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No fuel – no Air Power

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At a time when the cost of aviation fuel is at its highest, the guarantee of supply is at risk and there is opinion that the world has reached Peak Oil, the sustainability of fuel supplies for military aviation has surprisingly attracted scant attention in Australia's ongoing defence debate, which seems preoccupied with arguments over equipment acquisitions, and is now focused on network centric warfare issues. As fuel supply is a critical determinant in sustaining air power, Australia's position is as precarious as is the uncertainty of supply. It matters little what type of combat aircraft Australia acquires if the fuel supply chain cannot sustain credible rates of resupply to keep the turbofans turning.

The reality is that to sustain any number of combat aircraft the volume of fuel available must match or exceed the demand resulting from the Rate of Effort. A single sortie unrefuelled for an F/A-18, F-111 or F-35 typically requires a cruise fuel burn of around 6,000 to 7,000 lb/hr. Making allowances for combat burn and climb burn does not leave a lot of fuel in a smaller fighter for transit to and from the target or other area of interest. Tanker aircraft are therefore a prerequisite for almost all combat operations, be they air combat or strike oriented.

A key factor today is the demand for persistence in both air combat and strike roles, to exploit the engagement cycles that networking capabilities offer.

The current reality, manifest over Iraq and Afghanistan, is combat aircraft remaining airborne for up to 14 hours, compared to a Cold War sorties of three to six hours duration, and without significant persistence most of the effect of investing in networking is lost.

If we look at the pinnacle of the fuel dispensing chain, the tanker aircraft, Australia may not be able to deliver credible capability.

US experience indicates that an air force requires between one or two medium sized tanker aircraft for every four fighters but Australia's current planning, centred on five A330-200 tankers, will achieve around 25 per cent of the fuel offload capability required to be credible in combat for the existing and planned size of the fighter fleet.

Assuming that in a crisis Australia could borrow enough tankers to make up the gap between a properly sized force and the currently planned force there would still be problems in the second tier, which is the fuel storage and replenishment infrastructure at Australian air bases – not counting the fuel burn of the Wedgetail and other supporting air assets.

Oil refinery shipping terminal, Kwinana, WA.

In strategic terms, considering scenarios involving long range air strikes, defensive patrols over high value economic assets such as the Northwest Shelf and Timor Sea or a defensive barrier against suicide hijackers flying in from abroad, the two most critical locations are RAAF Learmonth near Exmouth (WA), and RAAF Tindal near Katherine (NT). Other locations of interest include RAAF Curtin near Derby (WA), RAAF Darwin (NT) and RAAF Scherger near Weipa (Cape York).

While these sites can support fighters, only Learmonth and Darwin have the runways to support sustained operations by tankers at high gross weights. Both these sites are strategically well placed.

If all of the RAAF's combat formations were deployed north, at least 60 combat aircraft would operate from these bases, with tankers operating from Learmonth, Darwin or perhaps Tindal. Assuming a single eight-hour sortie daily by each fighter, the aggregate daily fuel consumption by the fighter force would be about 1,500 metric tonnes. Fuel for tanker, AEW&C, LRMP and other uses would drive this closer to 3,000 metric tonnes per day or at least 84,000 tonnes per month, and any increasing the sortie rate or sortie duration would drive up these numbers proportionately.

At present, the existing infrastructure cannot sustain effort on this scale. Existing storage capacity at most bases in the north is predicated on holding supplies for about two weeks of operations for a squadron-size deployment of fighters, without significant tanker support. Indeed, neither Curtin nor Scherger have the runways to handle continuing tanker traffic.

The current global practice to replenish civil and military airfields is by pipeline from a refinery or a shipping terminal to storage tanks at an airfield. Best practice is to size storage at the airfield such that it can cover sustained consumption for the period between deliveries by ship, as few refineries are located near enough to oil fields to permit direct supply. The air campaigns in the Persian Gulf and the bombing of Serbia relied on pipelines used to replenish military airfields, the latter campaign exploiting the NATO Cold War era network of replenishment pipelines.

Fuel replenishment in Australia's north is by tanker trucks, which typically carry between 20 and 33 tonnes of fuel, while a road train towed by tractor can haul up to 120 tonnes. Therefore, sustaining 3,000 tonnes per day would require between 25 and 90 delivery trips per day. While this may prove feasible for Learmonth, assuming a suitable shipping terminal and intermediate storage in the Exmouth Gulf, it is less so for Tindal given the distance to Darwin, factoring in load and unload times for the tanker trucks.

The reality is that to provide a sustainable replenishment capability Australia needs to look at the much more conventional NATO model, and install suitable replenishment pipelines, shipping terminals and significant on-base storage capacity for key bases.

defence focus

Teiman road train tanker.


Darwin to Alice Springs railroad.

Implementing expanded on-base storage is not unusually demanding. Underground concrete tanks with reinforced column supported roofs, and a network of on-base fuel transfer pipelines and manifolds, supporting pumps and filtering equipment, is basic oil industry civil engineering.

Such an investment incurs expenses of the order of AUD$2 million dollars per 5,000 tonne tank, or more if significantly hardened.

A scheme to feed such fuel storage infrastructure with aviation kerosene would also be required. The conventional approach would be to construct a shipping terminal to allow fuel to be transferred from a moored tanker vessel or naval replenishment ship via a pipeline to the storage tanks. This model would be viable for Learmonth. Pipelines to Curtin and Scherger, as gap filler sites, may or may not be viable given the distances and fuel quantities involved. Tindal presents interesting issues, as the distance to Darwin is considerable and would drive up the cost of a pipeline significantly. However, Tindal is a mere eight nautical miles from Katherine, which sits on the recently completed Alice Springs to Darwin railway track. This presents two economical options for Tindal. The first is a railway siding at Katherine and fuel pipeline from Katherine to Tindal, using 100 tonne class railway tank cars to deliver fuel to Katherine and the pipeline to feed Tindal.

