18 July 2003

The Secretary
Joint Committee of Public Accounts and Audit
Review of Australia's Quarantine Function
Parliament House
CANBERRA ACT 2600

Dear Dr Carter,

Review of Aviation Security in Australia

Thank you for providing CSIRO with the opportunity to provide a submission to the committee's inquiry into aviation security in Australia.

CSIRO's attached submission primarily addresses Terms of Reference (g) *opportunities to enhance security measures presented by current and emerging technologies*. We have had significant input into aviation security in the past and expect to continue to contribute in the future.

We would be pleased to respond to any queries or provide further information as required.

Yours faithfully

Dr Warren King
Executive Chair, Information Technology, Manufacturing and Services

CSIRO Submission to Review of Aviation Security in Australia

This submission addresses Terms of Reference:

(g) *opportunities to enhance security measures presented by current and emerging technologies*.

It includes a brief history of CSIRO's involvement in Aviation safety and security in the past, some discussion of the current aviation security environment and finally some specific examples of current and future CSIRO research that could enhance aviation security.

1) History of CSIRO's involvement in Aviation Safety and Security

CSIRO has been involved with the development of a number of technologies that have offered improved safety and security to the aviation industry and to passengers.

During the 1970s, CSIRO built on its experience in microwave systems and radioastronomy to develop the interscan microwave landing system (MLS). It used a computer on board the aircraft to read a fine three-dimensional horizontal and vertical grid transmitted by microwave radio from an antenna on the runway. A second radio beacon provided distance measurements. Using these three signals, aircraft could pinpoint the runway from 30 kilometres away. The system allowed aircraft to approach the runway at a steeper angle and on a curved path, capabilities well beyond the limited straight-line approaches of the existing systems. It also enabled aircraft to be guided into airports in bad weather conditions, including in zero visibility. Now largely superseded by Global Positioning Systems (GPS), the ICAO did select MLS as the preferred landing technology for the world's 2500 airports in 1978. A successful outcome for a 10 year effort that involved CSIRO's Division of Radiophysics, AWA, Hawker de Havilland and the Department of Transport.

Also during the 1970s, engineers and scientists from the Department of Civil Aviation and CSIRO researched and developed a radically new system of airport approach lighting known as T-VASIS - visual approach slope indicator system. This involves the use of a groups of lights which appear to the pilot on final approach as an upright 'T' if he is below, and an inverted 'T' if he is above, the correct glide slope. If dangerously low the pilot sees red warning lights. T-VASIS has been adopted as a standard at airports all around the world.

In more recent times, CSIRO has received national and international recognition for its activities in the optimisation and scheduling of communication link loads, and the specification and design of aircraft separation and segregation standards. We have also worked with the Department of Industry, Science and Resources, to set public risk goals for the commercial space launch industry, enhance the accuracy of models for the risk of mid-air collision for the Australian Air Transport Association and the Regional Airlines Association of Australia and we are active in the optimisation of navigation system performance for the Defence Material Organisation. Additionally, CSIRO has investigated biometric technologies such as face recognition and participated in trials as a complimentary technique for the detection of undesireables.

2) The Aviation Security Environment

Many improvements to aviation have been achieved over the past decades with the introduction of X-ray scanning systems for luggage, metal detectors, explosives sensors and improved checkpoint surveillance. However, as we have seen in recent months, many of the breaches of these protocols are innocent and do not result in any increased risk to passengers or aircraft. Additionally, the cost to implement extensive systems that could potentially guarantee total safety are beyond the financial resources of the travelling public and governments, as well as a significant impediment to the use of the service and an excessive response to the estimated risk. Therefore, any approach should focus on the reduction of this risk to a residual level that is acceptable for all the stakeholders.

In Australia last year, approximately 50 International airlines conducted over 105,000 aircraft movements transporting 16.5 million passengers, 640 thousand tonnes of freight and 30 tonnes of mail, while domestically over 28 million passengers travelled. In terms of airports, there are only a small number that see significant traffic. However, the aviation system consists of a large number airports scattered across the country in rural and remote locations. Of the major airports, Sydney airports are the focus for international and domestic traffic; accounting for around half of all passenger and freight movements.

