

AIR POWER STUDIES CENTRE

PAPER 76

July 1999

**ADF EMPLOYMENT OF THE GLOBAL HAWK
UNINHABITED AERIAL VEHICLE (UAV)**

By

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About the Author

Wing Commander Gary Hale joined the RAAF in 1982 as an Engineering cadet, graduating in 1985 with a Bachelor of Communications Engineering. He has served in a variety of staff and base postings, mostly involved in space and C³I systems, including a tour at Townsville as the Assistant Base Radio Officer, Woomera as the Engineering Officer and as project officer for ATC radars and Global Positioning System project within the defence Acquisition Organisation. In 1994, he was posted to the United States Air Force Institute of Technology where he completed a Masters of Science specialising in Space Operations and was selected as a Distinguished Graduate. He was then posted to Capability Development as the officer-in-charge of satellite communications development and was awarded the CDF Commendation Medal for his work in this area. He is a graduate of RAAF Command and Staff Course and is currently both the Space Systems Project Manager and Hornet Upgrade Ground Support Systems Manager.

INTRODUCTION

The ADF must operate over vast areas of the Earth's surface, in particular Australia's northern sea and air approaches, with a relatively small force. The ADF's ability to locate threats and position forces will be crucial to its success in conflicts. The task of surveillance is critical in achieving this aim, and is identified as the ADF's highest priority force capability development task. As part of the surveillance task, the ADF have identified the need for a long endurance UAV capable of complementing, or acting independently of, other ADF and Allied surveillance and reconnaissance assets.¹

The Global Hawk system is under development as an United States Department of Defence (US DoD) advanced concept technology demonstrator (ACTD)² project and is expected to fly surveillance missions in which extended range and endurance are paramount. The ADF believe that the Global Hawk system has the potential to undertake this role and may offer the ADF significant advantages over existing manned surveillance platforms. Consequently, the ADF has accepted an offer by the US DoD to develop the Global Hawk through an agreement which aims to increase mutual understanding, and enhance each participant's surveillance and reconnaissance capabilities. This agreement³ will culminate in an operational trial of Global Hawk in Australia around early 2000. This trial will allow Australia to undertake any tasks or needs that might be ADF unique when operating Global Hawk.

In preparation for this trial, the ADF must begin to address the complexities of employing Global Hawk within the ADF's operating environment. The aim of this paper is to assess employment options for ADF use of the Global Hawk UAV as a surveillance and reconnaissance platform. This paper will briefly describe the Global Hawk, including both the air and ground elements and examine the ADF's operational needs for the Global Hawk system. The paper will then identify the key considerations for ADF employment of Global Hawk, describe the proposed ADF Global Hawk employment options, and finally, assess those options against the ADF's operational needs.

The paper will contain some limitations. The Life Cycle Costing (LCC) timeframe used for this paper is 10 years. Costs in this paper should be construed as representative and should not be quoted by other sources. Infrastructure support will be limited to the assessment of basing, deployment, command and control (C²), basic logistics and human resource issues. The Global Hawk employment options will be assessed with respect to use of the Global Hawk system in the surveillance and reconnaissance roles only.

¹ SR97 states: 'Long range and long endurance unmanned aerial vehicles (UAVs), carrying a range of sensors, could be an important supplement to space-based and other systems. They could provide a good reconnaissance and surveillance capability for coverage of significant areas in a crisis as well as a back-up system able to operate independently of United States' systems.'

² The ACTD strategy for development and acquisition provides a streamlined method for working closely with the user to rapidly demonstrate and field a new capability in limited quantity. ACTDs provide a critical step in evaluating the military utility of new technologies before commitment to acquisition. ACTDs are intended to reduce acquisition risks and uncertainties at relatively low costs.

³ This agreement is being developed between Force Development(Aerospace) and DARO.

GLOBAL HAWK OVERVIEW

Operational Capability

For the US DoD, Global Hawk is intended to complement manned and national reconnaissance assets by providing continuous all-weather, wide-area, high-resolution imagery coverage in support of military operations. Global Hawk is to operate in low-to-moderate risk threat environments and is optimised to support those surveillance missions in which long range, extended endurance and long dwell over the target area are paramount.

The notional mission profile for the Global Hawk system is shown in Figure 1. Global Hawk will have an operating radius of 5 600 km, a loiter speed of 340 knots, an operating ceiling of 65 000 ft, and a maximum on-station endurance of 24 hours. The maximum ferry range for Global Hawk for deployment purposes is 27 000 km. Each sortie can undertake surveillance of a 136 900 km² area in the wide area search mode, while 1 900 spot targets can be prosecuted. A detailed explanation of the operation and elements of Global Hawk is provided at Annex A.

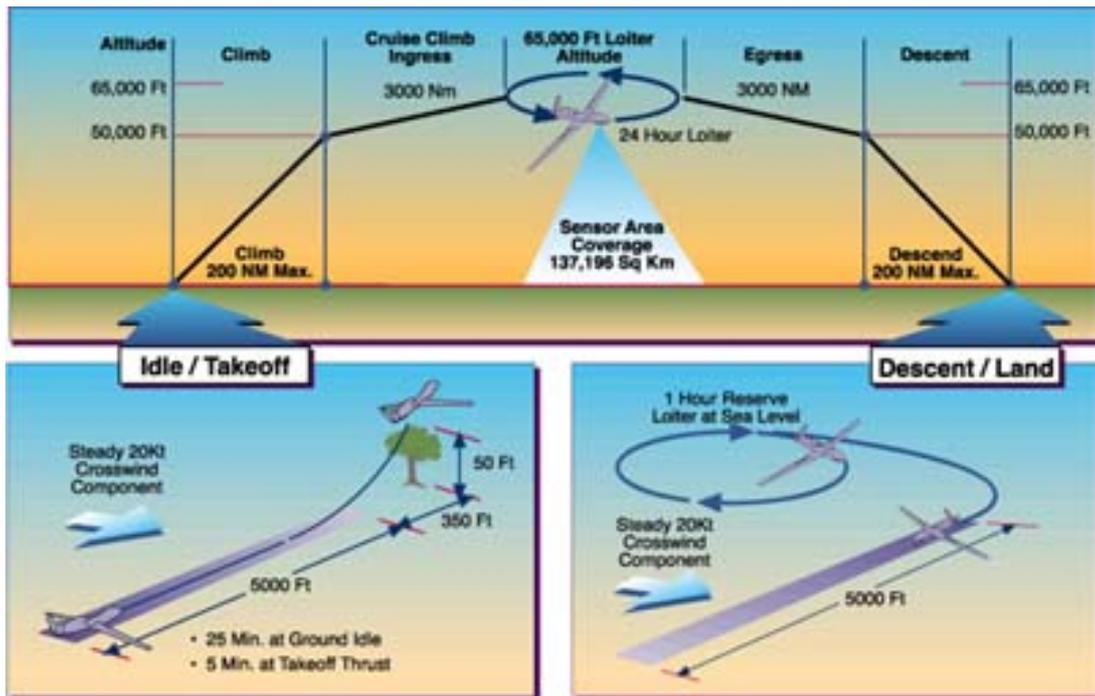


Figure 1 - Global Hawk Notional Mission Profile⁴

Elements of the Global Hawk System

The Global Hawk system comprises three main segments; the air segment, the ground control segment, and the ground support element.

