

Delivering the goods: the ADF's future
battlefield airlifter

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Introduction

The Australian Defence Force (ADF) airlift capability is critical to operations both at home and abroad. Airlift is a significant force multiplier because it obviates the need for prepositioning troops or supplies at every potential operational location, allowing instead for rapid deployment from further afield. And the advantages extend beyond warlike operations; the ADF is frequently in the vanguard of the response to natural disasters, as has been the case with floods and cyclones in Queensland, earthquakes in New Zealand and Japan, and a tsunami in the Indian Ocean basin.

During assistance operations, most of the airlift is now done by the C-17 *Globemaster III*, which has around four times the lift capacity of a C-130J *Hercules*.¹ The C-17s from 36 Squadron based at Amberley flew over 410 hours, moved in excess of 1,150 residents and delivered over 1,000 tonnes of cargo during operations QUEENSLAND FLOOD ASSIST and YASI ASSIST alone.² The C-17 also provides a global reach. The three available C-17s (from a fleet of four) were deployed to Japan in 2011 on humanitarian operations after the earthquake, flying thirty-one sorties carrying 450 tonnes of cargo, including the oversized pumps used to help deal with the damaged Fukushima nuclear reactors. The C-17 fleet has also been supporting the war effort in Afghanistan, delivering mission critical supplies to ADF forces in theatre.

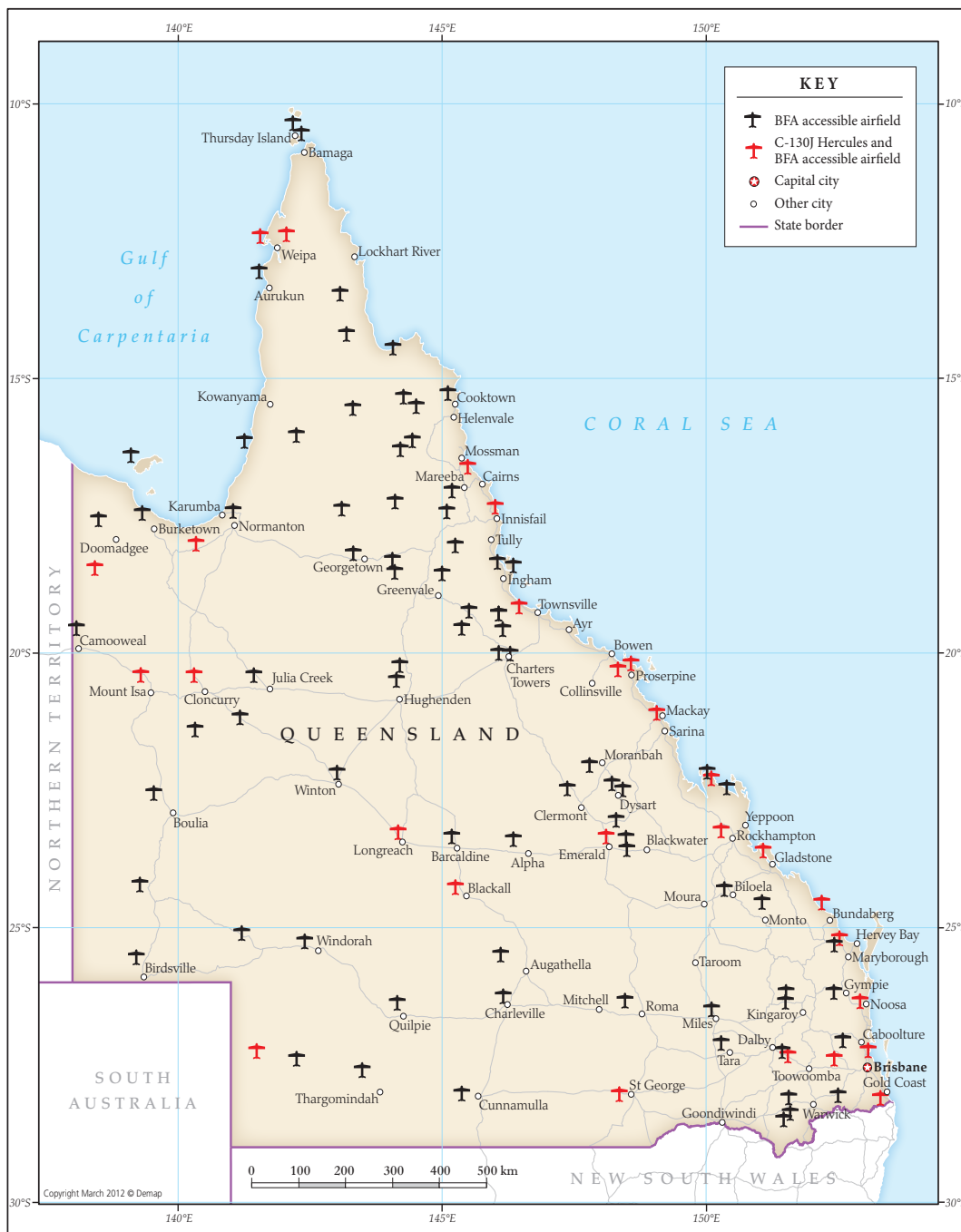
But the C-17 is only one component of the overall airlift capability. The ADF operational concept for the transport of cargo and other mission essential supplies to the battlefield is a 'hub and spoke' approach. C-17s and the new multi-role tanker transport aircraft, which also have a substantial cargo carrying capability, will deliver cargo to in-theatre transportation 'hubs', replacing the less efficient and slower turboprop C-130J in that role. From these hubs, the C-130J and the future battlefield airlifter (BFA) will carry cargo to local centres or forward operating bases, which may lack prepared or sealed landing strips.