Risks associated with aviation security include:

- passengers,
- weapons, explosives and incendiaries,
- interference with operational systems in flight
- biological organisms, virus, toxins,
- physical access to aircraft, ports or sterile areas, and
- physical or human assets that can be accessed by or targeted by aircarft

with the main mechanisms being

- baggage, freight, cargo and post,
- on person, and
- aircraft themselves.

Aviation is a multi-faceted transport system involving domestic and international carriage, leisure and business travellers, cargo and mail. It involves ground-based and air-capable assets that cross land and sea, that operate in a range of environment extremes and have sophisticated electronic control systems. Aircraft are contained environments that are vulnerable to skin penetration, electronic interference and the potential for the release of a toxin or biological agent. Aviation security therefore needs to have regard for both accidental as well as malicious acts.

Security of any asset or service is addressed in four ways, prevention, detection, response and recovery. CSIRO has a number of technologies and capabilities that could be applied to improve aviation security. Its significant advantage as a research organisation is its ability to draw upon a broad multi-disciplinary skills base to address issues of major interest.

Prevention strategies could draw upon the data mining and information skills to assemble sophisticated computer systems that identify weaknesses in critical aspects of the infrastructure or evaluation of information on people involved in either the operation of the system or travelling. Detection includes developing new techniques or enhancing existing technologies for the rapid detection of hidden objects, rapid screening of passengers and cargo. These could be based on electromagnetic, nuclear or biological approaches linked to leading edge image generation technology. Response is the provision of appropriate assistance to personnel involved in security breaches to better enable a safe outcome or in dealing with the result of an attack, be it physical (impact, explosive, theft, hostages, siege) or psychological (propaganda), information (intrusion, data corruption, denial of service such as air-traffic control). Expertise in manufacturing and materials and information systems would contribute in these areas. Recovery involves the reestablishment of systems and confidence to support the industry and community following the incident. Depending upon the target, this could involve skills as diverse as telecommunications and agriculture. These are all capabilities that exist within CSIRO.

Any attack involves four aspects - a motivated offender, a prospective target, opportunity and the absence of appropriate protection. To varying degrees, CSIRO can assist in all of these aspects from the identification of potentially high-risk offenders, multi-modal simulations for critical infrastructure threat assessment to the provision of technologies for the protection of assets.

3) Specific examples of how CSIRO's current and future research can aid in improving Aviation Security

The years 2001 and 2002 saw two tragic events in aviation history. The first is the well known September 11 terrorism attack on the World Trade Centre in New York; the second was a mid-air collision between a TU 154M aircraft with a Boeing B757-200 on July 1 near Ueberlingen in Germany. The first pertains to system security, the second to system safety. Both incidents are, in fact, intimately and inextricably related in engineering terms.

Airspace Modelling
In both situations the accurate and timely knowledge of an aircraft's position is required in order to be able to prevent a catastrophe. System level knowledge can provide both pilots and Air Traffic Management (ATM) operators with warnings of aircraft proximity (to prevent a mid-air collision) or knowledge of an aircraft's proximity to strategic or vulnerable geographical locations.

In Australia today, we only have knowledge of less than half of the airborne aircraft at any time. One approach to improve our awareness of the location of these assets, be they large aircraft circling a major city or a small craft arriving from a regional airport, would be to ensure that all craft are fitted with dependable high-speed avionic data-links for ship-to-ship and ship-to-ground communications. The design complexity of these communication systems increases dramatically with the number of aircraft. For example, if there are only two aircraft in a sector there can only be one proximity pair; by the time there are five aircraft there are 19 possible patterns of conflict; for 21 aircraft there are a staggering 28,723,877,046 possible patterns.

The combination of operations research (OR) and compromise decision support (CDSP) disciplines can make significant inroads to airspace design. For example, it is routine practice for CSIRO researchers and avionics designers to consider over 100,000 situations when testing the dependability of navigation systems. In contrast, the airspace safety cases have tabled as little as three situations, and in the cases where 70 or so situations have been tabled there are significant replications. These examples show that a significant difference in engineering maturity exists between those of airframe, avionics and engine designers and those of the historic airspace integrators.

