

Tanker Trouble: The limitations of the Royal Air Force's tanker fleet

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Abstract

The Royal Air Force (RAF) operates a fleet of ten A330 MRTT 'Voyager' aircraft in the air-to-air refuelling role, equipped exclusively with a 'hose and drogue' refuelling mechanism. However, as the RAF evolves, the service is acquiring a growing quantity of aircraft requiring a 'flying boom' to be refuelled. This means that the existing tanker fleet is increasingly limited in what it can refuel, restricting the operational potential of critical assets. This paper explores the impact of the current capability limitations and offers recommendations for how the service may address the issue.

Introduction

The A330 MRTT, known as the ‘Voyager’ in the Royal Air Force (RAF), is the backbone of the RAF’s ability to project air power worldwide, providing its air-to-air refuelling (AAR) capability. The RAF’s ten-strong fleet primarily supports the Typhoon and Lightning forces, including on Operation Shader, the UK’s fight against Daesh in Syria and Iraq.¹ The RAF’s tanker fleet is exclusively fitted with the ‘hose and drogue’ refuelling system, which requires the receiving aircraft (receiver) to be equipped with a probe flown into a drogue basket fixed at the end of a trailing fuel hose. The RAF operates four Voyager KC Mk.2s, fitted with two wing-mounted pods, and a further seven KC Mk.3s, equipped with a centreline hose in addition to the underwing pods that facilitates the refuelling of larger probe-equipped aircraft, such as the A400M Atlas, and previously, the C-130J Hercules.

The hose and drogue method of aerial refuelling is extremely advantageous when refuelling fighter aircraft, as a tanker can refuel multiple aircraft simultaneously and fulfil its task should one unit become inoperable. It is also easy to install on other aircraft.² The latter feature is particularly beneficial to the RAF, as they enjoy access to a ‘non-core’ fleet supplied by AirTanker, who lease the airframes to the RAF, meaning two additional aircraft can always be easily reconfigured to supplement core Voyager operations.³

The hose and drogue system features across the NATO community and is extensively used by the United States Navy and Marine Corps. However, the main benefits of hose and drogue refuelling are predominantly centred around fighter aircraft. Many larger modern aircraft require the ‘flying boom’ method instead, which can dispense fuel faster.⁴ Here, an additional ‘boom operator’ manually manoeuvres an extendable boom into a socket on the receiver aircraft. Notably, among the air forces globally operating a variant of the A330 MRTT, the RAF is the only operator without flying booms.

Despite this, as the RAF continues to modernise its capabilities and procure new aircraft types, more platforms require the flying boom method to refuel, meaning the Voyager is increasingly limited in what it can support. In 2016, Air Marshall (Retired) Greg Bagwell indicated the RAF’s interest in equipping at least some Voyagers with booms to mitigate this, pointing towards the additional flexibility it would provide the force.⁵ However, seven years on, none of the RAF’s tanker aircraft are configured with the flying boom, which can be found fitted to most A330 tankers globally. Although there has been conclusive justification for this, additional remarks made by Air Marshall (Retired) Bagwell in 2016 suggested the primary obstacle to acquiring booms had been financial.⁶ Nevertheless, the RAF’s current tanker capability consequently fails to acknowledge the RAF’s growing inventory, as platforms that require flying boom-equipped tankers are continually introduced.

Unpacking the issue

Of the aircraft types in the RAF that are capable of AAR, more than half require a flying-boom to refuel. This balance is gradually shifting as more types begin to require boom refuelling despite the limitations of the current tanker capability.

In June 2023, the fifteen-strong C-130J Hercules transport aircraft fleet was withdrawn from service as per the 2021/23 Integrated Review(s).⁷ Meanwhile, a new fleet of three E-7A Wedgetail Airborne Early Warning (AEW) Aircraft will begin their introduction into service in 2024. These procurement activities have flipped the balance in the long term, meaning that types requiring flying boom tankers to refuel will soon outnumber those that currently rely on the hose and drogue. Upon the introduction of Wedgetail, there will be approximately 23 AAR-capable aircraft in the RAF’s inventory, which their fleet of Voyagers cannot refuel. Therefore, to exploit the aerial refuelling capabilities of these assets and maximise their operational output, the United Kingdom must either go without AAR for these aircraft or call upon allied nations to fulfil this task.