Until recently, the ADF delivered supplies, troops and equipment to forward areas using a combination of C-130J and smaller *Caribou* aircraft, with the latter delivering to short and rugged strips that weren't suited for larger aircraft. Over short ranges, the CH-47 *Chinook* medium-lift helicopter can provide delivery, having the advantage of only needing a cleared spot.

However, helicopters can't compete with fixed-wing aircraft for range, speed and payload and are also comparatively expensive to operate. Similarly, the C-130J isn't economical for delivering small loads to forward areas. As well, Australia's remote areas and many of the territories within the ADF's primary operating area are served by small and rudimentary airfields that are unsuitable for heavier aircraft such as the C-130. Reportedly, in some cases where a C-130 has been used on small strips, the airfield has been damaged by the aircraft, necessitating time-consuming repairs.

Figure 1 shows the locations of airfields in Queensland, with an indication of their accessibility by C-130J and/or BFA—clearly there are many locations suited only to a smaller airlifter. A similar pattern would be typical in the countries in our immediate region that fall within the ADF's likely operating areas.

Figure 1: All weather accessibility to airfields within Queensland



With the retirement of the *Caribou* in 2009 and the older H-model Hercules in 2016,³ the RAAF needs a new BFA to complete the implementation of its hub and spoke approach to airlift. Defence project AIR 8000 is intended to meet that need. The Defence Capability Plan doesn't give a precise cost, but indicates an overall budget of between \$1.5 and \$2 billion.

The process to select the BFA has been running intermittently since the late 1990s. And it appears that the two contenders have each been judged in Defence processes as the preferred option at different times, although the decision hasn't been considered by government. It's not entirely surprising that either aircraft could be chosen—as is explained later, each has significant positive qualities that make them a plausible winner, depending on which selection criteria are given highest weighting.

