March **2014**

Air-to-Air Refuelling Consolidation

An Update

Joint Air Power Competence Centre

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Note: The full analysis of NATO AAR contains information, statistics and calculations that are classified. Classified information applies to Chapter III only and is not in this version. The comprehensive classified version is available on the NATO Secret Network (NSWAN) at http://nww.japcc.nato.int/JAPCC/JAPCCPubli/otherPubli.

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FROM:

The Executive Director of the Joint Air Power Competence Centre (JAPCC)

SUBJECT:

Air-to-Air Refuelling Consolidation – An Update

DISTRIBUTION:

All NATO Military and Civilian Structures, NATO Nations and Partnership Cooperation Menu (PCM) Nations – Releasable to the Public

Time and tide wait for no man, and so the JAPCC has been driven by both time and events to update the Air-to-Air Refuelling (AAR) Flight Plan, first published by the JAPCC in February 2011. This updated AAR Consolidation builds upon the JAPCC's initial assessment of NATO's AAR capabilities with additional analysis of recent AAR operations over North Africa and the introduction into service of a new generation of Tanker Transport (TT) platforms.

There can be no doubt as to the current value of AAR and its role in the employment of Air Power; however there remains a significant shortfall in this capability amongst European air forces. Only time will tell whether a new generation of fewer, but more capable, tankers can meet the level of ambition. With declining military resources, the Alliance is firmly focused on improving levels of interoperability in accordance with Smart Defence and the Connected Forces Initiative, as is the European Union with their concept of Pooling and Sharing.

The anticipated end of combat operations in Afghanistan in 2014 will inevitably focus military and political thinking upon future force structures, with air forces being no exception. Rather than focusing on force structures, Air Power advocates should aim to articulate an effective framework for developing its capabilities, sustainment, training and exercise to support the concepts of force efficiency and force effectiveness

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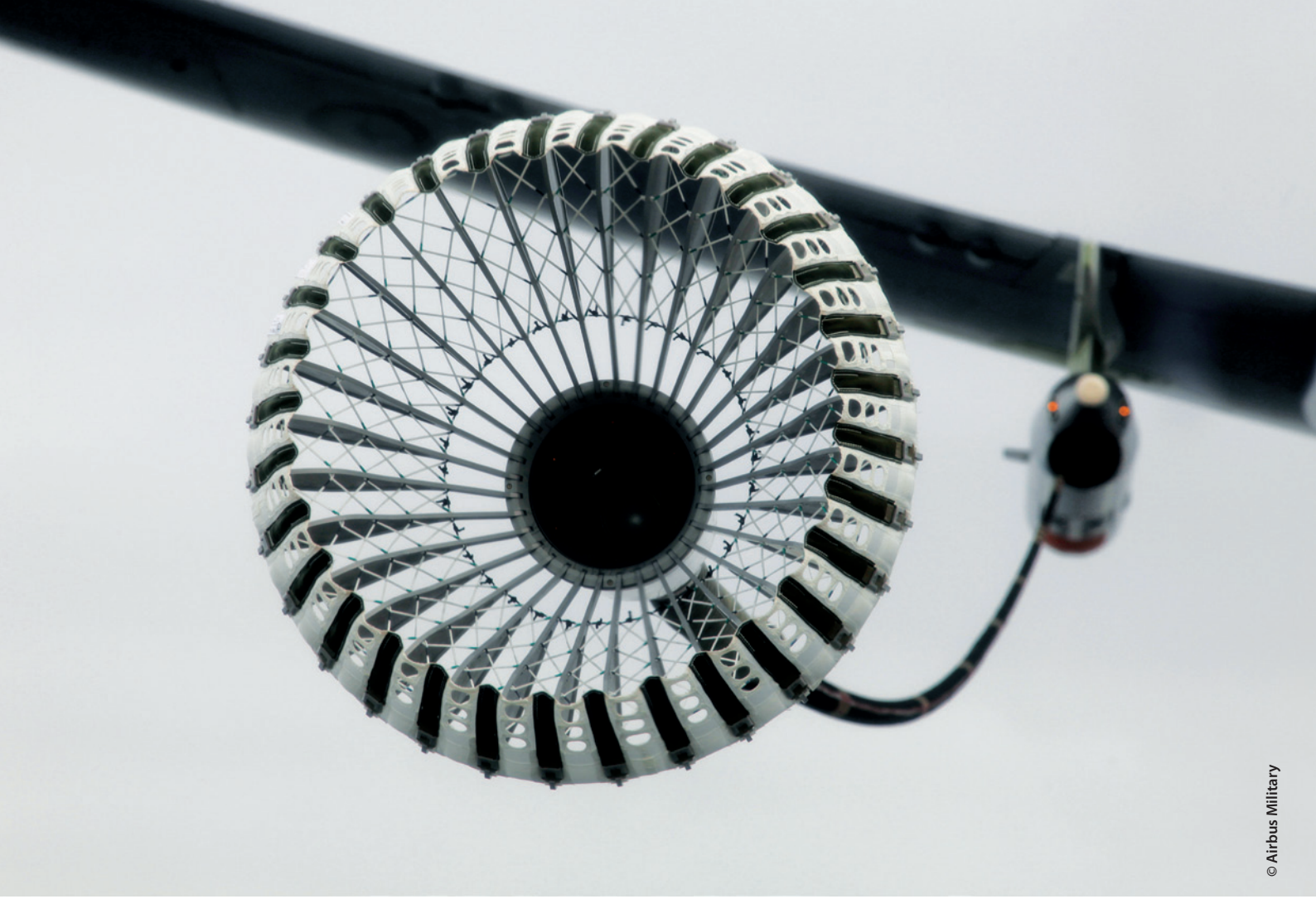