⁴ Air Combat Command, 1996, Concept of Operations for Endurance Unmanned Aerial Vehicles, Version Two, 3 December, Figure 3-4.

Air Segment. The air segment consists of two primary elements:

- a. **Air Vehicle.** The air vehicle is equipped with an automatic take-off and landing (no man-in-the-loop) system capable of handling a crosswind component of 20 knots, and permitting operations from a greater-than-5 000 ft improved runway in ‘zero zero’⁵ surface weather conditions. Vehicle operation will be essentially autonomous using fail safe programs with the capability of being reprogrammed in flight should changes to its flight plan be required.
- b. **Sensor Payloads.** The baseline payload incorporates electro-optical (EO), infrared (IR) and synthetic aperture radar (SAR) imagery sensors. All three imagery sensors are to be carried simultaneously and be capable of operating either the EO or IR simultaneously with the SAR. Only data from one sensor at a time can be downlinked from the air vehicle, using either line-of-sight (LOS) or satellite communications.
- c. **Ground Control Segment.** The ground control segment consists of two primary elements:
- d. **Launch and Recovery Element (LRE).** The LRE is a portable shelter that verifies the health and status of the vehicle’s sub-systems and loads the mission plan. During launch and recovery, the LRE is responsible for air vehicle control, coordination with local and enroute air traffic control facilities and air vehicle hand-off to the Mission Control Element.
- e. **Mission Control Element (MCE).** The MCE is a portable shelter that is responsible for key mission plan elements including flight, communications, sensor processing and aircraft and mission payload control, and can control up to three UAVs simultaneously.
- f. **Support Element (SE).** The ground support element includes all equipment required to operate and maintain the system, spare and repair parts, and personnel trained to maintain the air vehicles and ground elements.

Deployability

The Global Hawk system has been designed to be readily deployable, with pack-up for transport in 24 to 48 hours, and set-up/commencement of operations also taking 24 to 48 hours after arrival at the operating site. A fully-deployable Global Hawk system is envisioned to include a complement of three or four air vehicles, an MCE, LRE, SE kit (capable of supporting operations for 30 days without re-supply), and personnel. The Global Hawk ground elements are designed to be readily deployable in three C-141 equivalent loads (equates to six C-130H loads, assuming there are no oversize cargo problems). The Global Hawk air vehicles themselves are self-deployable.

⁵ ‘zero zero’ equates to zero visibility at ground level.

Datalink Support

Datalink support is separated into two separate elements, command and control, and sensor support.

Command and Control (C2) Datalinks. C2 communications to and from the air vehicle will be accomplished using Ultra High Frequency (UHF) military satellite communications (MCE and LRE), or through the Ku-band satellite communications (SATCOM) or line-of-sight (LOS) Common Data Link (CDL) (MCE only). The UHF capability will allow the MCE to control and monitor health and status from three air vehicles simultaneously over one data link. Appropriately equipped exploitation stations (both afloat and ashore) will be able to utilise the Ku-band and CDL links to directly control the onboard sensors when tactically directed.

Sensor Datalinks. The US DoD objective for the Global Hawk system is to have untethered worldwide operations using a satellite link for transmitting sensor data from the air vehicle to the MCE. All data links will be encrypted for security and will be designed to minimise susceptibility to jamming and interception. The system can utilise either the LOS CDL or Ku-band satellite communications data links to transmit sensor data back to the MCE. Global Hawk will also have a two-hour digital recording capability (at a 50 Mbps rate – total storage 45 Gigabytes) of wide area search imagery, with the capability to downlink from the recorder upon command.

ADF OPERATIONAL USE OF GLOBAL HAWK

The ADF operational needs for employment of Global Hawk in the surveillance role will be driven by the surveillance tasks required to be undertaken, and limitations on use of the Global Hawk air vehicle. The assessment of what tasks need to be undertaken by the ADF will be crucial to defining how Global Hawk should be used.

Taskings

The possible ADF taskings that could be undertaken by Global Hawk are:

- a. **DAA and DRI Tasks.** DAA and DRI tasks including:
 - i. surveillance of Australia's maritime approaches,
 - ii. surveillance of Australia's northern land mass and offshore territories,
 - iii. near real time (NRT) targeting and precision strike support,
 - iv. NRT combat assessment,
 - v. enemy order of battle (EOB) information,
 - vi. battle damage assessment (BDA),
 - vii. intelligence preparation of the battlefield (IPB),

- viii. special operations support, and
 - ix. sensitive reconnaissance operations.
- b. DGI Tasks.* DGI tasks including:
- i. United Nations (UN) treaty monitoring,
 - ii. blockade and quarantine monitoring,
 - iii. humanitarian aid, and
 - iv. other roles as required to support ADF, Coalition, Allied, or UN forces deployed overseas.
- c. National Support.* National support tasks including:
- i. Surveillance of identified areas in support of other Government Departments such as Customs, Immigration, Fisheries, etc,
 - ii. disaster recovery, and
 - iii. humanitarian aid.

A detailed explanation of these tasks is provided at Annex B.

Minimum Operational Capability

Given the suggested ADF operational roles for Global Hawk, the following capability is suggested as a minimum peacetime role for the ADF. The Global Hawk system must be capable of undertaking the following operations simultaneously:

- a. two separate long-range, long-endurance surveillance tasks for up to 30 consecutive days (24 hours/day) within the defined DAA/DRI operational area;
- b. two separate tasks within the defined DAA/DRI operational area (such as BDA, IPB, etc);
- c. one long-range, long-endurance surveillance task for up to 30 consecutive days (24 hours/day) within the defined DGI operational area (represents minimum deployable capability); and
- d. one long-range, long-endurance surveillance task for up to seven consecutive days (24 hours/day) within the defined National Support operational area.