Figure 1: Required methods of air-to-air refuelling by the Royal Air Force’s capable aircraft.

Hose/Drogue	Flying Boom
A400M Atlas	C-17A Globemaster
F-35B Lightning II	P-8A Poseidon
Typhoon	RC-135W Rivet Joint
C-130J Hercules (retired June 2023)	E-7A Wedgetail (in service from 2024)

Although the types requiring booms are smaller in their respective fleet sizes, they are all extremely high-value and in-demand assets, with three being C2 and C4 Intelligence, Surveillance, and Reconnaissance (ISR) capabilities. These assets have acquired a growing importance following the Russian invasion of Ukraine in February 2022. Most notably, the RC-135W Rivet Joint’s (RJ) operational commitments have increased exponentially since Russian military buildups began on Ukraine’s borders, flying a greater number of monthly surveillance sorties to Eastern Europe than previously observed.⁸

For successful execution, these and other ISR sorties benefit considerably by receiving tanker support using the flying boom method. For example, 30% of the United States Air Force's (USAF) RJ sorties flown from RAF Mildenhall use a tanker.⁹ AAR significantly increases the range and persistence of airborne ISR operations, allowing for increased loiter time in an area of interest. The US Navy also now conducts aerial refuelling for operations with the P-8A Poseidon Maritime Patrol Aircraft, which has served to 'enhance [the] mission effectiveness' of the aircraft through the aforementioned benefits.¹⁰ In the case of the P-8A, AAR is something that the RAF has yet to conduct with its fleet. Therefore, the RAF is limited in how it can operate these aircraft compared to its allies, holding back the type from unlocking its full range, persistence, and operational potential.

Air refuelling allows military commanders to 'manoeuvre and mass forces' according to continually developing and variable threat timelines, particularly at short notice.¹¹ The RAF cannot independently facilitate this across its entire AAR-capable inventory. Moreover, several aircraft currently unable to receive AAR from RAF tankers are also critical assets in constructing these threat timelines through their real-time surveillance of enemy behaviour in the air, on land and at sea, and non-kinetic applications within the Electronic Order of Battle. The lack of boom-equipped tankers poses an operational risk in theatre, reducing these assets' range, persistence, and security, which can hinder operational success. Such an inability to expand the capabilities of ISR assets limits their contribution to the shared Common Operating Procedure (COP), which can undermine situational awareness and make operational decision-making significantly more challenging.

Joint Doctrine Publication 0-34 (JDP-034) reaffirms these issues, referring to the case of Operation Odessey Dawn in Libya in 2011. According to the United Nations Security Council (UNSC), the intervention was to 'protect innocent civilians' and '[hold] the Qaddafi regime accountable.'¹² JDP-034 highlights the importance of AAR in enabling the participating ISR aircraft to provide the 'eyes and ears', which coordinated and facilitated a seven-and-a-half-hour mission to conduct a kinetic strike against adversary air defences within eighteen hours of the initial political decision to intervene.¹³ While the RAF had the tanker provision to mobilise the combat aircraft involved in the operation, 'USAF tankers allowed some [ISR] platforms to extend their time on task', revealing a longstanding dependency of the RAF on other nations' tankers.¹⁴

At the time of the operation, RAF aircraft, such as the now-retired E-3D Sentry AEW, could receive both hose and drogue and boom refuelling. However, the recent onset of new capabilities means that the current inventory does not reflect such flexibility. Therefore, should such operations be required, the RAF cannot conduct them independently, unless integrated into a coalition that includes available boom tankers. This would be particularly problematic in a Falklands-like conflict, where Britain is without significant support from its allies. This would undermine its ability to act independently and project long-range air power across a full spectrum of air operations supporting sovereign interests.