The options

The *Caribou* was the ADF's primary BFA for over 45 years. During its service, which included the Vietnam War, the *Caribou* clocked over 20,000 flying hours per aircraft. It wasn't a high-tech aircraft—its engines dated back to World War II—but it was rugged and durable. The *Caribou* was the last operational piston-engine aircraft in the ADF fleet and its short take-off and landing (STOL) capability gave it a unique battlefield advantage. The *Caribou* could take off with just a 350 m ground roll with a full 2,700 kg payload, and its into-the-wind landing distance could be shorter still. However, its payload and range were small by today's standards. Its retirement from service was planned for 2010, but when this date was brought forward to 2009, the debate about which aircraft could suitably replace it was reinvigorated.

The two aircraft in contention for the RAAF's BFA role are the C-27J *Spartan*, a product of the Italian aerospace company Alenia (which partnered with American defence company L-3 when the aircraft was offered to the US Air Force), and the European Airbus Military C-295. These two aircraft are in the same broad class—they are turboprop, high fixed-wing light transportation aircraft—and are similar in some ways, while differing in some important aspects. In particular, their fuselage shapes and dimensions mean that they have different load-carrying characteristics. The C-27J's fuselage is wide and tall, which allows access for larger items of cargo (such as light vehicles), but it's relatively shorter in length. The C-295 is longer, but narrower and has a lower cargo compartment height. These differing characteristics impact on the size, shape and disposition of loads that can be carried.

Before moving to a discussion of the relative merits of the aircraft, there's an important caveat: care needs to be taken in making judgements from open sources. The figures in 'glossy brochures' from manufacturers are often presented without context and—naturally—tend to provide the maximum capability against each of several performance criteria, without indicating the inevitable trade-offs that are required in practice. Ultimately, judgements need to be made on the basis of tender quality information. In the case of these two contenders, there is a US Government Accountability Office (GAO) report that provides a general overview of the comparative performance of these aircraft, but the public version is highly redacted and is therefore of less use than might be hoped.⁴ Perhaps surprisingly, it's also hard to get definitive figures on the physical dimensions of these aircraft from the open literature. The analysis that follows is based on our best estimates.

Selection criteria

The C-27J and C-295 have different strengths and weakness as potential future BFAs, although both are leagues better than the retired *Caribou* in every respect except for STOL performance. The contest will come down to a combination of the

performance criteria used (and the weighting given to each), the overall level of assessed risk and, of course, the price.

Cargo

It's important to understand what an airlifter might be called upon to move. The ADF moves its stores on standard 463L pallets which are 2.24 m by 2.74 m in plan view and typically 1.75 to 2.05 m high, with the C-17 able to transport pallets up to 3.04 m high and the C-130 up to 2.44 m high, subject to being within applicable weight limitations. Ideally, pallets should be able to be transferred from C-17 to C-130J to BFA without having to break them down and repack the contents, a task that consumes time and manpower. For moving personnel, there are different seating configurations that can be employed, and assumptions have to be made about the total all-up weight of troops and their personal equipment.

In terms of floor area, the C-27J can accommodate three 463L pallets, with room for an additional 'half pallet'. The total cargo capacity in volume is around 44 m³, with a maximum ceiling height of 2.6 m and a height of 2.44 m at the wing spar, offering a maximum pallet height of 2.11 m. The C-295 is longer but narrower and the cargo space has a lower maximum ceiling height of 1.9 m and a usable height of 1.5 m, although the greater floor area can accommodate the footprint of up to five pallets. According to Airbus, the C-295 has a cargo volume of just under 40 m³, excluding the ramp area.

Due to clearance requirements, neither aircraft can accommodate the maximum pallet height of 2.44 m that a C-130 can carry.⁵ As such, pallets intended for transfer to the BFA from the other airlifters will have to either be packed to a lower total height (and hence volume) or broken down and repacked in theatre. However, there is an additional constraint for the C-295 in terms of clearance around the pallets—the standard pallet footprint is a snug fit, leaving little room for personnel to move around. The C-27J can accommodate pallets of up to 2.1 m in height and its width should accommodate a standard pallet with the necessary clearance.