Area of Operations

The areas of operation for the Global Hawk are highlighted in Figure 2, and will include:

- a. *DAA Operations*. The area defined by the Area of Direct Military Interest (ADMI), focussing on the air/sea gap to Australia's north, and the northern Australian landmass.
- b. *DRI Operations*. As defined in Figure 2.
- c. *DGI Operations*. Covers the rest of the world, outside of the DAA, DRI and National Support regions.
- d. *National Support*. The MARSAT area as assigned through the international maritime agreement, including the Australian mainland.

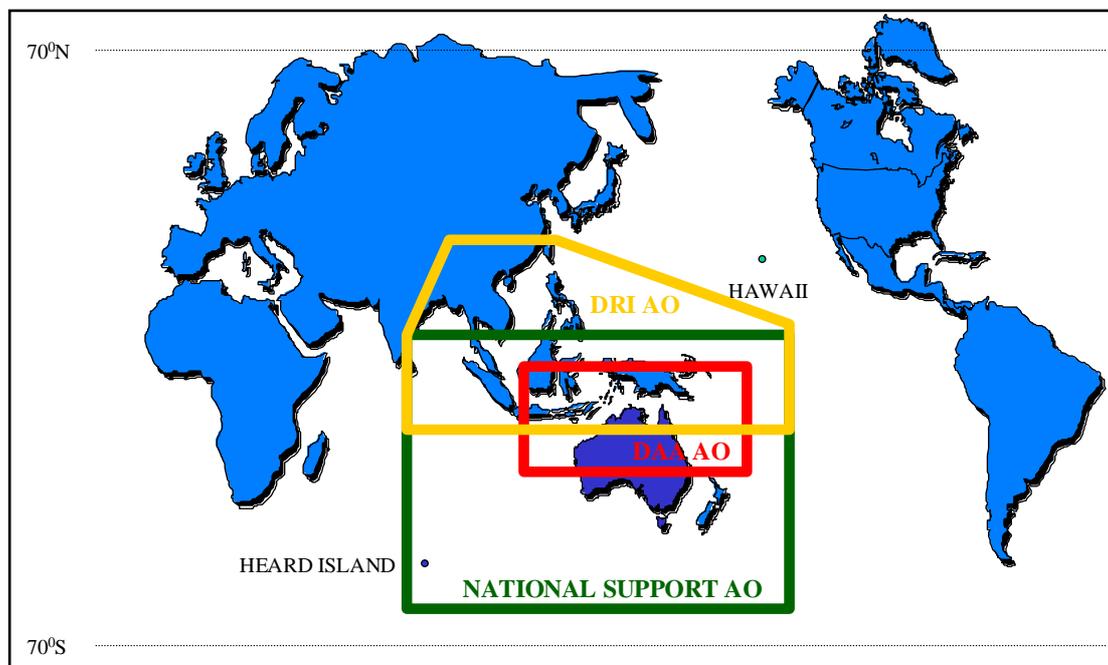


Figure 2 - ADF Areas of Operations

Command

Global Hawk is to be considered a tri-Service strategic surveillance asset, and therefore, tasking will be controlled at the highest practical level within the ADF (suggested level is HQAST). Global Hawk will be tasked as part of the Air Tasking Order (ATO) process.

Time to and on Station

The time to arrive on station should be no greater than 8 hours.⁶ The Global Hawk should be capable of undertaking the required roles over a single area of operations for a period of not less than 30 consecutive days (24 hour/day operations).

Information Processing Needs

Information obtained from Global Hawk's air vehicle payload sensors can be separated into two distinct areas:

- a. **Direct Support.** Direct support covers all of those users who have equipment suitable to directly receive the sensor data from the air vehicle. In general, tactical users of this information will normally be within LOS of the air vehicle, while higher level users may be using satellite communication links to achieve out-of-theatre connectivity. Sensor information from the air vehicle must be capable of being downloaded to the ADF Intelligence System (ADFIS), and therefore a direct connection with the air vehicle, or collocation of the MCE with an ADFIS input capability, is a must.
- b. **Indirect Support.** Indirect support covers all other users who will receive Global Hawk information through ADFIS, including both the Joint Command Support Environment (JCSE) and Joint Intelligence Support Environment (JISE) systems. JCSE and JISE will be the primary systems used for dissemination of the Global Hawk data to other users.

Interoperability Needs

The Global Hawk system should remain compatible, where feasible, with the original equipment supplied by the US DoD. Any ground-based receive equipment acquired for ships or land tactical units should be compatible with the datalink requirements for Global Hawk.

Operating Site Needs

The Global Hawk air vehicle requires the following minimum basing facilities:

- a. site with a sealed landing surface with a minimum length of 5 000 ft;
- b. access to restricted airspace and joint training areas, preferably collocated (not applicable when deployed); and
- c. access to maintenance facilities to perform maintenance on the air vehicles and deployable shelters.

⁶ Time taken to get on station should be minimised to ensure maximum time on-station. This will require the Global Hawk air vehicle to fly at the best endurance speed to and from station (rather than flying at maximum speed), otherwise time-on-station will be reduced. Therefore, the use of an airstrip closer to the operating area will be preferred.

Regulatory Needs

The US DoD is still addressing the issue of integration of UAVs into ICAO airspace. As this activity has not been completed, this will place some operational constraints on the selection of an operating base for Global Hawk. Consequently, the operating site selected for Global Hawk must:

- a. have a low volume of ground and air traffic or an existing RAAF base with an auxiliary airfield/site; and
- b. minimise interaction with civilian air traffic, especially visual flight rule (VFR) traffic.

EMPLOYMENT AND INFRASTRUCTURE CONSIDERATIONS

Global Hawk System Elements Required to Support ADF

Table 1 identifies the Global Hawk system components required to support a single continuous orbit (one long-range, long-endurance task). Global Hawk will support a single continuous orbit for 30 days without resupply or vehicle replacement with this force structure.

Table 1 - Global Hawk System Elements to Support a Single Continuous Orbit

	On-Base	On-Station	In-Transit	Standby (Alert)	BAI ⁷	Total
Global Hawk Air Vehicles		1	1	1	1	4
MCE	1					1
LRE	1					1
SE	1					1

The ADF requires sufficient quantities of Global Hawk air vehicles to support the ADF's minimum operational capability (see page 7 above), to support training and exercises, and to provide back-up aircraft inventory (BAI)/attrition reserve vehicles. Table 2 identifies these assets. Assets required to meet the minimum operational requirement are highlighted in grey.

The number of MCE and LRE cabins can be reduced by centralising the command and control, and payload control, into a single building. This will allow one site to control more than one Global Hawk mission using a centralised command and control facility. However, this type of arrangement requires substantial communications connectivity between the fixed control site and the Global Hawk air vehicle, and therefore the use of satellite communications will play an important role. These types of considerations will be used to develop different employment options for ADF use of the Global Hawk.

