Strategic Tanker/Transports for Australia

Part 2

The Boeing KC-25/KC-747

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Part 1 of this special report explored the evolving strategic context in South East Asia and identified a developing need for Australia's air force to acquire a substantial strategic/tanker transport force.

Since publication of Part 1, the December 2000 White Paper was released reflecting a similar viewpoint held by Australia's defence planners. Indeed, the White Paper extends established ADF doctrine to now encompass the use of tanker-supported F-111s for long range strikes against any military targets, maritime or land based that could represent a threat to Australia or its strategic interests. Another important feature of the White Paper is that it asserts the critical importance of maintaining air superiority over Australian territory and its maritime and air approaches. Ambitious capability goals are defined in this respect, in particular the capability to conduct sustained long range strike campaigns by the F-111 force, using aerial refueling.

Whether we consider the White Paper capability goals in counter-air operations or strike operations, it is clearly evident that the RAAF will need to field a substantial aerial refueling force to meet these objectives. The White Paper commits to five new technology tankers to replace the Boeing 707-338C fleet, which is suffering from fatigue and corrosion problems that would be prohibitively expensive to rectify.

Analysis based on strike, defensive combat air patrol and comparative fleet ratios indicates that about 12 to 16 large wide-body tankers or 24 to 32 medium tankers would provide appropriate fleet sizing for deterrence operations, long range maritime strike, air support of regional peacekeeping deployments, and air defence of the air sea gap and the 'deep north'.

Should 'heavy widebodies' be employed, then airlift and ongoing resupply of a brigade-size ground force element would also be feasible.

For all practical purposes the budgetary commitment in the White Paper addresses at best 40 per cent and, at worst, 20 per cent of the actual refueling capacity needs the RAAF will face. Pressures in crewing and fuel offload performance per airframe will drive tanking needs in the direction of large widebodies, whereas pressures in training fuel burn and low intensity operations will favour medium widebodies. It is likely that the immediate pressures of 707 training capability replacement will thus see medium widebodies adopted by the RAAF in the near term. In addressing the needs of high intensity operations, the most economical choice is then to further expand the tanker fleet by the use of large widebodies, thus producing a 'two tier' tanker fleet.

While a medium tanker requirement can be readily addressed using either Boeing 767 or Airbus 310/330 derivatives, neither have the offload performance to meet a heavy tanker requirement.

Boeing DC-10/MD-11 and Lockheed Tristar derivatives will be difficult to support in Australia, more so beyond 2010 when commercial fleets begin to downsize, and this is despite the adequate performance of these types as tankers. Indeed the USAF KC-10A will be orphaned post 2015, an issue of some concern in the US.

The only remaining type in the required size and performance class is the Boeing 747, and this aircraft is the subject of this final part of the series.

Boeing 747 Derivatives

The Boeing 747 family of aircraft is used both by Qantas and Ansett in Australia, and Air New Zealand. Qantas flies the 747 in passenger and freighter variants. Its design is a derivative of a 1960s Boeing proposal for a military airlifter that lost out to the Lockheed C-5A Galaxy. The aircraft was later evaluated against the DC-10 as part of the USAF Advanced Tanker / Cargo Aircraft (ACTA) program, losing out to the McDonnell Douglas KC-10A proposal despite its superior performance. Photographs exist of the 747 refueling even the SR-71A during these trials.

Several AAR boom and receptacle equipped 747-100B tankers were supplied to Iran during the mid to late 1970s, including aircraft with lower-deck fuel tanks, and two US military variants exist with AAR receptacles.

The conversion package for Iran was performed with the expectation that other clients would be found, and a full production standard documentation package was generated as a result. Therefore, a current retrofit of the basic KC-135 boom to the 747 incurs minimal Non Recurring Expenditure (NRE).