A more serious limitation due to the C-295's lower cabin height is the size of objects that can be accommodated. This is probably most significant in the case of vehicles. The ADF's new cross-country vehicle, the Mercedes-Benz G-Wagon will be fielded in a number of variants and configurations, but all will be around 2.0 m or more in height and so won't fit in the C-295's cargo space. Some variants won't fit into the C-27J either, but the basic 4 x 4 and 6 x 6 mobility variants will. Others, such as the reconnaissance and surveillance or ambulance models would require some disassembly and/or a multi-role aircraft lift. (Or could be air dropped from a C-130 if necessary.) Similarly, there are a number of vehicles under consideration for the future 'protected mobility vehicle - light' (the Army's proposed light armoured vehicle for operations in areas with a threat from mines, small arms fire or improvised explosive devices), most of which are too tall for the C-295 cargo space.

Personnel

Because of its additional length, the C-295 can carry more troops for a given seat spacing than the C-27J. Again, care needs to be taken with brochure figures, as they tend to be the 'best case' rather than operationally realistic figures. The number of troops that can be carried depends on the amount of equipment each carries—fully-equipped paratroopers take up more space and are heavier than light infantry, for example. For comparative purposes, assuming that equipped troops weigh around 120 kg, our best estimate is that the C-295 can accommodate fifty-eight and the C-27J about a dozen fewer. However, this conclusion is based on data from the commercial variants. The military variants will have different load

parameters, and the impact on payload of the military systems will be proportionally greater on the lighter C-295. The net result will be to reduce the number of troops that can be carried, but the exact number will depend on the operational parameters used by the ADF.

Performance

Aircraft performance is obviously important. As well as gross measures like maximum payload, range and speed—the numbers generally found in the manufacturer's brochures—a careful analysis based on actual mission profiles (and their estimated relative frequency) is required. Alas, most of the figures in the public domain are based on aircraft in a 'commercial' configuration. The military configuration includes specialised mission equipment, such as communications gear, electronic warfare self-protection and countermeasures against ground-to-air threats. As a result, the actual ranges and payloads will be different and there is a trade-off between the two—heavier loads can be carried only over shorter distances. Information available to ASPI suggests that range and payload combination won't be the most significant discriminator between the two types.

From the GAO report, it's clear that a more notable distinction between the two aircraft is their performance in a threatening environment. While the details have been redacted, the C-27J was judged to have a 'superior military operational envelope'. This is likely to have been due to two main factors—speed and time to height (both of which are attributable to a greater power to weight ratio). The C-27J has a greater air speed (315 kts or 583 km/hr) over the significantly slower C-295 (260 kts or 480 km/hr). Both of these factors would tend to take the C-27J out of harm's way faster in an environment where man-portable air defence systems or small arms fire were the main threat. (However, it should be noted that none of the ADF's existing airlift fleet and neither of the BFA contenders would be especially survivable in a higher threat environment). The GAO assessment on the air safety and survivability criterion was 'good' for the C-295 and 'excellent' for the C-27J.

Price

When both aircraft types were offered to the US Air Force (USAF) for its Joint Cargo Aircraft contest in 2006, the C-295 package was about 15% cheaper. In a contest for a contract to build 'up to 78' aircraft, the C-27J bid by L-3 came in at US\$2.04 billion (2007 figures) and the bid by US firm Raytheon (partnering with Airbus) was US\$1.77 billion. As usual with public cost data, caveats need to be applied to these figures. The implied unit costs of US\$26 million and US\$22 million respectively are likely to be airframe only costs—thus falling far short of covering the total cost of acquisition of either type.