⁷ BAI – Back-up air vehicle inventory/attrition spares

Table 2 - Global Hawk Components Required to Meet ADF's Minimum Operational Capability

Type of Mission	Number of Missions	Air Vehicles	MCE	LRE	SE
DAA/DRI					
Long-range long-endurance (30 days continuous)	2	8	2	2	2
Separate Tasks (BDA, etc)	2	4	2	2	2
DGI					
Long-range long-endurance (30 days continuous)	1	4	1	1	1
National Support					
Long-range long-endurance (7 days continuous)	1	3	1	1	1
Training		2	1	1	1
BAI		2	1	1	1
Total		23	8	8	8

Basing

RAAF Bases Tindal and Pearce, as well as the Woomera airfield, are the only Australian military air bases that are capable of meeting the regulatory requirements for the operation of Global Hawk. Table 3 provides a summary of each locations capabilities.

RAAF Pearce is well-placed to support National support tasks such as search and rescue and fisheries support in the Southern and Indian oceans. However, RAAF Pearce requires the longest transit time to support DAA and DRI tasks, the highest priority tasks within the ADF. Also, the nearby Perth airport, and its associated major and minor air routes, along with the significant amount of military training air traffic at Pearce, and the surrounding housing developments around Pearce, will severely limit the ability to operate the Global Hawk. While Pearce has a satellite airfield at Gin Gin, the same types of problems can be expected (excluding housing build-up). Therefore, RAAF Pearce is the least preferred site.

Woomera has the advantage of less civilian air traffic than RAAF Tindal, thereby reducing the interaction with civilian aircraft under VFR conditions. Also, Woomera provides access to restricted airspace for training. However, RAAF Tindal has a significantly reduced transit time for Global Hawk for DAA/DRI taskings, has access to restricted airspace and training ranges (including the electronic warfare range at Delamere), and has an enhanced base support infrastructure. Therefore, RAAF Tindal is the preferred main operating base for Global Hawk. This would also have the added advantage of collocating the Global Hawk surveillance capability with the ADF's primary surveillance command and control facility (NORTHROC), providing

opportunities for synergy in command and control of Global Hawk. Therefore, RAAF Tindal is the preferred site as the major operating base for Global Hawk.

Table 3 - Comparison of Suitable ADF Global Hawk Operating Bases

ADF Operational Needs	Tindal	Pearce	Woomera
Time-to-station (hours)⁸			
DAA/DRI ⁹	1.1	5.0	4.0
DGI ¹⁰	12.3	10.0	12.3
National Support¹¹	9.1	5.1	8.0
Operating Site Needs			
runway	Yes	Yes	Yes
restricted airspace/training areas	Yes	No	Yes
facilities	Yes	Yes	Yes
Regulatory Issues			
volume of ground traffic civil/military	low/medium	zero/v high	v low/v low
civil flying infrastructure:			
major air routes	no	yes	no
major civilian airports	no	yes	no
minor civilian airports	yes	no	yes
civilian traffic patterns	yes	yes	yes
minimise VFR traffic interaction	possible	no	possible
Civilian Ground Infrastructure (Housing, etc)	very limited	substantial	limited

Deployable Bases. The bare bases at RAAF Learmonth, Curtin and Scherger will be used as forward operating bases for Global Hawk. Overseas deployments to support DGI operations will need to be considered on a case-by-case basis. Forward positioning of Global Hawk system components, such as the LRE and SE, may be considered as part of the employment options to reduce air transport requirements.

Air Vehicle Control Options

The ability to fully utilise the capabilities of the Global Hawk system will be driven by the communications support that can be provided. The Global Hawk air vehicle has the ability to loiter for up to 24 hours, providing coverage of a 136 900 km² area in the wide area surveillance mode. Control of the air vehicle can be X-band LOS

⁸ Time-on-station is calculated using the Global Hawk air vehicles maximum endurance speed (380 knots or 700km/h)

⁹ Time-on-station is measured from the base to the centre of the air/sea gap in the DAA operating area. Surveillance of the air/sea gap is the highest priority task within the ADF.

¹⁰ Time-to-station is measured from the main operating base to the east coast of Africa. This measure is based on the time for the air vehicle to arrive at a forward operating base where it will be deployed from, rather than on time to arrive on-station. This site was selected as much of the ADF's DGI focus has occurred in Africa or the Middle East.

¹¹ Time-on-station is measured from the base to Heard Island, the most distant task that the ADF has had to conduct as part of national support operations.

CDL, UHF LOS, or UHF SATCOM. Figure 3 highlights the areas of operation provided by each method.