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CHAPTER 1

Introduction

'Of all air power force-multipliers, Air-to-Air Refuelling (AAR) is amongst the most significant. It provides an essential capability that increases the range, endurance, payload and flexibility of all capable receiver aircraft, and is especially important when forward basing is limited or unavailable, or air base operations limitations impose constraints.'[1]

1.1 Challenges to Future Success

1.1.1 There is little doubt as to the requirement amongst air forces for AAR capability. AAR capability is already, for more than half a decade, been identified as a capability shortfall in NATO, specifically amongst the European NATO members. Yet, time and again, the AAR capability has been proven to be effective in support of air operations over the former Yugoslavia, Iraq, Afghanistan, Libya and, most recently, Mali. Whether close to home or at extended range in support of expeditionary operations, there has been an increase in demand for AAR from a greater number of receivers. To the Cold War requirement to support strategic reach (Air Transport (AT), long-range strike) has been added the requirement to refuel Fighter/Attack, Intelligence, Surveillance and Reconnaissance (ISR), airborne Command and Control (C2) and Maritime Patrol assets.

1.1.2 With respect to 'ownership', there is no single office or focal point within the current NATO Command Structure to coordinate multinational AAR issues. The drafting of doctrine, equipment standardization agreements, tactical procedures, common qualification and currencies, and the training of

planning staffs is being undertaken by a large number of national and multinational organizations, agencies and individuals. This lack of central co-ordination has led to AAR lessons being repeatedly 're-learned' during the initial phases of air operations (e.g. analysis of the Balkan air campaigns is broadly similar to that of the Libyan campaign).

1.1.3 With potentially fewer AAR resources, NATO also faces an increasing demand for greater efficiency, largely driven by economics. Defence expenditure, amongst NATO countries is declining, and whilst new tanker platforms are more capable, they are being procured in fewer numbers so the overall capability may be reduced. Increasing the level of interoperability between existing resources is seen as a potential solution however, nations and industry must overcome their reluctance to share the technical data required to facilitate AAR clearances.

1.1.4 Given the continued fiscal constraints and procurement of fewer platforms, it is likely that, if these three areas are not invested in, AAR may become a limiting factor to NATO's future ambition rather than its current status as a significant force-multiplier.

1.2 The Path Ahead

1.2.1 The aim of this publication is three fold: to educate the reader in the current status of NATO's AAR capability; to explain, in detail, the areas of concern; and to inform the reader of solutions to address these concerns.

1. NATO, **Allied Tactical Publication (ATP) 3.3.4 Vol II AAR Doctrine** (Brussels: NATO Standardization Agency, 2013).

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CHAPTER 11

AAR in 2015

'The objective of AAR operations is to enhance combat effectiveness by extending the range, payload and endurance of receiver aircraft. It allows Air Power to be projected at greater distances or concentrated where and when it is needed most.'[1]

2.1 The Objective of AAR

2.1.1 The primary effect of providing additional fuel to airborne aircraft is a spatial and temporal extension of air capabilities. The increase in the range, endurance, payload and flexibility of receiver aircraft still outweighs the additional costs associated with delivering fuel in the air, confirming AAR as a significant force enabler and multiplier. To ensure these effects are optimized, it is important that AAR does not interfere with, or adversely impact upon, the receiving aircrafts' primary mission.

2.1.2 Knowing when and where this extension is to be employed are important factors in the successful employment of AAR capability. Considerations include; offloading the requested amount of fuel, rendezvousing at the coordinated point in airspace at the correct time and trailing the receiving assets during the deployment and redeployment phases. AAR capability is therefore expressed in terms of the number of tanker sorties generated, the time on station, the amount of fuel offloaded, the number of booms or hoses in the air, and the number of receivers supported. However, as an enabling capability, the overall efficiency of AAR is derived from the ratio between the aforementioned considerations and the mission results achieved by the receiving aircraft.