The other option, much more flexible strategically, is to construct a railway track from Katherine to Tindal, and move fuel by rail directly to the base. Construction cost would be of the order of AU$10 million. Given other uses for the railway, such as moving deployed land forces to a secure military airfield by rail, or resupply of munitions, the direct rail access model would be the preferred choice.

Resolving outstanding capability gaps in delivering sustained fuel supply can thus be addressed with relatively modest infrastructure investment provided Australia continues to have a reliable supply of aviation fuel in a crisis.

Long-term security of supply is an issue in its own right. In June 2004, the Department of the Prime Minister and Cabinet released ‘Securing Australia’s Energy Future’, a 104 page policy document dealing with energy industry issues. Fifteen pages dealt with security of supply.

The document outlines a range of current measures and arrangements intended to ameliorate or manage disruptions to global transport fuel supplies, largely available as byproducts of Australia’s membership in the International Energy Agency (IEA). These measures rely upon Australia drawing upon global stockpiles of transport fuels or crude oil in any contingency resulting in a major global supply disruption.

Contingencies not explored in this document are those in which substantial disruption to external supply occurs as a result of maritime interdiction or air strike operations within the region, or terrorist strikes against regional refinery infrastructure.

There is a significant risk that major contingencies arising in Asia could disrupt Australia’s supply. While arrangements under the IEA scheme would permit Australia to source fuels from global reserves outside the region, such arrangements would see much longer lines of supply impacting on the rate of resupply and cost of supplied fuels.

To place this in context, DITR statistics indicate that Australia consumes annually 4,700 ML (3.76 million tonnes) of aviation kerosene, of which 20 per cent is imported (mostly from Singapore), with Australian refinery output of 5,275.0 ML (4.22 million tonnes). The time lag involved in diverting fuel from sources outside the region, or bringing in additional crude for domestic fuel production, could severely stress domestic stockholdings.

Current policy thus assumes that domestic demand in a contingency would not increase dramatically beyond what can be managed, and assumes that Singaporean supplies are available. Neither of these assumptions necessarily hold, especially if any significant conflict arises in the region. Such circumstances see concurrent demands for increased ADF operational tempo and diminished access to regional fuel supplies.

What alternatives exist to plug this capability gap? The first is to significantly increase domestic stockholdings to buffer against delays, assuming that global demand will not shoot up. The strategic reality is that global demand is certain to climb rapidly if a major contingency arises in Asia.

The other alternative is domestic production of synthetic fuels, which have always had difficulty in competing against crude oil derived fuels. The two best examples of large-scale synfuel production were Germany during World War II and South Africa’s Sasol during the Apartheid era. In both instances fuel was produced from coal. While the cost of synthetic crude oil is now cited at US$20-35/BBL, less than half the price of natural crude oil, infrastructure investment cost amortisation rates have remained a major obstacle.

Synfuel technology has evolved in recent years and two specific synthetic fuel processes should be of interest to Australia. The first of these is Gas-to-Liquids (GTL) and the second is Underground Coal Gasification - Coal to Liquids (UCG-CTL).

Modern GTL processes, such as the Syntroleum process, are based on the legacy German Fischer-Tropsch process. Natural gas, rich in methane, is reacted over a catalyst with compressed air to produce synthesis gas, which is fed into a Fischer-Tropsch catalytic reactor to produce synthetic crude oil. The synthetic crude can then be processed in a refinery to produce high purity gasoline blends, diesel fuel, aviation kerosene and chemical feed stocks. The Commonwealth licensed the Syntroleum process as part of the abortive effort to construct a GTL plant at Sweetwater in WA.

Underground Coal Gasification is a technique pioneered by the Soviets. Rather than mine coal and produce synthesis gas in a reactor, the UGC process involves drilling holes into a deep coal deposit, igniting it, pumping in air and steam, and extracting synthesis gas from the subterranean cavity. Linc Energy in Queensland operates a pilot plant at Chinchilla.

As the UGC process is a relatively cheap source of synthesis gas it can also be used to feed a Fischer-Tropsch reactor and thus produce synthetic crude oil. Linc Energy and Syntroleum have recently partnered to develop this process in Australia.

Why the GTL and UGC-CTL processes should be of interest in Australia is because Australia has world-class natural gas and coal reserves. Australia has 76 billion tonnes of known coal reserves, ranking it fifth globally, and 2.407 trillion cubic metres of natural gas, ranking it fifteenth globally.

Should a synthetic fuels industry be developed in Australia, using coal and/or gas as a feedstock supply, then long term issues of security of supply in key strategic fuels such as aviation kerosene and diesel vanish. Current policy mostly relies upon market forces to drive resource development, and until the recent growth in global crude oil pricing, synthetic fuels were considered borderline in terms of profitability due to investment costs.

The confluence of technological evolution and global demand driven pricing now creates an opportunity, since a well focused national energy policy, which aims to first develop synthetic fuel capabilities in Australia around strategic fuels such as aviation kerosene and diesel could provide domestic self sufficiency, even at the demand levels required for ADF operations increases.

In summary, current and past planning sees Australia in the position where it is not able to exploit much of its stated air force capability in a serious contingency due to an underdeveloped fuel replenishment and production infrastructure. By the same token, opportunities have developed recently which allow this capability gap to be plugged affordably, but to date none are reflected in planning or policy.