Boeing 747 derivatives

The Iranian aircraft employed an operator with direct view as per the KC-135 design, but located behind a recessed rear fuselage window in the aft pressure bulkhead, rather than in a protruding fairing as used by the KC-135.
A cheaper alternative to produce, at the expense of some NRE, would be the remotely operated boom as used on the KDC-10-30CF. The classic KC-135 boom was recently re-engineered in a number of areas to employ current production techniques such as extrusion rather than riveting. Booms supplied on recently delivered KC-135R conversions have been based on this newer implementation that would be used in any new-build 747 retrofit.
The lower deck volume of the -100/200/300 and -400 models available for container freight provides ample space for additional auxiliary fuel cells, and these would be essential to extract the full offload potential of the aircraft as a tanker. Since intercontinental variants of the 747 carry a generous internal fuel load, at MTOW for most variants only about 20 to 40 tonnes would need to be carried in auxiliary lower deck fuel cells, with cross feed from the main tank employed. A typical implementation for a lower deck fuel cell would resemble a reduced height LD2 type freight container, indeed the auxiliary fuel cells for the new Longer Range 747-400 and 747X series are built in exactly this format.
Without potentially expensive structural reinforcement of the lower lobe floor, the auxiliary fuel cells are weight rather than volume limited. The aggregate gross weight limit for fore and aft lower lobe compartments is 47.7 tonnes, assuming an evenly distributed load, which bounds the available capacity of lower deck tanks. The US FAA requires the tanks withstand loads of 9G. Typical contemporary implementation employs a rigid double walled tank design, rather than the older "fuel bladder inside a metal box" style.
Offload performance at a 1,900 NM radius would be about 95 tonnes of fuel or better, for a Combi or freighter configuration with lower deck auxiliary fuel cells. Such performance is superior to the KC-10A.
US military 747-200B variants are designated C-25A, such as the VC-25A 'Air Force One'. The designation C-19A is reserved for 747-100 aircraft committed to the CRAF scheme. Therefore, a 747-200B tanker/transport variant could be designated a 'KC-25A', with a different suffix applied for a different 747 variant, examples being a 'KC-25B' for 747SP model or a 'KC-25C' for a 747-300 model.
A simple measure of the Boeing 747 against other established tankers is that it delivers offload performance potentially superior and payload-range superior to the KC-10A Extender, yet it is fast like the KC-135R and Boeing 707 tankers, cruising at 0.84-0.85 Mach. This is a very important attribute for strike and offensive counter-air refueling operations, since the tanker must keep up with a fighter package, and must be capable of operating at the boundaries of contested airspace.
Therefore, this aircraft is the only type which satisfies the requirement of an existing domestic operator base, the requirement for an established boom equipped AAR conversion, and delivers the long range AAR offload performance and volumetric requirements needed for both the strategic AAR and airlift roles.
Freighter conversions of the four basic versions are widely used in the commercial air freight market, indeed the current industry trend is for older 747-100 and -200 airframes to be retrofitted into freighter configuration by the addition of a large aft fuselage Side Cargo Door (SCD) and installation of the freighter floor. Designated a 747 'Special Freighter' (747SF or 747-100SF/200SF/300SF), conversions are performed by Boeing Wichita, GATX-Airlog, Pemco Aeroplex, Israel Aircraft Industries and HAECO with costs depending on the scope of the conversion package. Typical costs are between USD 12M and 20M per airframe.

Boeing 747-100 and 747-200

Five basic models of this aircraft exist, manufactured from about 1970. The 747-100 and -200 are the oldest models and, given accrued airframe fatigue and corrosion, many airframes may not be a viable consideration for a large long-term investment with the cost of airframe life extension. The last -200F freighters were built during the early 1990s and may have acceptable fatigue life. Typically, the fatigue life of older 747s can be extended through Section 41 reworks and Pylon and D checks, with the cost of such a work package reaching up to USD 10M per aircraft. Engine overhauls typically cost USD 1.5M each at intervals of 1,200 to 1,500 cycles. The market value of 747-100 and older -200 aircraft varies between USD 4.6M and 7.7M, with later build 747-200 variants commanding between USD 13.8 and 26.2M apiece.

Boeing 747-300

The 747-300 is the extended upper deck variant of the late build -200B airframe, manufactured between the early eighties and nineties. With the advent of the extended range -400 model, the demand for this model in the commercial market has declined and it is readily available, while accrued fatigue life will be modest for examples flown mostly on long-haul routes.
At present, there is a glut of used 747-200B/C and -300B/CF aircraft in the market; a good proportion of these are Combis that are already fitted with the large SCD freight door and would thus incur lower costs to convert to a tanker/transport configuration. Typical unit costs fall between USD 39.4 and 50.8M, but will vary with the age, condition and fit of the aircraft. Given the saturation of the market, it may be feasible to acquire aircraft at prices well below the actual value of the aircraft.
The extended upper deck on the 747-300 series aircraft provides the means of carrying up to 85 economy class passenger seats in addition to main deck freight, but does so at the expense of reducing the ceiling height of the main deck fore of the wing, thereby imposing some limits on the carriage of taller freight items. Special Freighter conversions, however, may have a modified upper deck floor to extend main deck internal clearances, at the expense of the useful upper deck floor area.
A 747-300 can thus be more flexible in terms of its ability to mix freight and troop loads, but at the expense of the mix of freight item sizes it can accommodate, in comparison with a 747-200 derivative.