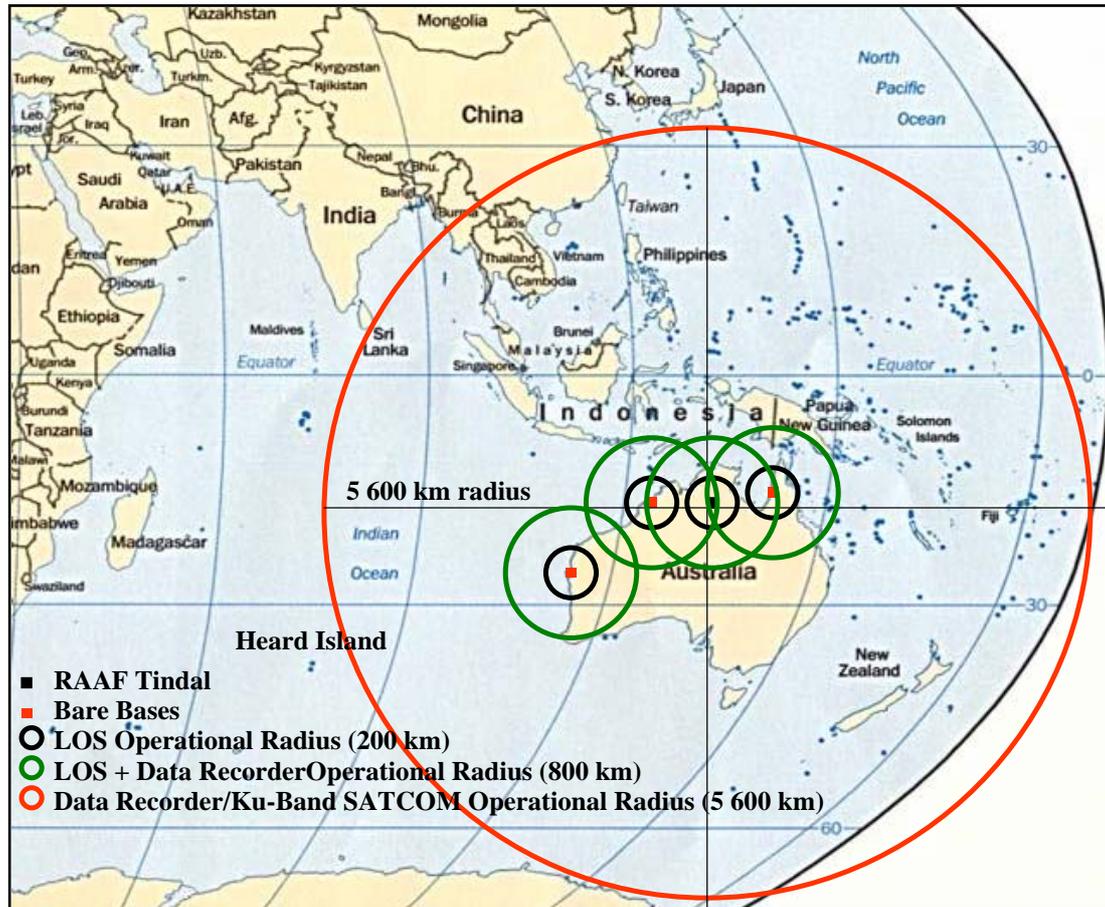


Figure 3 - Global Hawk – Areas of Operation

X-Band LOS CDL/UHF LOS. LOS communications require direct line-of sight between the control facility and the air vehicle, no matter whether using the X-band CDL or UHF LOS. Assuming the Global Hawk air vehicle is flying at its ceiling of 65 000 ft, the maximum radius of operation that can be achieved, while maintaining LOS, is 200 km.¹²

UHF SATCOM. UHF SATCOM can be provided by the coverage supplied by LEASAT 5, a UHF satellite currently leased by the ADF to support Navy operations. UHF satellite coverage is shown in Figure 4. Maximum radius of operation will be limited to 5 600 km¹³, or by the footprint of LEASAT 5.

Coverage. The coverage for control of the air vehicle is sufficient to meet all the ADF’s mission needs. Should the Global Hawk system be deployed on a DGI task, then access to either the US DoD UHF MILSATCOM or the United Kingdom’s

¹² This assumes an elevation angle of 5° between the surface of the Earth and the look angle to the Global Hawk air vehicle.

¹³ This maximum radius assumes that transit time for Global Hawk will not exceed 8 hours.

Skynet 4 satellite systems will be required. These systems provide worldwide coverage for UHF SATCOM.

Payload Control Options

Information can be downloaded from the Global Hawk air vehicle via three methods; download from the airborne recorder on return from a sortie, near-real-time download via LOS communications during flight, or near-real-time download via Ku-band satellite communications during flight. The area of operations provided by each method is highlighted in Figure 3.

Download. The Global Hawk air vehicle's onboard recorder can retain two hours of surveillance data. The area of operations will be within the maximum operating radius of 5 600 km. Assuming no communications are available for downloading while in flight, the actual recording of data will be limited to an 11 500 km² area in the wide area surveillance mode.¹⁴

LOS Communications. LOS communications will be as per control of the air vehicle. This could be extended by using the flight recorder, thereby extending the operational radius to 830 km.¹⁵ In the wide area surveillance mode, coverage will be limited to an 125 600 km² area within the 200 km operating radius, and an 136 900 km² area using the data recorder as an adjunct (within the 830 km radius of operation).

Ku-Band SATCOM. Ku-band satellite communications support significantly diminishes the limitations on Global Hawk's operational radius, and provides for untethered flying over a large operational area. The radius of operation using this method will be 5 600 km. In the wide area search mode, full coverage of a 136 900 km² area can be achieved. The only limitation here is that the Global Hawk air vehicle must remain within the footprint of the satellite being utilised. Ku-band coverage is shown in Figure 4.

Coverage. Ku-band SATCOM coverage is limited in the ADF's area of operations, especially over Australia's air/sea gap, south-east Asia, and the Indian, Pacific and Southern Oceans. Options will need to be pursued to improve coverage in these areas, especially the air/sea gap to Australia's north. These options are outlined in Annex C. The most promising short-term option is to use the proposed Optus C1/D X-band satellite communications steerable beam for coverage of the air/sea gap. Coverage for this capability is highlighted in Figure 4. The ADF will need to address increased coverage to support Global Hawk, and possibly other manned and unmanned aircraft, in its next generation of communication satellites.

¹⁴ The 11 500 km² coverage for the digital data recorder is calculated by working back from the coverage area for 24 hour operations. The Global Hawk can cover an area of 136 900 km² over 24 hours, therefore, working backwards, Global Hawk should cover one-twelfth of this area over two hours.

¹⁵ This assumes that one hour of data is recorded outbound from the LOS radius of operations, and one hour is recorded on return to the LOS radius of operations.

