried out automatically using a cam or manually using a central control lever to vary the G applied.

The clearly labelled knobs and dials provided an interesting comparison against the digital displays and controls that we're more familiar with. There's a large red emergency stop button that trips all electrical power to the motor generator and applies the hydraulic brakes to bring the arm to a stop. This has only failed once, and Sue showed us a video of when this occurred. Fortunately, the fast reaction of the subject, who managed to get his head down below his heart, did not result in injury despite sustaining 15G.


Control desk with view into chamber

The plant room

The plant room contains all the heavy equipment that drives the centrifuge arm. It's a closed loop system that converts the AC electrical power from the grid via a DC generator to the centrifuge motor with a differential amplifier comparing the required speed from the control room with the actual speed and sending difference signals back via the Thyraton controller to the DC generator. All the machinery dates back to the 1950s.

The gondolas

There's a gondola at each end of the 62ft (19m) arm, which is an unusual configuration as most centrifuges have a single gondola. Only one gondola is manned at any time, with the other gondola counter-balanced in weight using sandbags. They're fitted out with representative cockpit seats, harnesses, controls and displays pertinent to the experiment or training being undertaken.

The subjects would have been dressed in the appropriate Aircrew Equipment Assembly (AEA) and have various medical monitoring devices attached. The gondola had a light bar that the subject could move with a joystick to indicate their limit of peripheral vision. The gondolas are also equipped with sick bags.


Thyratrons and control amplifier

Medical observer station

The medical observer station is situated in the centre of the arm and there's a station facing each of the gondolas. The subject is always in communication with the medical observer by voice and video link and the medic will be monitoring vital signs via ECG and visual observation. The observer is in two-way communication with the control room and the recording room. The observer controls the run and also has an emergency red button to bring the centrifuge to a halt.

Changing times

In 1994, the RAF IAM was reorganised into two parts, one of which was subsumed into the Defence Research Agency (DRA) with the remaining part re-named the School of Aviation Medicine (RAF SAM). The RAF SAM also had two Hawk fast jet aircraft to carry out the flight trials of the life support equipment and flying clothing. In 1998, RAF SAM became part of the RAF Centre of Aviation Medicine and moved to RAF Henlow.

The centrifuge continued to be operated by DRA and subsequently QinetiQ until 2019. In 2006, the RAF IAM site was sold for housing development but fortunately the centrifuge obtained Grade II listing and remains to this day in the middle of a housing estate.

The centrifuge was replaced by a new machine at RAF Cranwell, built by Thales and AMST from Austria, which opened in February 2019. This centrifuge can replicate the highly manoeuvrable flight regime of the Typhoon, Hawk and F35 Lightening combat aircraft. The Farnborough centrifuge's onset rate is 1G/sec while the RAF Cranwell centrifuge can accelerate at up to 9G/sec and rotate up to 34 times a minute.

This was a fascinating visit and an interesting look back at human factor in the 1950s, where ground-breaking work was done to enhance safety for fast jet pilots. It's particularly of relevance as we approach our 75th anniversary year. ■

Visit www.farnboroughcentrifuge.org.uk for more information on the centrifuge.