A more concrete figure for the C-27J is provided by the 'fly-away cost' in 2012 USAF budget papers, which give the per unit cost of the C-27J aircraft and initial spares as US\$34.2 million.⁶ Even then the total project cost is substantially higher than that figure would suggest. With all mission systems, test equipment, technical documentation, simulators and support services, an Australian Government request to the US Government for pricing under the Foreign Military Sales (FMS) program of ten C-27J aircraft and supporting systems came in at a total of US\$950 million.⁷ On top of that would be any facilities work required plus other project overheads. When buying military equipment, it pays to look beyond the sticker price. (Although we note that previous FMS acquisitions have come in under budget, suggesting an element of 'worst case' about the quoted price.)

Assuming the same 15% differential as in the USAF competition, the fly-away cost of US\$34.2 million for the C-27J would translate to around US\$29.1 million per aircraft for the C-295 for the same package. Of course, the actual cost tendered

to Australia might be different. For example, the C-295 production line has been running several years longer than in 2006, which will tend to drive down the unit cost. As well, there are factors much less amenable to analysis. For example, the financial situation in Europe is very different today from the time of the USAF contest, and prospects for military contractors are relatively bleak, which might make either of the European suppliers keen to cut a deal. In this context, Airbus has reportedly offered a 'package' deal of a sixth multi-role tanker transport aircraft (MRTT), the C-295 and an industrial work package in Australia.⁸ The total cost is unknown.

Then there's maintenance and running costs, which are even harder to estimate. ASPI's previous work suggests that maintenance costs tend to be proportional to the acquisition cost—which makes sense given that it's the complexity of the system that tends to drive both. In that case the same differential might apply. As for running costs, the lower powered C-295 is likely to be more economical. Airbus have claimed that the lower fuel consumption of the C-295 would save Defence \$300 million over the thirty year life of a fleet of ten aircraft.⁹ However, it's not clear what the underpinning assumptions for that figure are in terms of rate of effort and mission profiles. It should therefore be considered a 'brochure figure' and, as usual, tender quality information with a detailed explanation and supporting figures would be required to be sure.

In the case of the C-27J, some data on the reliability and support costs is available from the USAF, albeit limited by the short duration of the aircraft's service and its impending precipitous retirement (see below). From public data, the per hour cost of a C-27J is about one-quarter of that for a C-130J and about one-tenth of a C-17.¹⁰

Interoperability

Until recently, it was hoped that interoperability with US forces would be a factor in any acquisition of the C-27J—especially given the 2011 announcement of an increased presence of American forces in Australia and its immediate region. However, the budget situation in the United States has put paid to that prospect. The USAF has not only cancelled the planned further acquisition of the C-27J, but is planning to divest itself of the fleet of twenty-one aircraft already on order or in service. (It doesn't seem likely that the divested aircraft will be offered for sale—at the time of writing the USAF seemed intent on putting the aircraft into long-term storage.)

It's worth noting the Pentagon's cited reason for the planned divestment of the C-27J:

The C-27J was developed and procured to provide a niche capability to directly support Army urgent needs in difficult environments such as Afghanistan, where we thought the C-130 might not be able to operate effectively. However, in practice, we did not experience the anticipated airfield constraints for C-130 operations in Afghanistan and expect these constraints to be marginal in future scenarios. Since we have ample inventory of C-130s and the current cost to own and operate them is lower, we no longer need nor can we afford a niche capability like the C-27J.¹¹

The obvious question is whether this reasoning also applies to the ADF—would it be better to not acquire a BFA at all and make do with the C-130 fleet, thus avoiding the fixed costs of introducing another type?

ASPI has often been an advocate of type rationalisation for reasons of economy of scale. But in this instance what is 'niche' to the USAF is more important for the RAAF. The US has created a number of large airfields in Afghanistan which are suitable for strategic airlifters and there are many medium and heavy lift helicopters in theatre that are suitable for delivery to forward operating areas. Neither of those

considerations apply in the ADF's primary operating environment—it contains numerous small airfields that are widely separated, making the USAF model difficult, if not impossible to implement. A BFA makes sense in that context.