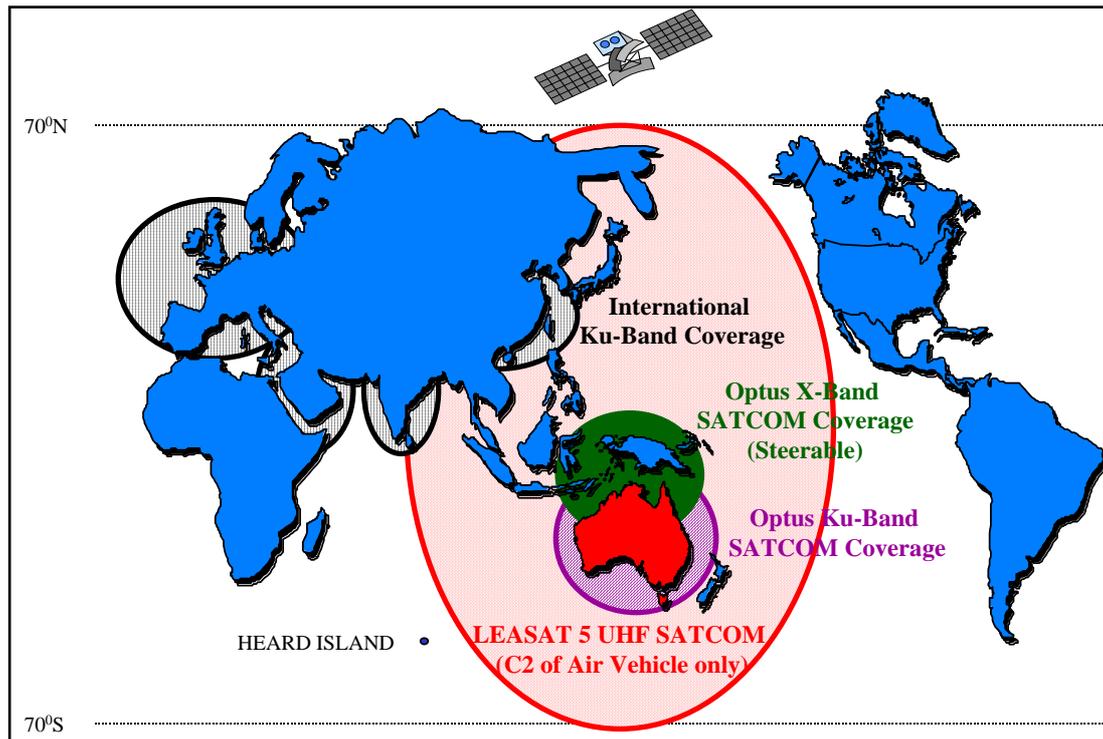


Figure 4 - Satellite Communications Coverage in Support of Global Hawk

Support Infrastructure

Air Transport Support. A single deployment of the Global Hawk system from Tindal to a bare base will require six C-130s. Given this deployment scenario, each C-130H would need to fly an average distance of 4 740 km¹⁶ (or 12.9 flying hours), costing \$100,000 per deployment per aircraft.¹⁷ The cost to meet the minimum operational capability will be \$5.4 m per annum.¹⁸ Given that the RAAF has only 24 C-130s, and the associated flying costs, deployments may need to be minimised. This can be achieved by pre-positioning support equipment at forward operating bases and/or centralising some of the command and control elements. When assessing employment options for Global Hawk, trade-offs between increased acquisition costs for acquiring additional infrastructure, and the operational costs for deploying equipment through use of the C-130s, should be made. This will be considered further as part of the development of the various Global Hawk employment options.

Human Resource Issues. Manpower requirements will be based upon a sustained wartime environment (WE). 44 personnel will need to be deployed to support a single Global Hawk deployment.¹⁹ Reductions in manpower can be made by centralising command and control and other support requirements. Therefore, the manpower

¹⁶ Based on a C-130 flying the following route: Richmond-Tindal-Scherger-Richmond.

¹⁷ Based on an hourly flying rate of \$7 723 per hour, as provided by the RAAF Program Manager for flying hours. This rate is based upon recovery of the RAAF Program costs for additional flying hours.

¹⁸ This assumes that each of the tasks outlined in the minimum operational capability will be conducted only once per year. The total cost is based on five bare base deployments to Scherger (387 flying hours), plus one overseas deployment to Africa (25.8 flying hours).

¹⁹ Based on a 30 day deployment, each person working 9 out of every 10 days on 12 hour shifts.

required to meet the ADF's minimum operational capability will vary depending on how Global Hawk is employed. This will be considered further as part of the development of the various Global Hawk employment options. Training and selection of appropriate personnel to undertake operation and maintenance of the Global Hawk system will need to be assessed carefully, however, these areas are outside the scope of this paper. A breakdown of the manning requirements is provided in Annex D.

ADF GLOBAL HAWK EMPLOYMENT OPTIONS

Options for ADF employment of the Global Hawk system will be driven by the basing policy, level of deployment, the command and control arrangements, and the payload support communications provided. Three options have been selected that provide considerable variation in capability and cost, thereby allowing any committee to fully understand the full spectrum of capabilities available from an advanced UAV system. It should be noted, however, that a solution could be developed by choosing any mix of the various elements of each of the proposed options.

The following issues are common to all options:

- a. the Global Hawk air vehicles will be based in Tindal, inclusive of maintenance and logistics support;
- b. UHF satellite communications will always be made available to support command and control of the Global Hawk air vehicle; and
- c. each option will be capable of supporting the minimum deployment capability (one DGI long-range, long-endurance tasking).

Option 1 - Collocation Deployment Option

Deployment Only. Equipment will be deployed from Tindal for each task. For each long-range, long-endurance task this will include four air vehicles, an MCE, LRE and SE. A workforce of 44 personnel will be required for each individual task to support 24 hours per day operations for up to 30 days.

Decentralised Command and Control. Command and control of the deployed Global Hawk air vehicle will be through the MCE and LRE collocated at the deployed site. Local command and control of the air vehicle will be used, with tasking provided through the ATO process.

Limited Satellite Communications Support. Satellite communications will not be provided for payload command and control, nor data transmission. The X-band LOS CDL will be the only means of communications connectivity with the air vehicle. A wideband satellite capability will be required to link the MCE with ADFIS for the transmission of Global Hawk data to the Australian Theatre Joint Intelligence Centre (ASTJIC), and for the supply of ATOs through the JCSE system to the planning staff in the MCE.

Concept of Operations. Figure 5 highlights the concept of operations for Option 1. Each task will require the air vehicle to be flown from Tindal to the selected bare base. Support equipment, such as the MCE, LRE and SE, will be deployed from Tindal to the bare base using C-130 aircraft. The MCE and LRE will provide LOS command and control of both the air vehicle and the sensor payload. Operations will be restricted to a radius of 200 km for near-real-time downloading of sensor information, or could be extended to 830 km through the use of the data recorder. An autonomous flight mode is also available which would allow the air vehicle to operate out to a radius of 5 600 km, with the data recorder used to record surveillance information. This mode may be useful where static spot targets are to be observed and the target locations are well known. In this mode, the data would be downloaded from the air vehicle on its return from the mission. Sensor data can be pre-processed in the MCE shelter; however, it would require on forwarding to the ASTJIC before full assessment, and then dissemination, could be achieved.