2.1.3 The new generation of tankers utilize existing AAR technology so it is reasonable to assume that extension will remain the primary AAR effect for the foreseeable future. None of the NATO nations has indicated their use of an alternative AAR system; the next development is likely to be the variance in

receiver aircraft. Tilt-Rotor platforms have been added to fixed and Rotary Wing (RW) receivers with unmanned receivers most likely to be next progression. Research and development using unmanned receivers have, to date, used manned receiver flight profiles and procedures reinforcing the assumption that force extension will continue to be the preferred method of employment.

2.2 AAR Resources

The legacy of the Cold War procurement of AAR tankers still bears its mark on the inventories of the NATO nations' tanker inventories. Twenty years since the fall of the Soviet Union many nations are only now undertaking the process of procuring new platforms or the recapitalization of existing fleets. Whilst the requirement for AAR has increased, from fighters and bombers to the full spectrum of air platforms, there has not been a corresponding purchase of additional tanker aircraft.

2.3 Tanker Characteristics

2.3.1 Aircraft Types

2.3.1.1 The current standard tanker for NATO planning is the KC-135 which, at a maximum gross weight of 300,000 pounds, can be termed as a medium-sized tanker. The majority of new platforms, including the KC-135 replacement, will be classed as medium-to-large tankers with maximum weights between 350,000 and 500,000 pounds.

2.3.1.2 The market in medium-to-large tankers (in terms of size, payload, range and speed) is currently dominated by two companies: Airbus Defence and Space and the Boeing Company. Airbus manufactures the A310 and A330 Multi-Role Tanker Transport (MRTT) aircraft with Boeing offering variants of the B767 as the Multi-Mission Tanker Transport (MMTT). The small and medium tanker market is currently dominated by the Lockheed C-130 with future additions to the market expected in the form of the Airbus A400M (at 285,000 pounds), the V-22 Osprey and the Embraer C295.

2.3.2 Fuel Transfer Technology

NATO has ratified the standardization of the two existing, and different, fuel transfer systems: the probe and drogue and boom systems. The two systems are not compatible however the use of a Boom Drogue Adaptor (BDA) fitted on the ground preflight and the purchase of dual system tankers (fitted with both probe and drogue and boom equipment) addresses the needs of current receivers. To date, no NATO air force has identified the requirement for a different AAR system.

Cargo compartment of an Italian KC-767 tanker transport.

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2.3.3 Dual-system Tankers/Tanker Transports

2.3.3.1 NATO does not own any AAR tankers and is reliant upon the Member States to provide this capability. With no common procurement strategy, these nations have, in the past, acquired AAR tankers in accordance with their own national, not multinational, policy. A nation with probe-equipped receiver aircraft have previously bought drogue-equipped tankers; nations with boom receivers have acquired boom-equipped tankers. The requirement for both AAR fuel transfer systems on the same aircraft has been stimulated by the increasing pressure for greater levels of interoperability amongst NATO allies faced with purchasing fewer (in overall numbers) of the new generation of TT aircraft.

2.3.3.2 The TT platforms could be called upon to perform missions other than AT and AAR. Aeromedical Evacuation (AE) has been undertaken by national AAR assets in the AT role and their future use for ISR and C2 should not be discounted.

2.3.3.3 Commanders and planners must be cognizant of the advantages and constraints of each dual-role aircraft and type and its aircrews. Whilst flexibility should prove a clear advantage, the correct apportionment and task prioritization is vital to the efficient employment of these tankers, whether in its primary AAR role or secondary AT/other role. Equally, the allocation of aircrews, to each or all roles, could prove problematic with the correct balance between the training costs and the required force readiness levels.

2.4 AAR Employment Concept

As previously stated, AAR provides an essential capability that increases the range, endurance, payload and flexibility of all capable receiver aircraft. This includes support to tactical and strategic operations, expeditionary operations, inter-theatre fighter movements and air transport operations. The 'art' of AAR encompasses both complexity and vulnerability. The inherent dangers of aircraft flying in close formation and refuelling are self-evident; common AAR procedures address this complexity. To address the vulnerability, tasking authorities minimize exposure to enemy threats by planning to conduct AAR in relatively-benign environments once a high degree of air superiority has been achieved. AAR may however be conducted in less benign areas when required and the addition of defensive aids to future platforms (specifically the KC-46) may indicate the need or will to do so.

2.5 Basing

2.5.1 The majority of current tankers are not fitted with threat warning or defensive aids and as such they are not normally based in close proximity to the immediate battle space. But given the hybrid symmetric/asymmetric nature of recent operations, the basing of tankers also deserves some thought.

2.5.2 Current NATO planning, based on likely scenarios and operational concepts, has identified forward basing options, albeit within NATO territory, for tanker bed-down locations. The planning process encompasses analysis and verification with host nations to ensure adequate provision of infrastructure, access and supplies. In order to realise economies of scale, maximize logistics efficiency and to minimize the Force Protection footprint, a smaller number of airbases with larger capacities is preferred to more numerous, smaller airbases. Although the new generation of NATO tankers (A330, KC-46) is not significantly larger in physical dimensions than the current fleet (KC-10, KC-135), tanker bed-down spots will have to be reviewed, perhaps using the KC-46 as the standard size. The new generation is however significantly more capable in terms of fuel uplift so fuel supply estimates will require closer examination.