Once the problems of knowing an aircraft's physical location is solved then the system's designers are in a position to focus on the issues of the intent of the user. This is a complex and difficult area of soft values (e.g. privacy, malicious use, etc.,) and must involve police, customs, and defence authorities. Complete and accurate knowledge of the physical location of aircraft will aid in this type of assessment.

Detection of concealed articles
Access to aircraft is controlled via a range of devices to detect metals, image luggage and bags and sense trace elements of explosives. A significant amount of research is being conducted into new, high-speed technologies with improved detection capabilities for the screening of all passengers and cargo. Full-body scanners that are capable of seeing through clothing and produce detailed images of bodies are now being trialed in airports as the latest tool to counter-terrorism. Designed to detect hidden plastic weapons, explosives or contraband missed by metal detectors, theses systems use backscattered X-ray technology. The X-rays pass through clothing but deflect off the skin,

producing the grey image of a person's body. Objects of greater density, such as guns, knives and explosives show up as dark and defined objects. These scanners have generated significant concerns relating both to privacy and to exposure to ionising radiation and cost around $250,000. CSIRO has been investigating the use of passive imaging systems that take advantage of the fact that there is a difference in temperature between the body and any concealed object. While the privacy issues would still need to be addressed, exposure to radiation is not an issue as this approach relies purely detection of the inherent characteristics of the body or the concealed items. The other major advantage of the approach being pursued by our researchers is that due to the novel detector and imaging configuration, there should be a significant price and weight advantage over other systems making hand-held, portable imaging systems a viable reality.

Metal detecting systems used for routine scanning of passengers at airports are based on induction coil technology and have difficulty detecting metal objects with low electrical conductivity, such as surgical quality stainless hypodermic needles. In addition, orientation is a factor in that tall, long, thin metal objects can be positioned so that detection is extremely difficult. CSIRO has prototype technology that is being developed for the detection of "sharps" such as needles in hospital waste environments. However, this technology could be engineered to detect small, concealed items at distances comparable to that commonly used in current 'walk-through' scanners. This approach is based on high-temperature superconducting (HTS) technology – specifically HTS SQUIDs (Superconducting Quantum Interference Devices). SQUIDs are magnetic field detectors that have advantages in that they are extremely sensitive, use a magnetic field gradient detection system to minimise interference from the surrounding environment and measure all three axes of the magnetic field overcoming the orientation problem.

CSIRO also has a mature-technology that is currently being used for the non-destructive testing of aircraft skins and components in-situ. The small, hand-held device uses acoustic waves to detect voids and inclusions in composite structures. It's size makes it particularly suited for the evaluation of spaces that are difficult to access or that might require the disassembly of components. CSIRO is working with a major aircraft manufacturer to optimise the performance of this technology. While it has been developed for non-destructive testing applications, one could envisage that there might be applications where there could be a concern related to the structural integrity resulting from sabotage or illegal access.

Biological releases in airports or on aircraft

While there are many concerns about weapons being carried on aircraft or aircraft themselves being used as terrorist weapons, a more insidious an potentially far-reaching scenario could be the deployment of a biological agent either in an airport or on-board an aircraft that could contaminate large number of travellers depending upon the incubation period and the strategic traffic position of the port or craft.

CSIRO has been involved with the development of a range of sensors for the detection of chemical and biological contaminants. Recent advances have seen the development of nano-technology, high-sensitivity, high-discrimination sensors capable of detecting very low-levels of toxins, explosive or biological organism. These sensors could be integrated with existing air-handling systems within airports or on board aircraft. CSIRO has the skill and expertise to develop these types of sensors, although there has not been any work done in the specific sorts of gases that might be considered in the launch of a security breach.

In addition to sensing contamination, we have been working on a low-pressure plasma device for destructing microbiological species in building air supplies. This technology has been specifically designed for buildings but might be able to be modified for application in aircraft.