Exposing Dependency: RC-135 Operations

Figure 2: RAF RC-135 sorties and tanker support January 2023
Data collected by the author's observations from Flight Trackers cross-referenced between ADS-B Exchange, RadarBox24 and FlightRadar24.

Date	RC-135	Tanker (type/callsign/serial)
6.1.2023	RRR7206 ZZ664	KC-135R/LAGR51/58-0100
11.1.2023	RRR7211 ZZ665	KC-135R/LAGR51/63-8008
12.1.2023	RRR7212 ZZ665	No tanker observed
19.1.2023	RRR7219 ZZ665	No tanker observed
23.1.2023	RRR7223 ZZ665	KC-135R/LAGR51/57-1439
25.1.2023	RRR7225 ZZ665	KC-135R/LAGR51/57-1439
28.1.2023	RRR7228 ZZ664	KC-135R/LAGR51/59-1511
31.1.2023	RRR7231 ZZ664	KC-135/BART10/62-3562

Almost all RAF RC-135 missions utilise the USAF's tanker support, primarily due to limitations relating to the runway at their home base, RAF Waddington.¹⁵ The suggestion is that Waddington's runway is not long enough for the aircraft to depart when fully fuelled. However, there is no official evidence of this. Nevertheless, the number of sorties flown by the RAF involving tanker support is comparatively higher than their USAF counterparts, suggesting that the RAF are restricted in operating from the installation.

Throughout January 2023, approximately 75% of RAF RC-135 sorties used a tanker (Figure 2). Flight tracking data also shows that those sorties were comparatively shorter flights, where a tanker was not used. This has previously encouraged discussions about relocating the RAF RC-135 fleet to a facility with a longer runway, such as RAF Mildenhall, to allow for co-basing with their USAF counterparts.¹⁶ This would reduce the demand for 'borrowed' tankers on missions but would still require the support of the partner nation for longer-range or longer-duration surveillance missions. The USAF acknowledges that around 30 per cent of their missions flown out of RAF Mildenhall also use tanker support.¹⁷

Co-location would not thus provide a steadfast solution for the RAF's current issues, as not only would RJ operations still require flying boom-equipped tanker support, but because the RAF's wider fleet would remain restricted by the lack of boom tankers, this solution would not be ubiquitous, leaving a significant capability gap preventing the RAF's independent AAR of all of its platforms.

Credibility Concerns

Following criticism from a US General in early 2023 that the British army is no longer at the 'top-level', the inability to self-support the distribution of air power, in particular ISR operations, undermines the overall credibility of the British armed forces, and in particular the RAF as a force capable of undertaking sovereign action.¹⁸ Thus, without boom tankers, the RAF is open to the same criticisms from our closest allies, risking becoming viewed as a lesser peer in comparison to our most important partners and hindering Britain's ability to lead from the front.

July 2023 saw an RAF A400M conduct the type's longest-ever flight, flying non-stop from RAF Brize Norton, Oxfordshire, to Guam in support of Exercise Mobility Guardian.¹⁹ The 22-hour mission saw the aircraft refuel from a Voyager on three occasions en route, demonstrating the advantages afforded by AAR in long-range air power projection ahead of its participation in the exercise.

Officer Commanding Air Mobility Force, Air Commodore Lyle, was quoted saying that '[the flight] allows [the RAF] to demonstrate the speed, reach and utility of the RAF, underpinned by the assets from the Air Mobility Force, and reinforces our ability to rapidly conduct global air operations'.²⁰

While this is true of this particular combination of aircraft (an A400 and two Voyagers), the operation was facilitated exclusively by hose and drogue refuelling. This highlights that such accomplishments are not as easily replicated when considering assets such as the C-17A or RC-135W.²¹ Air Commodore Lyle reflected on the RAF's ability to relocate an aircraft 'to the other side of the world in a timely manner'.²² However, to achieve such vast reach with what will soon become most aircraft types, the support required would have to come from our allies. The RAF's long-range and reactive capabilities would be significantly undermined if allied nations cannot spare their tanker assets or are unwilling to support a particular operation.