2.6 Employment Efficiencies

2.6.1 With the potential of fewer, but more capable, tankers supporting an increasing community of receivers, efficiencies in the employment of receiver-capable tankers will be sought. The two predominant methods to extend the performance of tankers are force extension and fuel consolidation. The two

methods are similar with the delineation between the purpose of force extension as an organic supporter to planned deployments of specific flying units and fuel consolidation in support of the broader AAR mission.

2.6.1.1 Force extension has been employed to refuel tankers when supporting the long-range deployments of receiver aircraft formations. The dedicated supporting tankers are refuelled whilst airborne thus eliminating/reducing the requirement for en route fuel stops.

2.6.1.2 Fuel consolidation involves tanker-tanker AAR to enable the most efficient combination of tankers by taking advantage of any spare airborne fuel capacity and to avoid tankers returning to base with unused fuel. This process enables the release of tankers to return to base without reducing the amount of available fuel in the operating area. The returning tanker can then be turned around, with a different crew, for a different mission. This consolidation enables more dynamic scheduling or retasking by planning staffs either whilst the tankers are airborne or for the following Air Tasking cycle.

2.7 The Rise of the Machines

All current NATO AAR tanker procurement programmes are manned platforms. There are established programmes for unmanned AAR receivers however standardization across the Alliance is in its infancy. A 5-nation Memorandum of Understanding (MoU) Technical Group (TG), the Future Technologies Aerial Refueling (FTAR) TG, is mandated to provide the constituent members (France, Germany, Italy, the UK and the US) with the sharing of current research and technological data. In the future, the TG aims to provide standardization guidance to industry and interoperability guidance to the military for the automated AAR of Unmanned Aerial Systems (UAS).

1. NATO, **Allied Joint Publication (AJP)-3.3(A): Allied Joint Doctrine for Air and Space Operations** (Brussels: NATO Standardization Agency, 2009)

Two US National Aeronautical and Space Administration (NASA) Global Hawks preforming AAR. Note: the lead UAS is actually the receiver.

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CHAPTER III

Areas of Concern

NOTE: For a more detailed analysis on the NATO tanker requirement, please see the classified version of this document available on the NATO SECRET (NSWAN) webpage at the following address: http://nww.japcc.nato.int/JAPCC/JAPCCPubli/otherPubli

3.1 NATO Tanker Requirement

3.1.1 The NATO AAR requirement is derived from the NATO Defence Planning Process (NDPP) and is the AAR capability needed to meet NATO's Level of Ambition – to undertake, concurrently, two Major Joint Operations (MJO) and six (one air-heavy) Small Joint Operations (SJO). The criterion for the air component contribution for each scale of operation is detailed in the classified version of this publication. This planning figure is based upon the performance and capability of the KC-135, the standard metric, with factors applied to other allied tankers.

3.1.2 On paper, NATO has sufficient numbers of tankers to meet its Level of Ambition, yet, this is only possible through heavy reliance on US assets. There has been much debate in open sources about whether NATO's tanker resources truly meet NATO's requirement. A discussion of AAR in relation to current and previous Priority Shortfall Areas is available in the classified version of this document.

3.1.3 The required total, derived from the NDPP, is inaccurate for a number of reasons. The number does not account for:

- The double counting of TT aircraft to concurrently fulfill both AT and AAR requirements;

- The differentiation between boom-capable tankers, probe and drogue-capable tankers and Dual-system tankers, but assumes absolute interoperability between all variants of tankers and all receivers;

- The correlation between platform capability and mission profile. There are certain mission profiles unsuited to strategic tankers (in terms of size, payload, range and speed) e.g. RW AAR. Vice-versa, there are certain missions that tactical tankers are unsuited to e.g. heavy aircraft boom AAR;

- The link to force generation i.e. the willingness of a specific nation to deploy their forces to a specific operation in the quantity agreed to, and stated, within the NDPP.

3.1.4 NATO has not changed its level of ambition and, given the recent declaration that the US can no longer plan to undertake concurrent large-scale wars and its shift in military focus to the Asia-Pacific region, NATO must revise the quantitative AAR requirement within the NDPP. The current figure is far too low and reliant upon the US providing the vast majority of the capability.

NOTE: See the classified version for detailed analysis of the NATO AAR requirement and capability. (Table 1 is classified and not in this version.)