Boeing 747-400

The 747-400 is the current production model, introduced in the early 1990s, available in passenger, Combi and Freighter versions. It features the extended upper deck of the -300, and a new extended wing fitted with winglets. Since it is available either new-build or with a service life under 10 years, fatigue life is not an issue for the 747-400 at this time.
The 747-400 offers the best load carrying performance of any 747 variant, but its larger MTOW imposes the need for better runways, and due to its large wingspan ground handling can be an issue on some sites. It is also expensive in the used aircraft market, as it remains strongly in demand, with typical used aircraft worth between USD 92.5M and 158.5M.
The Longer Range 747-400 incorporates additional lower deck fuel and improved engines. The 747X, with a new wing design and fuselage stretch, will be available by 2005 and will deliver significantly better payload radius performance than the 747-400 series.

Boeing 747SP

The Boeing 747SP is a high performance, lightweight, long range variant, manufactured between 1976 and the late 1980s, with only 45 built. The aircraft was specifically designed for very long range, low load factor routes as a replacement for the long range variants of the Boeing 707. It employs a shortened fuselage, lighter structure and enlarged tail surfaces. Until the advent of the extended range -200B variants and the -400 it was the 747 variant with the best range performance.
As the -400 has penetrated into the commercial market, the demand for the 747SP has fallen strongly. As at July 1999, seven were in storage and four dismantled for structural spares. Qantas continues to operate two examples. No less than fifteen 747SPs are currently on the market, including some VIP transports, with a unit cost cited between USD 5.3M and 7.7M apiece. Because of the poor profitability of the 747SP on most routes, it is considered to be worth more as scrap than as a commercial asset. As the 747SP was almost exclusively used for long haul operations, the number of cycles on the airframes will mostly be excellent, in relation to the age and accrued flight hours of the aircraft (typically between 9,000 and 13,000 cycles on aircraft aged around 18 years). Such numbers are more typical for 747 aircraft of 12-15 years of age.
However, the general condition of many of the available aircraft is unclear, and considerable refurbishment, and corrosion repair effort may be required in addition to the required AAR hardware modifications. Providing that candidate airframes are adequately investigated prior to purchase, this risk can be managed reasonably precisely.
The 747SP has the best short field take off performance of any 747 variant. Most large widebodies require about 3,100 metres of runway, the 747SP typically requires 2,350 to 2,750 metres at MTOW, reflecting the lower MTOW and load carrying performance of this variant.

Boeing airlifters

As a tanker, the 747SP provides an internal fuel capacity of 148 to 153 tonnes, and lower lobe floor strength to accommodate about 30 tonnes of auxiliary fuel. Given existing MTOW limits on the aircraft, this yields about 74-80 tonnes of offload at 1,900 NMI, which is competitive performance against the KC-10A. Clearing the aircraft for a 4% increase in MTOW would bring offload closer to 85 tonnes under these conditions.

The limitation of the 747SP as a tanker/transport airframe is its low structural payload limit of 38 tonnes in the standard configuration, and the need to perform a Combi or Freighter conversion, neither of which were standard build options. A production option was an increased structural payload limit of 45 tonnes, and it may be feasible to further improve upon this. The issue is thus the NRE of such structural work, and the NRE associated with adapting the standard 747-200/300/400 freight floor and SCD installation. Given the low cost of basic airframes, such modifications are well worth exploring, especially since they are based upon standard components used in the 747-200B/CF/300CF freighter conversions.

In terms of initial acquisition costs and performance as a pure tanker, the most suitable 747 variant is the 747SP. With lower deck fuel cells its offload performance is competitive against the KC-10A, yet the cost of the basic airframe is 1/4 to 1/3 of current DC-10-30CF costs, and it offers superior short field performance and cruise speed. This competitive advantage must be balanced against its limited performance as a freighter, typically of the order of 40% to 50% of the structurally limited payload of a 747-200/300 series aircraft, and 50% to 60% of a KC-10A aircraft.

Biasing the requirement toward airlift and factoring in availability and fatigue life, the most suitable 747 variants for a strategic tanker/transport role would be the 747-200/300/400CF/SF, should examples with suitable maintenance histories be selected.