Support

The USAF decision to stand down the C-27J fleet will have an impact on the overall economy of scale of support arrangements—the thirteen aircraft that were in service prior to the budget announcement constitute about 25% of the current worldwide in-service fleet. But it's difficult to estimate how big the cost impact will be. Further aircraft are in the process of delivery to other operators, which will tend to offset the USAF move, and the model for support is contractor-based in any case.¹²

The C-295 and the related C-235 are in widespread use around the world, with a mixed fleet of well over 200 aircraft, of which C-295 deliveries total eighty-five to date. Support arrangements are in place around the world.¹³

Whichever aircraft is chosen, there shouldn't be any insurmountable difficulties in contracting support arrangements. In both cases there is likely to be a reliance on contractor support and neither is operated by a close ally with a strong air force to air force relationship with the RAAF. But, as noted earlier, the C-295 is likely to be cheaper to support and operate, and has the added advantage of being flown in greater numbers.

Project risk

Both of these aircraft are now coming off established production lines, and there's little reason to worry about development problems—especially if 'Australianisation' is resisted. However, as Australia has discovered to its cost, there are other project overheads when introducing new aircraft into service. Certification processes are potentially time-consuming and difficult. In this respect the C-27J probably has an advantage. If purchased under FMS, the aircraft would come with US government and military certification, which would make Australian processes straightforward—as it was with the C-17 and *Super Hornet*.

Other previous aircraft purchases have been more problematic when it came to certification, with delays and costs accruing as a result. The worst examples of delays in certification of non-developmental airframes have been helicopter purchases—the *Tiger* armed reconnaissance helicopter and MRH-90 utility helicopter.

Another risk is the development path and production future of the aircraft chosen. In this respect the C-295 appears to have an advantage; Airbus is a large multinational company with a diverse production base and an annual turnover approximately ten times larger than Alenia.

The decision

Neither aircraft has a clear decisive advantage against all criteria. As is usually the case, the decision is likely to come down to how important each factor is judged to be. That's where it becomes important not to 'situate the appreciation' by demanding that a rigid set of criteria be used to give a yes or no answer. For example, for some tasks, having the capability to lift a light transport vehicle is essential. Light vehicles constitute the Army's primary light reconnaissance mode and the selection of the G-Wagon seems to heavily favour the C-27J. Although a *Chinook* can under-sling a single vehicle, the range and efficiency factors

mentioned earlier would apply. The C-17 and C-130J can accommodate vehicles easily, but can't operate out to the end of the 'spokes' where access to prepared air landing strips isn't guaranteed. If, on the other hand, missions in which the ability to move one or two light vehicles is important but constitute only a small fraction of the mission profile, then a judgement could be made that advantages in other areas take precedence.

Table 1 shows ASPI's judgements of the relative strengths of the two types, based on the information we have available. The qualitative judgements are well supported by fact, but in most cases we can't quantify the differences due to lack of detailed information.

Table 1: Relative advantages of the competing options

Criterion	C-295	C-27J
Acquisition cost	♦	
Through-life cost	♦	
Speed		♦
Range empty		♦
Payload/range	?*	
Survivability		♦
Pallet handling		♦
Troops	♦*	
Vehicle lift		♦

*Depends on operational weight parameters of the military variant

Conclusion

Either aircraft would give the ADF an increased capacity to move troops and stores to short or rough airfields, as per its hub and spoke approach. The C-295 is cheaper per unit to acquire and is likely to be cheaper to run per flying hour. However it won't be able to carry the ADF's new light vehicles and its cabin size limitations will impose more restrictions on the transfer of stores from the larger C-130 and C-17 aircraft than its competitor.

The C-27J is more expensive per unit to acquire, and has a higher hourly running cost, but has a larger fuselage with the ability to easily fit some of the larger items the ADF will want to move intra-theatre, and is more compatible with pallets from the larger airlifters. It also offers better performance in terms of speed and time to height, both of which contribute to greater survivability in low-level threat scenarios, as well as meaning less flying hours for the same distance. As well, the ability to move some of Army's light vehicles is a plus. Given the small number of BFAs to be acquired and the limitation to a single light vehicle per flight, the extent to which that capability should be weighted is debateable, but having the option broadens the mission choices. The C-27J thus unquestionably offers superior operational flexibility.