3.2 The NATO Inventory

Analysis of the current NATO AAR inventory (Table 2) highlights the following areas of concern:

- The ratio between the capability of the United States and the remainder is vast: 9:1 of the overall capability (subtly different from the requirement);

- 17 of 28 (or 61%) NATO nations have a receiver requirement however only 9 (or 32% of) nations have a tanker capability;

- The current European inventory suggests these nations are only capable of undertaking a single air-heavy Small Joint Operation, in the best scenario. Indeed, only seven European Member States currently operate tanker aircraft and only a portion of these aircraft are 'deployable' on a given day (detail provided in the comprehensive classified version). To compound this lack of capability, there are twelve different types of tankers in the European inventory, for which, more than 40% of the required clearances are missing. All the other Member States rely heavily on US spare AAR capacity;

- The combination of fragmentation (the numbers of aircraft variants, both tankers and receivers) and the two principle AAR systems (boom receptacle, probe and drogue) hampers standardization and thus interoper-

USAF KC-135R refuelling two USAF F-16s.

© U.S. Air Force, SSgt Suzanne Day

Nation	AAR 2014 Receivers	Tanker Inventory 2014[1]	2020-2025 Tanker Inventory
ALBANIA	NO		
BELGIUM	YES		Purchase flt hours through EDA Pillar 4[2]
BULGARIA	NO		
CANADA	YES	4 CC-130HT (Drogue)[3] 2 CC-150T (A-310 MRTT) (Drogue)	2 CC-150T (A-310 MRTT) (Drogue)
CROATIA	NO		
CZECH REPUBLIC	YES		
DENMARK	YES		
ESTONIA	NO		
FRANCE	YES	7 C-160NG (14 aircraft capable but only 7 kits) (Drogue) 11 C-135FR (Boom and Drogue) 3 KC-135R (Boom and BDA)	10 A400M (U/W pods + 5 HDU)[4] 12 A-330MRTT (Drogue and Boom?)
GERMANY	YES	4 A-310MRTT (Drogue)	4 A-310MRTT (Drogue) 10 A400M (10 U/W pods + 6 HDU)
GREECE	YES		
HUNGARY	YES		
ITALY	YES	4 KC-767 (Boom and Drogue) 9 KC-130J (Drogue)	4 KC-767 (Boom and Drogue) 9 KC-130J (Drogue)
LATVIA	NO		
LITHUANIA	NO		
LUXEMBOURG	NO		
NETHERLANDS	YES	2 KDC-10 (Boom)	Strategic Tankers under EDA Pillar 4[2]
NORWAY	YES		Strategic Tankers under EDA Pillar 4[2]
POLAND	YES		Strategic Tankers under EDA Pillar 4[2]
PORTUGAL	YES		
Romania	NO		

Nation	AAR 2014 Receivers	Tanker Inventory 2014[1]	2020-2025 Tanker Inventory
SLOVAKIA	NO		
SLOVENIA	NO		
SPAIN	YES	2 B-707 (Drogue) 5 KC-130 (Drogue)	9 A400M (9 U/W pods + 3 HDU) Strategic Tankers under EDA Pillar 4[2]
TURKEY	YES	7 KC-135R (Boom and BDA)	7 KC-135R (Boom and BDA)
UNITED KINGDOM	YES	4 TriStar K1/KC1 (Retire in 2014) 7 Voyager KC2 (A-330 MRTT) (Drogue)	14 Voyager KC2 (A-330 MRTT) (Drogue)
UNITED STATES	YES	397 KC-135R/T (Boom & Drogue/BDA) 59 KC-10 (Boom and Dogue) 48 MC-130E/H/P (Drogue) 36 HC-130P/N (Drogue) 15 MC-130J (Drogue) 9 HC-130J (Drogue) 28 KC-130T (Drogue) 46 KC-130J (Drogue)	179 KC-46 (Boom and Drogue)[5] 218 KC-135R/T (Boom & Drogue/BDA)[6] 59 KC-10 (Boom and Drogue)[7] 22 MC-130J (Drogue) 20 MC130H (Drogue) 36 HC-130J (Drogue) 74 KC-130J (Drogue)
TOTAL (including USA)		709	697+31[8]
TOTAL (without USA)		71	89+31
TOTAL (without USA/ CAN/TUR)		58	80+31

1. All numbers in current inventories are taken from the national declarations made durung the NATO AAR Working Group in Apr 2013. The only excetions are the C130-tyoe tanker numbers sourced from the US Air Force and US Navy.
2. It is assumed a minimum collective procurement of 8 strategic tankers under Pillar 4 of the European Defence Agency initiative. The exact number has not yet been decided.
3. Forecast Out of Service Date 2020.
4. The total number of underwing kits represent the total number of A400M tankers available. The additional Hose Drogue Units do not represent additional tankers.
5. Delivery of the KC-46 programme will be completed in 2028. For the purpose of this document the 2025 timeframe includes all aircraft deliveries.
6. The estimated number of KC-135 still in service during the period 2020-2025 is based on a one-for-one replacement with KC-46.
7. The USAF is considering retiring its KC-10 fleet in the near future and delaying the retirement of the KC-135R.
8. Under the EDA's AAR Initiative (Pillar 3) the purchase of an additional 31 U/W kits and 15 HDUs will convert a further 31 A400M aircraft to the tanker role from the existing fleet; but, as of yet, no A400M nation has signed up to this option.