An issue for any Boeing 747 AAR tanker conversion will be the provision of hose/drogue refueling hardware, as no current user (Iran) has had such fitted. The simplest alternative is the installation of one or two fuselage hose/drum units, in a manner akin to the KC-10A or RAF Lockheed Tri-Star, preferably using the same hardware. Refueling the C-130J and larger RAF assets imposes the constraint that such a fuselage installation be used.

The need for redundant hose/drogue systems to account for possible failures enroute indicates that the preferred configuration would employ either a pair of fuselage hose/drum units, or a three-point arrangement with a single fuselage hose/drum unit and a pair of wing-mounted Mk.32B pods as used on the RAAF's Boeing 707-338Cs. The latter would be more attractive operationally but a much more expensive choice since the overheads of design, wing modification to accommodate fuel lines, and flight testing would be incurred.

The Engineering, Manufacturing and Development contract for adding wing-mounted 'hose and drogue' refueling pods to the KC-135R Stratotanker cost approximately USD 24.4M. The cost of conversion kits to fit Mk.32B pods to USAF KC-135R aircraft is about USD 2.55M per aircraft, excluding the cost of the pods. The cost for a KC-25/747 kit would be slightly higher due to the longer fuel lines required. Given that Boeing have performed the adaptation of both the KC-135R and KC-10A for wing mounted Mk.32B pods for the USAF, it is reasonable to assume that much of the design work could be directly adapted to a KC-25/747 design, thereby reducing the magnitude of the NRE required. The all up cost of equipping a dozen KC-25/747 aircraft with pods would be thus of the order of USD 50M, excluding the cost of 24 pods and appropriate spare components.

The 747 as an Airlifter

A very attractive aspect of the standard Boeing 747-200CF/300CF and 400F Combi and Freighter conversions is the size of the standard rear fuselage SCD freight door. It provides a vertical clearance suitable for a three metre high load, and a horizontal clearance suitable for a 2.5 metre wide load. The door is 3.4 metres wide, but some allowance must be made for swinging the load around as it is inserted.

The floor width is 6.13 metres, which means that on paper both the standard ASLAV and M-113 can be loaded, albeit with some care required during insertion. Clearances will need to be verified by a load check since the ASLAV is 18 cm wider and 45 cm longer than the standard 2.44 x 6.05 metre freight pallet. Specialised variants of the ASLAV, such as the command vehicle and ambulance may not fit through the 747 freight door due to their bulkier and higher profile.

Unlike a conventional military airlifter allowing Roll-On/Roll-Off (RORO) loading, the Boeing 747 would require that the ASLAV be first tied on to a 6.05 metre pallet, and then handled and loaded into the aircraft as if it were an 11 tonne, 6.05 metre contoured freight container. A forklift would be used to load empty pallets on to the loader, for roll-on loading of the vehicle on to the pallet. Once the vehicle is secured to the pallet it may be loaded into the aircraft. For unloading, the palletised vehicle is released off the pallet and driven away, and a forklift is used to remove the empty pallet from the loader.

Since the vehicle is slightly longer than the standard pallet size, the locked down positions of the pallet would have to be slightly different to a standard load of 6.05 metre containers or pallets. On paper, this arrangement would allow four or more ASLAVs to be loaded, side by side, together with other freight.

Unlike conventional military air lifters that have loading ramps and a very low floor height, the Boeing 747 requires specialized support equipment for loading and unloading. The height of the 747 main deck is between 4.67 and 5.33 metres, depending on the weight of the aircraft. Therefore, if the aircraft were to be operated into airfields that are not equipped to handle containerised freight, such equipment would need to be prepositioned, carried in by the 747 strategic transport, or delivered by other aircraft prior to the arrival of the 747 strategic transports.

Ground-based loading equipment may be fully mobile container handling equipment like the 30 tonne capacity USAF/SEI 60K Tunner, or the 13 tonne capacity SEI 25K loader series, or much cheaper collapsible frame container and pallet elevators, like those employed by the USAF with the KC-10A. Fully mobile loaders are the most flexible in use but more difficult to deploy, e.g. the USAF Tunner requires either C-141, C-5 or C-17 lift. Smaller loaders are compatible with the C-130.

New build Boeing 747-200CF/300CF/400F Freighters and many Combis have been delivered with a lifting Nose Door, similar in concept to that used on the C-5 Galaxy. This door has size limitations, primarily the vertical clearance limit of 2.49 metres imposed by the floor of the cockpit and upper deck section.