Despite the E-7A program being limited to three airframes, experts continue to advise increasing the order to return it to the originally planned five, which was extensively discussed in 'Winging it?', a recent report into UK aviation procurement.²³ Despite no concrete plans to acquire the additional two aircraft, the calls to do so suggest future fleet growth that necessitates boom-refuelling. Therefore, continuing to acquire boom-dependent aircraft without acquiring a boom tanker only limits the potential of the RAF. Furthermore, it increases its dependence on allied nations, reducing the United Kingdom's ability to act independently, ultimately subverting the overall credibility of Britain's military infrastructure.

Therefore, the deployment to Guam illustrates a stark point as the Indo-Pacific region becomes an area of increasing interest and concern. Not having boom-equipped tankers drastically limits the UK's capacity to rapidly deploy to this theatre and the assets it can mobilise quickly, particularly ISR assets. The Integrated Review establishes the objectives of a Global Britain. It highlights the importance of responding to the growing instability and threat of conflict worldwide, particularly in the Indo-Pacific region. Pursuing these aims is drastically held back without the capability to independently mobilise air power globally.

Issues with US-Dependency

The primary facilitator of boom refuelling for the RAF is the USAF, despite significant shortfalls within their tanker fleet as platforms are progressively retired in favour of the KC-46.²⁴ USAF aircraft reportedly require more refuelling stops on land than previously to reach destinations that might ordinarily utilise a tanker when transiting from their home base. For example, the USAF's RC-135s, which frequently deploy from their residence at Offutt Air Force Base in Nebraska to locations in Europe and the Middle East, have increasingly had to land in Iceland and Spain en route to their destinations according to open-source flight tracking data. For example, on 7 January 2023, an RC-135S Cobra Ball (callsign 'Olive62') was tracked landing at Naval Air Station Keflavik, Iceland, on its way home from a deployment to the Middle East, a stop which had not previously been noted being made by the type, typically only occasionally making a UK stop during this type of rotation.²⁵ This is due to a limited supply of serviceable tanker airframes, as many have either been withdrawn from use or are in high demand for other missions.

The USAF has made an unprecedented turn towards civilian-contracted AAR to mitigate its supply shortages. In June 2023, during Exercise Resolute Hunter, Metrea Strategic Mobility conducted the first documented aerial refuelling of a USAF aircraft from a civilian-operated tanker.²⁶ Metrea operates a fleet of four KC-135s, acquired from the Republic of Singapore Air Force in 2020, capable of both flying boom and hose and drogue refuelling.²⁷

The United States Navy has used contracted tankers for many years, reducing the burden on the USAF, which would otherwise be their primary AAR source. Historically, they primarily relied on Omega Air Refuelling's hose and drogue-equipped aircraft to support non-combat operations, facilitating their domestic training requirements. While it is most likely that the USAF will also predominantly exploit the capabilities of commercial tankers in this way, their willingness to explore alternative options for AAR shines a light on how the RAF's dependence on the USAF could be threatened if the tanker supply chain becomes more stretched.

As of March 2023, the USAF has 179 of their newest tanker, the KC-46A Pegasus, on order as they move to withdraw their KC-10 fleet by October 2024.²⁸ While they intend to continue KC-135 operations with no clear indication of its complete withdrawal from service, there is still a notable reduction in the USAF's overall AAR capability. This may be to the RAF's detriment in the long-term, as the US could soon begin to prioritise its assets and taskings in theatres of operations, particularly as the Indo-Pacific and Arctic regions become their priorities.²⁹

If the USAF does become stretched in this fashion, the RAF will suffer from the inability to self-support a significant portion of its aerial refuelling operations. While the risk is mainly hypothetical at this stage, the best insurance policy to restore credibility and confidence in the RAF's tanker capability is to acquire or gain access to boom-capable tankers.