Table 2: NATO Tanker Inventory (Current) and 2025 (Projected)
Note: More detailed information in the classified version.

ability. The acquisition of a new generation of dual-system tankers and the reduction in the variants of receivers should alleviate, but not eradicate, this issue;

- Within the European nations' inventory, there is a shortage of boom-equipped tankers. The United Kingdom has procured new tankers without a boom capability; France has yet to decide on a dual-system tanker; Germany has retired its last remaining boom receiver and will revert to probe only; the Netherlands and Turkey have yet to procure replacements for their existing boom-equipped fleets.

3.3 Organization

3.3.1 Each of the new generation Tanker Transport aircraft will be more capable than previous platforms, in terms of available fuel offload and its own performance (range, endurance, speed, fuel efficiency). However, the decrease in physical numbers will be exacerbated by a significant increase in the demand for AAR. As it is unlikely that there will be a future increase in the numbers of tankers available to NATO, the employment of current assets must be optimized which may necessitate fundamental changes to the controlling/tasking organization(s).

3.3.2 The NATO Command Structure (NCS)

3.3.2.1 At the time of writing there is no single, permanent office, or focal point, within the NCS to analyse and staff AAR issues in preparation for operations. During operations, the Transfer of Authority provides Allied Command Operations (ACO) with Operational Control of national assets. Air operations over Afghanistan and Libya have demonstrated that a NATO-led Air Operations Centre can C2 the Joint Force Air Component (JFAC) in support of the Alliance's aims. However, this capability must be placed in context due to the size, scale and complexity of these particular air operations.

3.3.2.2 Reform of NATO Air Command's (AIRCOM) command structure resulted in a single Allied Air Command Headquarters at Ramstein, Germany, with the additional role to act as the JFAC. The NATO Combined Air Operations Centres (CAOC) (Uedem, Germany; Torrejon, Spain) are tasked with the Air Policing of, respectively, Northern and Southern European airspace. Personnel from these two CAOCs will augment the deployable JFAC during operations but whether a single Allied Air Command can meet the C2 challenge for 2 x MJO plus 6 x SJO is open to debate.

3.3.2.3 What is certain is the lack of AAR expertise within the NCS. The Air Policing of NATO airspace requires very few (if any) permanently-assigned AAR assets thus the CAOCs in Uedem and Torrejon do not teach or practice large-scale AAR planning. The NATO-led air operation over Libya exposed the lack of qualified AAR planners within the CAOC (then based at Poggio Renatico) and there remains no dedicated, multinational training for AAR Planners anywhere in NATO.

Recommendation 1: A permanent office or advocate for AAR capability within AIRCOM is required to ensure coherence between Allied Command Operations, Allied Command Transformation and the Alliance nations.

3.3.2.4 This lack of an AAR focal point within the NCS has led to the proliferation in the number of multinational Commands, organizations and agencies tasked with improving the levels of standardization and interoperability amongst the Alliance nations.

HQ AIRCOM, Rammstein AB, Germany.

3.4 Multinational Initiatives

3.4.1 The Movement Coordination Centre – Europe (MCCE) was established in July 2007 as a result of the merging of the European Airlift Centre (EAC) and the Sealift Coordination Cell (SCC). The aim was to improve the effectiveness and efficiency, through greater coordination, of the 25 member nations' capabilities in the fields of Movement and Transportation including AT, AAR, Sealift Transport (ST) and Inland Surface Transport (IST). An AAR Cell and an Airspace Management Office were established within the

MCCE Operations Section, with its main task of handling and developing AAR and Airspace cooperation amongst participant Nations. The MCCE encourages the exchanging of air services through the compensation mechanism defined in the Air Transport, Air-to-Air Refuelling and other Exchange of Services (ATARES) to which the US has recently joined. The admission of the US to ATARES will potentially see the transition from the current situation whereby United States Air Forces Europe (USAFE) assets are the pre-eminent supporter of Europe's demand for AAR to a position where USAFE is both a provider for, and a receiver of, European AAR services.

3.4.2 The European Air Transport Command (EATC) was established in September 2010 with the aim to make more efficient use of AT and AAR capabilities. The Participating Nations transferred and integrated all relevant national responsibilities (in reality only Operational Control (OPCON)) into one single Command in order to direct the force generation and the mission execution of the combined AT. The Command also encourages the harmonization and standardization in training and employment matters in addition to technical and logistical support. Current participating nations include Belgium, France, Germany, Luxembourg and the Netherlands with the imminent addition of Spain. The addition of Italy to the EATC is currently being staffed.