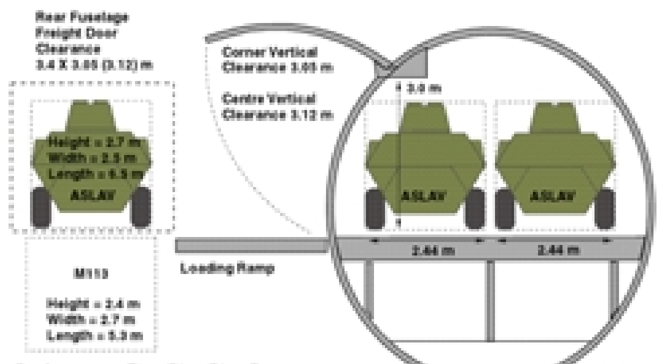
This is inadequate for the ASLAV but may be sufficient for the M-113. It would however be convenient for roll-on/roll-off loading and unloading of 4WD vehicles and smaller trucks with heights under 2.45 metres, using a loader to lift them level with the aircraft main deck.

The Freighter/Combi Nose Door is, however, attractive insofar as it allows the aircraft, with minor modifications, to carry the Boeing On Board Loader device, which is stowed in the nose of the aircraft and deployed once on the ground to provide autonomous freight handling. This device takes 30 minutes to deploy or stow, weighs 6.6 tonnes and can handle payloads of up to 13.6 tonnes. When stowed it displaces two 2.44 x 6.05 metre containers or 6.7% of main deck capacity.

The Boeing On Board Loader may be disconnected from the aircraft nose and used as a free standing loader. It is designed to load and unload 2.44 x 6.05 metre pallets or containers, using either the Nose Door or the Side Cargo Door. The loader is powered from the aircraft's electrical system at either door, or by a ground based generator.

An interesting side note is that the design of the loader was paid for by the Iraqi national airline during the late 1980s. They were the sole client for this piece of equipment. We can but speculate upon reasons for the Iraqis wanting to be able to load and unload large 13 tonne containers at unprepared sites.

This loader is not suitable in its basic configuration for the handling of the ASLAV and M-113 and would require some design changes for this purpose. Slight modification of the loader design to increase its width and length would thus be required. Nominal time to load or unload an aircraft using this device is about one hour, assuming the device is already deployed.



Boeing 747100F/200F/300F/400F
ASLAV25 Loading Fit Check

An important limitation of the Nose Door is that the nose refueling receptacle design would need to be adapted to use a flexible or articulated connection to the fixed fuel lines in the forward fuselage, or shifted above the cockpit, thereby incurring some additional NRE.

The feasibility of retrofitting the Nose Door as part of the freight modification needs to be further investigated, as this would provide more flexibility in the choice of airframes which otherwise must be selected from the limited pool of Nose Door equipped Combis available in the marketplace. Another alternative is to rework the design of the Boeing On Board Loader to allow it to be deployed from the SCD rather than the Nose Door. The final option is a mixed fleet with only some aircraft fitted with the Nose Door.

There may be some scope for faster reconfiguration time between the airlift and troop carrying configuration: by using dedicated 2.44 x 6.05 metre pallets fitted with fixed canvas troop seats, rather than commercial Combi airliner seating. This could be implemented in a manner that would save considerable weight, compared with commercial seating, thereby allowing more troops and freight to be loaded into the aircraft.

A simple measure of the Boeing 747-200CF/300CF/400F as an airlifter is that it provides payload range performance in the class of a C-5 Galaxy, but its freight loading door limits payload items to sizes similar to those carried by a C-130 Hercules or C-141 Starlifter. With the exception of length, the Boeing 747 SCD can handle items slightly larger than either the C-130 or C-141. Therefore any Army assets air-portable by C-130 will almost certainly be portable by 747, thereby taking a significant load off the RAAF C-130 fleet.

Its principal limitation in comparison with purpose-built airlifters is inferior short field performance, greater runway strength required, and the need for external loaders. For bulk strategic airlift of personnel and palletised freight into secure areas with suitable surfaces, using the C-130 for forward distribution, the 747 outperforms all airlifters other than the C-5.

Crew and Passenger Access

An issue of some inconvenience is the absence of a door or hatch and internal ladder for crew and passenger access to the aircraft at sites without appropriately sized boarding facilities for airliners. The solution is to employ a modification used on the USAF's Boeing E-4B NEACP airborne command post and the VC-25A VIP aircraft. These aircraft carry a deployable set of air-stairs stowed in the forward lower lobe cargo bay. Installing deployable air-stairs would remove at least one fuel cell in the forward bay. Given the load carrying capacity of the lower lobe floor and MTOW limits in both the 747-200/300/400CF/SF and 747SP models, this would not impair the potential offload performance, as a single cell amounts to 10% or less of the lower deck capacity.