The final decision will likely come down to the premium that is acceptable for that flexibility and the degree to which some tasks can be regarded as 'nice to have' rather than essential. If the price difference is small, then the C-27J has the inside running. But if the difference is substantial, a case can be made to trade versatility for economy, with the difference being reinvested elsewhere in the ADF's force structure for greater overall utility.

When both aircraft were offered to the USAF in 2006, the cost differential was just 15%, and the judgement justifiably came down in favour of the C-27J. But the Australian Government should look very carefully at the tender quality cost data it can expect to receive—and it should resist making a commitment until it has that data. If the cost differential is substantial, there's still a decision to be made. Since 2006 both types will have moved along their production learning curves and global support arrangements now in place will make for economies of scale. The larger C-295 (and C-235) fleet might be expected to have benefitted most from both of those factors. As well, the total value of the Airbus 'package' offer of another MRTT, the C-295 and industry work should be carefully studied. It's the total cost-benefit differential that's important.

Notes

- 1 The ADF currently operates a mix of C-130H and C-130J *Hercules*, but the former will be retired in the near future.
- 2 Gregor Ferguson 'ADF Airlift Capability', in *The Cost of Defence: ASPI Defence Budget Brief 2011–2012*, ASPI, (2011):203.
- 3 The newer J-model *Hercules* will continue in service after that, but the net result will be a decreased number of *Hercules* in the fleet.
- 4 Decision in the matter of: Raytheon Company, Space and Airborne Systems, 27 September 2007. <http://www.gao.gov/decisions/bidpro/2986262.htm>
- 5 More than you ever wanted to know about pallets can be found in '463L Pallet Cargo System', <http://www.globalsecurity.org/military/systems/aircraft/systems/463L-pallet.htm>
- 6 2011 US Department of Defence Budget Estimates. The quoted figure is the 'weapon systems unit cost' which is equal to the cost of the aircraft and major mission systems plus the cost of support items.
- 7 *Australia – C-27J Aircraft and Related Support*, Defense Security Cooperation Agency news release, 19 December 2011. http://www.dsca.mil/PressReleases/36-b/2011/Australia_11-51.pdf
- 8 Future tanker work tied to C-295 buy, *Australian Aviation*, 14 March 2012. <http://australianaviation.com.au/2012/03/future-tanker-work-tied-to-c295-buy/>
- 9 Claim for \$300m saving on planes, *The Age*, 21 December 2011, <http://www.theage.com.au/national/claim-for-300m-saving-on-planes-20111220-1p40j.html>
- 10 *Fiscal Year (FY) 2012 Department of Defence (DoD) fixed wing and helicopter reimbursement rates*, Office of the Undersecretary of Defense, October 2011. http://comptroller.defense.gov/rates/fy2012/2012_f_h.pdf. Note that these figures are not the actual costs, but are the billable rate when the aircraft is provided on a reimbursable basis to other parties. The actual costs should scale similarly.
- 11 Bill Carey, *C-27J chopped in U.S. budget cuts*, AINOnline, 3 February, 2012. <http://www.ainonline.com/?q=aviation-news/ain-defense-perspective/2012-02-03/c-27j-chopped-us-budget-cuts>
- 12 The C-27J is in service with the Bulgarian, Greek, Italian and Lithuanian air forces and is being delivered to Morocco, Mexico and Romania. Other countries considering a purchase include Canada, India, Peru and Taiwan.
- 13 The C-295 is operated by Brazil, Poland, Portugal and Spain, is in the process of being produced or delivered to Finland, Czechoslovakia and others. It's also a candidate for Canada and Peru.

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