3.4.3 In order to realize the benefits of increased efficiency, these multinational organizations must have sufficient resources and a form of command authority. The MCCE, as a coordination centre, does not have a command function. Any efficiency is therefore dependent upon the willingness of nations to make assets available rather than utilising the full inventories of all participating nations. The EATC has OPCON of some but not all AAR assets and is demonstrating, year-on-year, greater efficiency and resultant effectiveness, albeit primarily in the AT domain. The efficiencies in AAR have yet to materialize due to the small number of tankers assigned to the EATC; the largest contributor would be France however most of their tankers are withheld in support of their national nuclear task.

3.4.4 Furthermore, these multinational organizations are undermined by the sensitive political issue of national sovereignty. This is most evident during combat operations. The all-too-frequent use of national caveats and restrictions diminishes the collective will and negates the potential efficiencies shown through peacetime cooperation.

3.4.5 At the working level, NATO's regulation of doctrinal and technical standards is coordinated by the Air-to-Air Refuelling Working Group (AARWG) chaired by the JAPCC. The JAPCC is a NATO-accredited Centre of Excellence however, significantly, **does not** sit within the NATO Command Structure. The AARWG is a subordinate group to the Military Committee Air Standardization Board (MCASB) and primarily focuses on the development of operational standards and the exchange of information that enhances effective AAR employment and interoperability. The principal activity of the Working Group is the identification, proposal and development of Standardization Agreements (STANAGs) and Allied Publications (APs) that embrace doctrine, tactics, techniques and procedures in the field of AAR, which are essential for current and future NATO operations.

3.4.6 The development of technical STANAGs is central to the work of the Aerial Refueling Systems Advisory Group (ARSAG). Although ARSAG is a US-based organization, the Group is dedicated to improving all aspects of Aerial Refuelling worldwide. The not-for-profit joint military-industry professional association was chartered in 1978 and is recognized as the global workplace for technical and operational Aerial Refueling topics. ARSAG's scope brings together the NATO air forces, allies and industry to promote the safety of, and interoperability between, AAR equipment and systems.

3.5 The AAR Clearance Process

3.5.1 Interoperability, especially between nations operating the same platforms, will be improved by accelerating the AAR Clearance Process. The clearance to conduct AAR involves not just the technical compatibility between the receiver and tanker aircraft but

also financial and legal issues and the standardization in employment, specifically in training, qualification and currency. The final overall clearance, including the technical clearance, will always be retained by the national Operating Authority, usually the particular national command, as the 'owners' of both the clearance and the risk. The process of authorizing AAR Clearances is lengthy and expensive involving both ground and air tests, evaluation and risk management. To complicate matters further, there is no agreed international standard for the Clearance Process and thus nations maintain their own procedures, applied by their respective Flight Test Centres and Airworthiness Authorities, many of which are not necessarily controlled or commanded by the specific national air force but by a Joint or central civilian agency.

3.5.2 Much of the lethargy in the AAR Clearance process can be attributed to ignorance of multi-lateral requirements or bureaucratic national procedures. However, a significant factor is the lack of sharing of technical information between nations with technically similar variants of either tankers or receivers. With several countries operating the (technically) same receiver aircraft and tankers, a system of technically clearing receiver/tanker combinations en masse should be pursued rather than nations acting independently. As a minimum, technical data should be shared between those operating nations. However, it is not always possible to share this technical data as the proprietary owner of this data, either the air force or industry, is not always certain. The 'need to share' is perhaps lacking in the military psyche accustomed to the 'need to know.'

Recommendation 2: Ministers of Defence (MoD)/ Air Chiefs should impress upon their Airworthiness/Release-to-Service staffs the importance of the 'need to share' technical data with respect to AAR clearances.

3.6 Fail to Plan, Plan to Fail

3.6.1 NATO not only has an over-reliance on US tankers but also an over-reliance on the provision of US Joint Force Air Component Commanders, functional Air Operations Centres (AOC) and AOC personnel, specifically AAR planners. The Lesson Identified by HQ

US Combined Air Operations Centre.

Airbus A330 flight simulator.

AIRCOM from OUP that the NATO JFAC lacked expertise in a number of key areas has not been adequately addressed. NATO's declaration for declaring Initial Operating Capability and Full Operating Capability for the restructured NATO Command Structure ignored the Lesson Identified that the AOCs should be manned with qualified and trained personnel and not just any personnel.

Recommendation 3: Commander, AIRCOM should ensure JFAC staffs are fully trained (qualified and current) for their assigned task and conversant with the organizational and command structures.

3.6.2 NATO does not have a dedicated AAR Planners course and is reliant upon US-trained personnel to lead the AAR sections of NATO CAOCs and JFAC. In the reorganization of the NATO Command Structure, the NATO CAOC at Poggio Renatico has been re-tasked as a Deployable Air Command and Control Centre with the potential to be used to train NATO CAOC personnel. However, currently, only the USAF teaches AAR planning to air mobility personnel assigned to AOCs.