The RAF is not a member of NATO's multinational tanker fleet (MMF), consisting of nine boom-equipped A330 MRTTs. The six current member states of this burden-sharing arrangement benefit from a shared fleet that can facilitate AAR refuelling by either hose and or flying boom. The MMF allows its members to purchase flying hours, which the owner nation can task according to their requirements.³⁰ It intends to relieve the burden on the US tankers based in Europe imposed by NATO's European members who require flying boom refuelling and lack tanker capability.³¹ As the operator of the largest fleet of boom-equipped tankers in Europe, with fifteen KC-135s at RAF Mildenhall, UK, the USAF typically provided AAR for European allies, such as Germany, before establishing the NATO MMF.³² Membership of the NATO MMF would, therefore, be advantageous to the RAF, as it would benefit from access to a boom-tanker capability, which can be independently tasked and reduce the reliance on Mildenhall's tankers.

The Australian Tanker Model: The Perfect Structure?

The RAF has recently developed close ties with their partners at the Royal Australian Air Force (RAAF), mainly through the Wedgetail training program.³³ The RAF shares a growing commonality with the RAAF, as both nations operate Poseidon and the A330 MRTT (KC-30 in RAAF service). However, where they differ is that RAAF KC-30s are equipped with both booms and hose and drogue. While the RAF are yet to reap the full potential of Poseidon's capabilities, the RAAF has successfully refuelled theirs using the KC-30.³⁴ The RAAF can also potentially deploy the E-7 with 'unlimited range,' proving how the A330 MRTT becomes a more effective tanker when equipped with a boom.³⁵

The RAAF has also proved the KC-30's ability to refuel the C-17 during tests with the USAF at Edwards Air Force Base, which the RAF has not yet experimented with.³⁶ These tests were part of a program which certifies coalition states to refuel USAF aircraft, including the F-16 and F-15; the RAAF has also conducted refuelling with their Japanese partners using the boom.³⁷ This undoubtedly highlights the multi-layered benefits of boom-equipped tankers to their operators. While the RAAF can refuel all their capable types, they can also more closely integrate with allies and partners, among whom boom refuelling is now more prevalent, opening the door for more options in supporting operations, burden sharing, and demonstrating the unity of the involved states to potential adversaries.

Possible Resolutions

Following the tragic loss of Nimrod MR.2 XV230 in 2006 due to the swift retrofitting of refuelling probes to the receiver aircraft, it is prudent to dismiss the option of modifying any of the RAF's receiver aircraft relating to the fitting of hose and drogue receiving probes.³⁸ In the case of XV230, the Board of Inquiry found that the incident was caused by 'the escape of fuel during air-to-air refuelling,' likely due to an overflow during AAR, meaning fuel leaked and 'likely' accumulated in the No. 7 Tank Dry Bay before igniting, causing the aircraft to catch fire in flight.³⁹ The investigation refers to the 'insidious' way the modifications were carried out, concluding that flaws within the design had not been identified, eventually culminating in 'unforeseen ramifications far beyond their perceived significance.'⁴⁰

To safeguard the lessons learnt from this incident, it must be argued that attempting to modify the growing variety of aircraft, which would require fitting with refuelling receiver probes, is an unsafe and unviable option, which could put lives at unnecessary risk. Turning to an already proven capability in the A330 MRTT would prove considerably safer and vastly more efficient than investing in several research and development programs, which would also prove extremely costly. Given the variety of types that would require conversion, instead of acquiring or modifying safe, operationally proven, and well-established boom-equipped A330s, the latter option is vastly superior.

As allied nations have demonstrated, it is feasible to fit flying booms to at least some of the RAF's Voyager fleet. Retrofitting a small number of the RAF's Voyager fleet would protect the fleet's sustainability, where allied countries cannot provide tankers. More importantly, it would enable autonomous air operations. Nevertheless, in 2021, Jeremy Quin, former Minister for Defence Procurement, stated that the Ministry of Defence (MOD) had 'no current plans' to fit booms to the RAF's Voyagers – a controversial position which does not appear to have changed since.