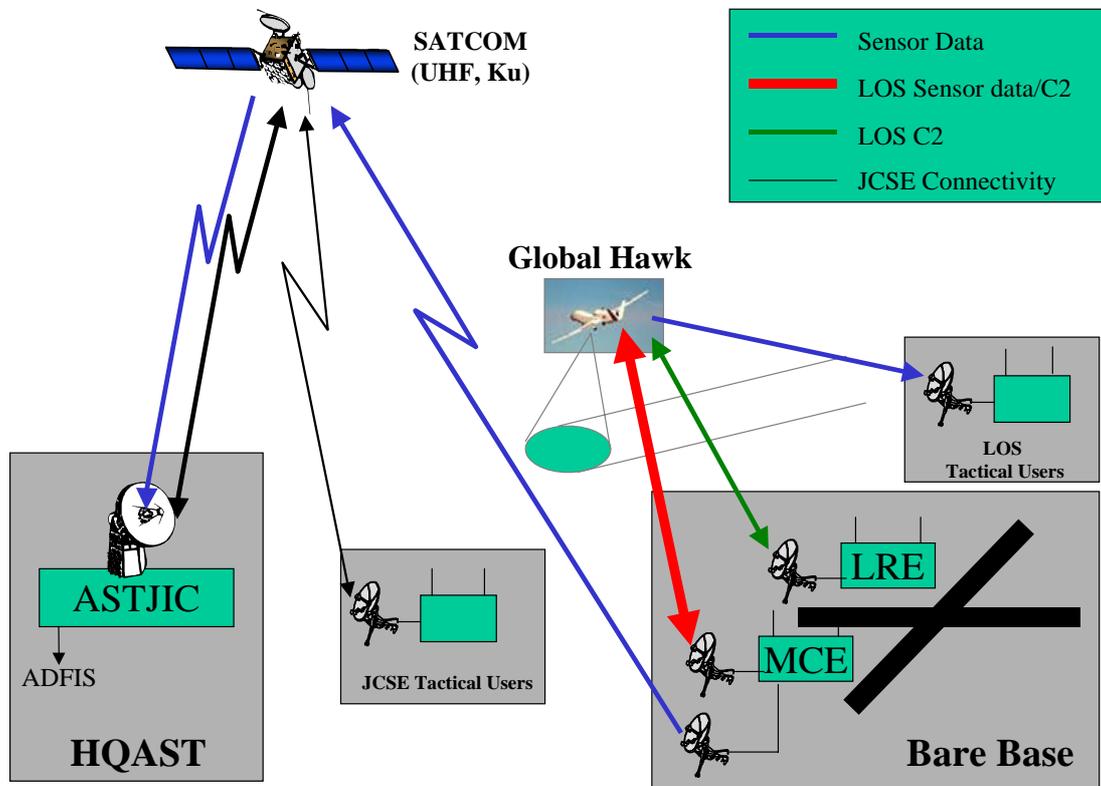


Figure 5 - Collocated Deployment Option: Concept of Operations

Option 2 - Split-Site Deployment Option

Centralised Basing/Limited Deployment. For each long-range, long-endurance task, three air vehicles, an LRE and SE will be deployed. The MCE function will be centralised, with control of the payload and its data conducted from Tindal. Spare Global Hawk air vehicles will be held at Tindal, rather than deployed individually, thereby allowing a reduction in the required number of back-up air vehicles. A workforce of 25 personnel will need to be deployed for each individual deployment to support 24 hours per day operations for up to 30 days. The UAVCC will require a

workforce of 30 personnel to support 24 hours per day operations for up to 30 days. This manning will be independent of the number of operational tasks being undertaken.

Centralised Command and Control. Only the LRE will deploy with the Global Hawk air vehicle to the forward operating base. The LRE will provide local command and control of the air vehicle for take-off and recovery operations. A centralised MCE capability (to be known as the UAV Command Centre - UAVCC) will be built and collocated with NORTHROC at Tindal. ATOs will be provided to the UAVCC through Tindal's connections to the existing fixed communications network. Global Hawk intelligence data will be transmitted directly from the air vehicle into both the UAVCC and ASTJIC for assessment and dissemination.

Full Satellite Communications Support. Ku-band and X-band satellite communications will be provided for command and control of the payload, and for the transmission of payload data. The LRE will use the X-band LOS CDL for local area control of the air vehicle. A narrowband satellite capability will be required to link the LRE with the UAVCC for provision of limited ATO traffic.

Concept of Operations. Figure 6 highlights the concept of operations for Option 2. This option provides significantly more capability than Option 1, as well as improved flexibility. Risks are the loss of SATCOM to support air vehicle payload command and control. Each task will require the air vehicle to be flown from Tindal to the selected bare base. Support equipment, such as the LRE and SE, will be deployed from Tindal to the bare base using C-130 aircraft. The LRE will provide LOS command and control of the air vehicle for take-off and recovery operations. The UAVCC will provide command and control of the air vehicle after take-off, and accept the sensor data from the air vehicle using satellite communications. The UAVCC will be capable of supporting the minimum operational capability without supplementation. The air vehicle will operate out to a radius of 5 600 km, providing near-real-time sensor information. Should the satellite communications link be lost, the air vehicle will automatically revert to its pre-programmed flight program, and will use the data recorder up to its two hour recording limit. Once the recorder is full, the air vehicle will automatically return to base. Should the satellite communications link return before two hours recording is achieved, the UAVCC can download the recorded information, and continue the operation as planned. This provides a risk mitigation strategy should satellite communications be lost or jammed.

Option 3 – Split-Site Deployment Option Plus Equipment Pre-Positioning

Centralised Basing/Limited Deployment/Equipment Pre-Positioning. As per Option 2; however, critical elements of the Global Hawk system, such as the LRE and SE, will be pre-positioned at bare bases to reduce the need for an airlift capability.

Centralised Command and Control. As per Option 2.

Full Satellite Communications Support. As per Option 2, however a narrowband satellite communications capability will be pre-positioned with the LRE and SE to provide immediate connectivity with the UAVCC.