Integration of the deployable air-stairs will render some small portion of the main deck floor above the forward lower lobe cargo bay unusable for freight, so as to provide space for a hatch to access the air-stairs. Since retractable stairs must be installed to provide access between the main deck and the upper deck, these should be located adjacent to the hatch to the air-stairs to minimise the loss to main deck floor space. The air-stairs provide the ability to load and unload passengers, as well as providing access for the crew, regardless of site facilities and should be a serious consideration for all aircraft in a fleet.

Implementation Issues

While a Boeing 747-based strategic tanker/transport is not the ideal solution for the strategic airlift requirement, it is an excellent basic platform for a strategic tanker: it is readily available via the modification of units from the large pool of used commercial airframes, and it is much more affordable than any new build alternative.

In terms of variants, it would appear that a mix of 747SP and 747-200/300CF/SF models - given that examples of suitable condition can be located - would be the most practical choice.

The 747-200/300CF/SF is the better strategic tanker and transport by virtue of its higher MTOW, better offload performance and ability to carry heavy freight. The 747SP offers much lower initial acquisition costs and slightly lower fuel burn. It also offers better operational flexibility per total fleet offload performance and better short field performance. Limitations are the slightly lower unit-offload performance, inability to carry freight without modification, and similar crewing and support requirements to the 747-200/300. The age of the aircraft may also prove to be an issue, since corrosion may limit the long term viability of a 747SP.

Therefore, the 747-200/300 offers a better longer term return on investment, with a much greater initial acquisition cost. The proportions of any mixed fleet would therefore have to be based upon a careful analysis of the point in the fleet lifecycle where the difference in initial acquisition cost favouring the 747SP is balanced by the lower return in airlift capability given similar crewing and support costs.

Determining the number of aircraft to provide the capability required will need some detailed modeling of AAR performance for the ranges in question along with analysis of the airlift requirement. First order estimates indicate that between 12 and 14 747-200/300 aircraft would be required, depending on the offload performance achievable for a given configuration, runway capabilities available and aircraft empty weight after the installation of AAR hardware and freight modifications. For the same fleet offload performance, 12 to 16 747SP aircraft would be required. Some spares would be required.

According to Boeing-Wichita information, the 747-200/300 could be modified into a freight configuration with a lead time of only several months.

Conversion for this dual role capability would require the following modifications:

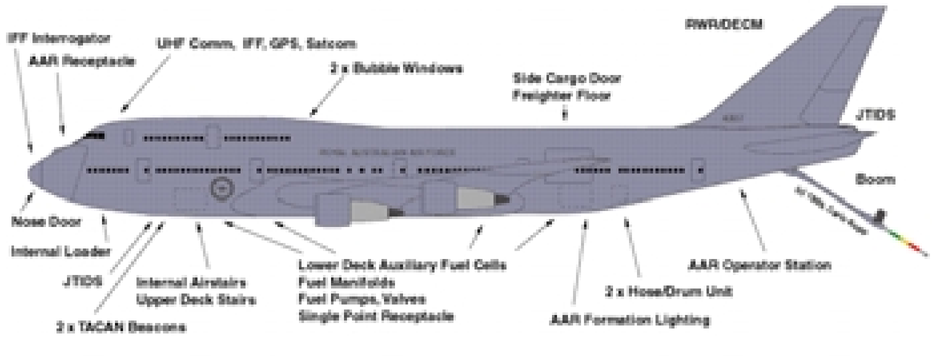
1. Installation of an AAR boom and operators' station.
2. Installation of two fuselage hose/drum/drogue units, or a single fuselage hose/drum/drogue unit and a pair of wing mounted Mk.32B pods.
3. Installation of AAR fuel pumps, valves, manifolds, plumbing and operator controls.
4. Installation of lower-deck auxiliary fuel cells.
5. Installation of AAR receptacle for tanker-to-tanker refueling.
6. Installation of single point ground refueling receptacle for lower deck auxiliary fuel cells.
7. Installation of the forward lower deck internally stowed air-stairs and retractable upper deck stairs.
8. Installation of at least two observers' bubble windows, replacing aft upper deck windows.
9. Installation of dual TACAN beacons and formation lighting.
10. Installation of military UHF communications equipment, preferably with crypto capability, IFF and JTIDS equipment.
11. Installation of military GPS navigation equipment.
12. Installation of IFF interrogator.
13. Installation of a suitable intercom system.
14. Installation of Echidna RWR and DECM package, possibly also IRCM on engine pylons.
15. Installation of the Side Cargo Door if not already fitted.
16. Strengthening of the main deck floor to freighter standard and installation of freight handling hardware.
17. For aircraft with extant Nose Door installations, modification to support the Boeing On Board Loader, and supply of these devices, modified as required.