The Royal Canadian Air Force (RCAF) is one example of an air arm that has achieved a flying boom-capable tanker through a similar conversion package. The RCAF has procured at least two ex-civil A330s to undergo modifications to tanker specification, which will be like the RAF's Voyagers but with flying booms equipped. The RCAF specifically identified the dual AAR mechanisms as an advantageous capability and proved that a safe and functional retrofit is possible.⁴¹

The RAF's Voyager KC Mk.2 variant is the most suitable modification option, as it carries no centreline refuelling provisions. This would protect the integrity of the existing capability, allowing them to maintain their wing-mounted pods to support Typhoon and F-35 operations, alongside maximising what the Voyager force would be capable of supporting. The RAF would then possess dedicated aircraft that can facilitate niche tanking requirements without losing any existing provisions to support the needs of hose and drogue refuelling. Additionally, the A400M's AAR capability still requires a hose and drogue, meaning there is still an operational requirement for the Voyager KC Mk.3's centreline hose.⁴²

Retrofitting would temporarily reduce overall fleet output, as aircraft must be pulled out of service interim as modifications occur. This could be mitigated through the reconfiguration of AirTanker's non-core fleet of A330s to support any meantime hose and drogue operations.

Although retrofitting might be cheaper, the MOD could also consider procuring brand-new or second-hand (as per the RCAF model) A330s to be fitted with both booms and wing pods. This would enable the existing fleet to continue operations unaffected before adding additional aircraft, boosting overall output. If the main barrier to this is financial, it could be worth exploring any potential options for the part exchange or sale of some of the existing fleet (such as the less-capable KC Mk. 2s), which can be used to part fund the procurement of an equal number of boom-equipped Voyagers.

Altering the fleet by exchanging or selling existing Voyagers would also be in keeping with the MOD's 2022 Sustainable Support Strategy. This seeks to move the MOD's acquisition life cycle (CADMID) to a 'more circular' approach, which repositions the endpoint of a capability to 're-use, repair or repurpose'.⁴³

Though a sovereign tanker capability would be the best scenario to enable liberty of operations and complete control over taskings, the RAF and MOD should immediately consider membership in the NATO MMF. Membership of the NATO MMF would be an ideal interim solution, especially if the availability of funds prevents immediate changes to the UK's Voyager fleet or throughout a capability gap imposed by the retrofitting or sale of the existing fleet. British membership of the MMF would undoubtedly boost the RAF's operational capabilities and reduce reliance on US tanker capabilities. The RAF already has trained aircrew on the A330 MRTT, meaning membership would not drastically change any conversion or operational training requirements. It would allow for swift UK integration, providing access to boom tankers to mitigate the current shortage. MMF membership would also reaffirm the UK's overall ties with the alliance and demonstrate further commitment to partner nations.

Conclusion

The lack of flying-boom-equipped tankers conclusively places the RAF at an operational disadvantage, reducing key assets' range, persistence, and potential. This is most notable in the field of ISR, where AAR is fundamental to the employment of the Rivet Joint Signals Intelligence platform, where its operations have, to date, relied on tankers provided by the USAF. Lacking a complete package tanker capability significantly reduces the RAF's ability to self-support operations and prevents effective long-range or high-persistence air power projection if no one can or is willing to offer tanker support to RAF operations.

The MOD should, therefore, immediately consider procuring additional or replacement aircraft equipped with a flying boom to facilitate the AAR of a growing number of platforms that require this method. Alternatively, a boom-retrofit of the existing Voyager KC Mk.2s would be a viable solution in quickly gaining this capability for the RAF. This has already been proven possible by the RCAF's project to retrofit two second-hand A330s to MRTT specification with booms equipped. Finally, the MOD should also consider RAF membership of the NATO MMF to increase the number of available boom tankers, which can be called upon immediately, whilst a permanent solution for the Voyager fleet is ongoing.

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