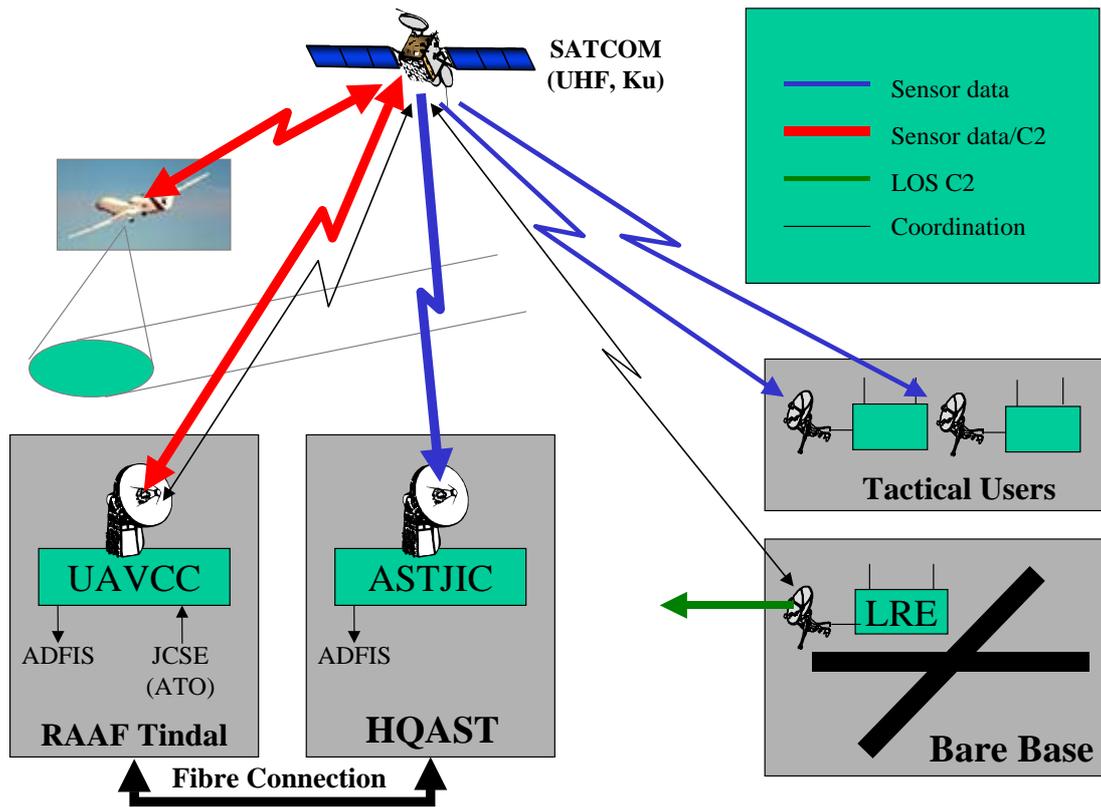


Figure 6 - Split-Site Deployment: Concept of Operations

Concept of Operations. As per Option 2, but only one C-130 aircraft is required to support each deployment as the majority of equipment will already be forward deployed to bare bases. This aircraft will also be used to move personnel required to support the deployment.

Comparison of Employment Options

Table 4 provides a comparison of the three options against the ADF operational needs outlined in this paper, and includes the 10 year LCC.

Option Two is cheaper than Option One, and provides significantly more capability, as well as flexibility. Option Two provides near-real-time coverage out to 5 600 km from the deployed air base, while option one has only limited coverage. Time to deploy is reduced because MCE shelters do not have to be deployed under Option Two. This also reduces acquisition costs, as not as many MCE shelters are required. Also, Options Two uses centralised command and control, through the UAVCC, allowing centralised allocation of back-up air vehicles, and therefore reducing the overall number of air vehicles required. Also, centralised command and control reduces the number of personnel to be deployed by half, providing significant reductions in operating costs. The primary risk with Option Two is the loss of satellite communications connectivity between the UAVCC and the air vehicle. This risk can be mitigated through fail-safe measures in the air vehicle which will allow it to continue its mission for another two hours using the data recorder, before automatically returning to base. Should the satellite communications connectivity

return before the end of the two hours, recorded data could be downloaded and the mission continued as planned. This capability is no less than that provided for in Option One. Therefore, Option Two is preferred over Option One.

Table 4 - Comparison of Suitable ADF UAV Operating Bases

	OPTION 1	OPTION 2	OPTION 3
Capabilities			
Radius of Operation	200 km (LOS) ²⁰ 830 km (LOS + DR) 5 600 km (DR only)	200 km (LOS) 830 km (LOS + DR) 5 600 km (SATCOM/DR)	200 km (LOS) 830 km (LOS + DR) 5 600 km (SATCOM/DR)
Coverage	125 600 km ² (LOS) 136 900 km ² (LOS + DR) 11 500 km ² (DR only)	125 600 km ² (LOS) 136 900 km ² (LOS + DR) 136 900 km ² (SATCOM/DR)	125 600 km ² (LOS) 136 900 km ² (LOS + DR) 136 900 km ² (SATCOM/DR)
Time to Deploy	48 hours	36 hours	< 2 hours
C-130 Support (hrs/annum)			
DAA/DRI/NS Tasks	387	387	65
DGI Task	26	26	26
Personnel Required			
Deployed	308	175	175
UAVCC	-	50	50
Costs			
Acquisition Costs	\$810m	\$749m	\$749
Operating Costs Per Annum	\$52m	\$45m	\$43m
10 Year LCC	\$1 170m	\$1 060m	\$1 050m

Option Two and Three are much the same; however, Option Three uses pre-positioning of key elements of the Global Hawk system to reduce the need for C-130 flying hours. No additional equipment is required to support this, and therefore, this equates to a reduction in operating costs over the life of the Global Hawk system. Given the difficulty in obtaining C-130 flying hours during high tempo operations, and also the reduced cost over the life of the Global Hawk system, Option Three is preferred to Option Two. Therefore Option Three is the preferred ADF employment method for use of the Global Hawk system.

²⁰ Those items bolded represent data being provided directly from the air vehicle to the MCE or UAVCC (near-real-time). All others involve data recording and downloading.

CONCLUSION

The ADF must be capable of undertaking surveillance and reconnaissance of the air/sea gap to the north efficiently and effectively, as well as other selected DAA, DRI, DGI and National Support tasks. While the RF-111 provides limited capability, Global Hawk's strategic surveillance capabilities take Australia that next step towards achieving this aim. This paper assessed various employment options against ADF operational needs, and makes a recommendation on which employment option should be developed further for ADF use of Global Hawk.

The key considerations that affect the employment of Global Hawk are basing, deployment levels, command and control, and communications connectivity. Only when all four work in harmony will the right ADF employment method for Global Hawk be chosen. Tindal has been chosen as the main operating base due to its closeness to the ADF's primary operating area, as well as restricted airspace and the Delamere Range. Furthermore, it has limited commercial traffic, thereby reducing the interaction between the Global Hawk air vehicle and civilian air traffic. Command and control, deployment levels and communications connectivity are interactive in nature, with communications connectivity being the primary driver. If significant satellite communications connectivity can not be provided, then deployment levels will increase, and opportunities for centralising command and control will decrease, thereby reducing capability. The cost of additional satellite communications is offset by the increase in deployment requirements. Communications connectivity is an area of concern as Australia's primary areas of operation do not have significant Ku-band commercial coverage. While military X-band can be used as a gap-filler, consideration will need to be given to developing an ADF satellite communications system capable of supporting unmanned and manned aircraft. A study should be conducted to identify Australia's future manned and unmanned aircraft satellite communications needs up to 2010.

In considering these key elements, Option Three, the Split-Site deployment option with pre-positioning of key Global Hawk elements, is the preferred option for ADF employment of the Global Hawk system. This option provides an operational radius in excess of 5 600 km, maximises coverage opportunities, and reduces manpower and C-130 support needs. Furthermore, this option is the cheapest in both acquisition and operating costs. The Global Hawk trial to be conducted in Australia in 2001 will provide the ADF with an opportunity to test this capability.

Annexes:

- A. Global Hawk System Description
- B. ADF Operational Roles for Global Hawk
- C. Satellite Communications Options to Support ADF Use of Global Hawk
- D. Deployed Manpower Requirements
- E. Global Hawk Life Cycle Costs