Serious consideration should be given to the use of a standard configuration, if possible, whereby all aircraft are fitted with the air-stairs, Nose and Side Cargo Doors, the Boeing On Board Loader, and refueling receptacles.

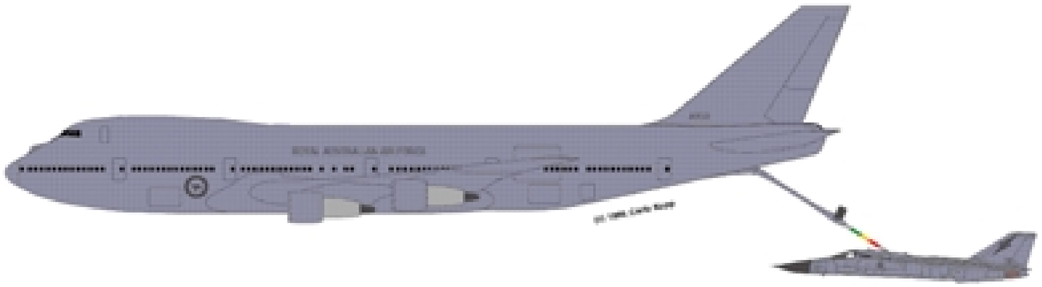
Whether to retrofit the aircraft cockpits to a current standard 'glass cockpit' arrangement is open to debate. While this would increase the unit conversion cost, it offers the longer-term economy of a two-person flight crew, against a three-person flight crew, assuming a dedicated AAR operator. Given that most commercial models now have glass cockpits, maintenance of currency for reservists flying commercial models would indicate that a glass cockpit would be preferred. This would also provide the opportunity to standardise the inertial navigation and communications equipment fit across the fleet. A FANS compatible system would be desirable.

There may be some merit in retrofitting all aircraft to a common engine type, should airframes of suitable quality not be fitted with such. Qantas will be well equipped to advise on the performance and idiosyncrasies in supporting specific engine types. Overhauled used engines of suitable quality may be acceptable, since the aircraft in RAAF service would not be operated at the tempo of a commercial operator outside periods of war or other contingencies.

Tanker/Transport Implementation



Boeing KC25C (747300CF) Tanker/Transport



The commercial aspect of such an acquisition is of modest complexity, since with the exception of the AAR conversion, multiple sources exist for freight conversions, airframe life extension and engine overhaul or retrofit. The only extant and flight tested AAR conversion was performed by Boeing.

While other vendors such as IAI may be competent to engineer an AAR conversion, they will incur the full engineering overheads and development risks of a new design. Therefore, Boeing will have a significant competitive advantage over any other vendor, and this may also be true of a comprehensive modification package incorporating all changes. There may be considerable potential for domestic offsets by performing portions of the structural work and modification at the Avalon facility, which has the runway and hangar sizes required. ASTA performed structural work on 747 aircraft some years ago.

Whether the best strategy is to release an RFP for the supply of fully modified 747 aircraft to a specified configuration and place responsibility for the choice of airframes upon the vendor, or to acquire the aircraft directly off the commercial suppliers and then release an RFP for the modifications, remains to be determined. We could expect that shifting the burden onto the vendors will have some impact on the price tag as they would want to cover any risks they might incur.

The availability of suitable airframes and pricing in the market will vary and this should be a consideration, since the pool of available aircraft and prices will fluctuate as older airframes are absorbed into the freighter market.

The total expense for the acquisition phase of the program would comprise the cost of the used airframes, the cost of any re-engining, zero-timing and corrosion repair, the total cost of the required AAR, and where applicable, freighter modifications as detailed above. Since the program would involve a reasonable number of aircraft, some economies of scale in the production phase could be achieved.

The issue of which runways to upgrade, and whether to include them in a project budget, is an interesting one. Strategically, the two most important sites are Darwin (for airlift and air support of peacekeeping forces) and Learmonth (for air defence, strike and maritime operations).

Neither would require substantial runway work to support operational detachments, although significant upgrades to the fuel replenishment infrastructure may be needed to sustain high intensity operations. At this time the ability to resupply aviation kerosene at hundreds of tonnes per day would be the limiting factor.

Learmonth would require a modest 10 per cent runway extension to support the 747-200/300 at MTOW. The runway strength at Curtin is not adequate for high gross weight operations, and its remoteness makes the resupply of large quantities of fuel to support tanker deployment difficult. Darwin would provide a better runway than Tindal for 747-200/300 operations. Townsville would require a new parallel runway rated for the 747, while Amberley could operate the aircraft with some gross weight limitations applied. All of the major civilian airports in Australian capitals could support the aircraft. Amberley would appear to be the best prospect, with weight limits imposed, for a squadron home base capable of supporting training flights only.

From a practical perspective, the full MTOW capacity will be required only for long range or long endurance AAR operations, or for heavy lift transport operations. The former category of operations is geographically confined primarily to Learmonth and Darwin, both of which have adequate runways. The latter category would be confined mostly to Darwin and Townsville.

Crewing the aircraft will be a major issue. Assuming a fleet size of twelve aircraft, with a glass cockpit and two person flight crew, the nominal 1.6:1 (USAF) crew/aircraft ratio yields almost 40 pilots, and a 2:1 ratio suitable for sustained high intensity operations yields 48 pilots, with half qualified as aircraft commanders. Maintaining currency, given the hourly operating costs of such aircraft, would be by any measure expensive. Simulators, no matter how good, are not a substitute for time in a real cockpit.

Therefore, it will be necessary to explore other alternatives. One possibility worth exploring is that of hiring out the aircrew to the airlines, at such a rate where the offer is attractive to commercial operators.

The contractual arrangement would be such that these pilots would fly regular operations for the airline in the same manner as the aircrew employed by the airline, however they could be recalled by the RAAF at very short notice to crew the strategic tanker/transport fleet.

Such a strategy has several attractions. The first is that it is an unbeatable attraction in the recruiting game, for those applicants with long term aspirations of an airline career. The second is that the crews get to maintain a high level of currency on the basic aircraft, and long haul overseas flight experience in the process. For the airlines, there is the advantage of simplified recruiting of junior pilots, who will have acquired their ab initio, early flight training and some multi-engine time in the rigorous RAAF training regime. Contractual arrangements would need to be such, that the airline could recoup the training investment in such aircrew after they complete their service in the RAAF.

Conclusions

The arrangement would have to be such to make 'poaching' of such aircrew impossible before their contracted service periods run out. The aircrew would periodically fly the RAAF aircraft to maintain proficiency in AAR flight operations, but would gather most of their hours on commercial aircraft.

The crewing issue does not disappear with a PFI fleet, the burden is merely shifted upon the commercial operator. For combat operations, reservists would almost certainly be essential.

Conclusions

This report argues the case for the acquisition and deployment of a substantial strategic tanker/transport force for Australia, comprising a fleet with a large proportion of modified variants of the Boeing 747 transport.

Such a force would wholly address the capability goals defined in the December 2000 White Paper, and plug the 'capability gap' between the government's stated five-tanker fleet, and actual operational needs for a credible force.

The Boeing 747 makes for an excellent strategic tanker, but not an ideal airlifter. However it is the only aircraft type that will allow Australia to deploy a large strategic tanker/transport force with a modest initial expenditure, while exploiting the established training and support base.

To provide a general measure of capability, one dozen 747-200/300/400CF/SF derivative KC-25 strategic tanker/transports provide the cruise speed and offload performance equivalent to around thirty KC-135R tankers, or 26 767-200 tankers, and can lift the payloads of a dozen C-17A airlifters over about a 60% greater distance, all at about one-third of the total acquisition cost of the combined packages of KC-135R and C-17A aircraft. A mixed KC-25 fleet, including some 747SP derivatives, yields similar offload performance and lesser airlift performance, with even lower acquisition costs. A mixed fleet of C-17A and KC-25s yields inferior offload performance, but would provide a superb airlift capability, with a penalty in acquisition costs.

In summary, it is fair to say that the strengths of the 747-200B/300/400CF/SF and 747SP as a strategic tanker/transport outweigh its limitations, especially in comparison with other alternatives derived from commercial airframes. While its weaknesses are most prominent in the airlift role, it performs this role far better than other commercial types.

At this time the composition of the RAAF's future tanker force is yet to be determined. What is abundantly clear at this time is that a force which is robustly sized to meet the capability goals in the new White Paper will have to contain a substantial fraction of heavy strategic tankers. Should the 747 be used as the basic heavy tanker platform, the economics will be well within Australia's reach.

Footnote

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