3.6.3 The USAF Air Mobility Command detachment at Hurlburt Field, Florida, teaches all aspects of a functioning (US-centric) AOC, including AAR planning and integration into the Air Tasking Order (ATO) cycle. The AAR course is available to UK and Canadian personnel assigned to a NATO CAOC post through the Foreign Military Sales mechanism.

Recommendation 4: NATO should introduce a common training programme for AAR Planning staff as pre-employment in a NATO CAOC.

3.7 Training

The challenges associated with sustaining a capability through training are not unique to AAR. The resources expended by NATO countries during a decade plus of expeditionary operations in Afghanistan, Iraq, Libya and Mali has impacted the resources available for individual and collective training.

3.7.1 Individual Training

The individual training of AAR receiver aircrew and air refuelling system operators remains the responsibility of the nations. Indeed the national representatives to the NATO AAR Working Group specifically requested (in 2013) that nations retain a degree of discretion regarding training requirements vice a common standard. However, in the multinational context, there has to be an assurance, a level of confidence, between tanker and receiver that the receiver pilot and/or boom operator is AAR qualified and current to conduct safe operations.

3.7.2 Common Qualification and Currencies

3.7.2.1 Within the NATO AAR capability there are no common qualification and currency standards for

AAR receiver pilots and boom operators. Each individual nation determines its own respective standards. This complicates both the risk assessment for commanders and also the task of the planners to assign qualified receivers to tanker aircraft.

3.7.2.2 The adoption of a multinational and/or NATO standard would enhance interoperability, alleviate the planning task and, potentially, increase flexibility in the tasking.

3.7.2.3 The NATO AAR Working Group is to propose the adoption of a Common Qualification and Currencies Standards-Related Document to align the respective national standards, and for inclusion in ATP-3.3.4.2 AAR Procedures. Compliance with this multinational standard whilst on NATO operations would mitigate the risks inherent in coalition operations. Nations would retain the right to determine more/less stringent standards when operating, unliaterally or bi-laterally, outside of NATO command or control.

Recommendation 5: NATO should adopt common minimum qualification and currency standards in order to mitigate risk during multinational AAR operations.

3.7.3 Collective Training

In the current economic climate it is unrealistic to argue for an AAR-centric exercise. There is an argument to place greater emphasis on AAR in the current Joint collective training environment given its status as a critical enabler and the increasing likelihood of operating with tankers of a different nation. AAR is often classified as an exercise enabler rather than an integral element to be trained. There is also significant environmental pressure restricting the size and location of live-fly air exercises, many of which now do not require AAR participation, either platforms or planning staff. This training artificiality, of restricted geographical distance, does not exist in the operational domain with the majority of missions requiring AAR support. Pre- and post-strike or ingress/egress AAR should be planned and practised to more accurately represent the operational demand, even if the training aircraft do not require any additional fuel to complete the training mission. Again, the participation of multinational force elements can only improve levels of standardization and interoperability.

3.7.4 Synthetic Training

3.7.4.1 With increasing financial and environmental pressures being placed on live-fly training, a complementary synthetic training environment is increasingly seen as essential to maintaining core capabilities. There is, of course, the fear that live training will eventually be replaced by synthetic training without first determining the minimum safe level of live activity, below which the risks associated with operational flying are increased.

3.7.4.2 In the new generation of boom-equipped tankers, the boom operator physically controls the boom from a remote station via a synthetic link. He/she no longer has actual eyes-on the receiver aircraft. The case for synthetic training for boom operators is therefore very strong if not absolute.

3.7.4.3 With respect to receiver pilot AAR training, the argument for increased synthetic training is more complex. Modern simulators have yet to meet the required modelling and responsiveness requirements to simulate 'live' AAR. Furthermore, the level of live training below which flight safety could be compromised has yet to be determined. Until such time as this safe level is determined, synthetic training has to be viewed as complementary to, and not as a replacement for, live flying activity.

Recommendation 6: NATO Joint Collective Training should be reviewed to:

- ***Identify training/exercise opportunities to integrate AAR planning and execution;***
- ***Establish the minimum safe level of live AAR training required and the potential for the increased use of complementary synthetic training.***

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CHAPTER IV

Proposed Solutions

4.1 Addressing the European Shortfall

4.1.1 There is recognition[1] that, collectively, Europe could, and should, contribute more AAR capability to alleviate the Alliance's dependency on the US. Europe's AAR initiative is led by the European Defence Agency (EDA) whose wider mission is to support the European Council and the Member States in their effort to improve the European Union's defence capabilities in support of the Common Security and Defence Policy (CSDP). The EDA AAR initiative is structured in 4 pillars (see Fig. 1): Short term Gap Filling (with potential commercial opportunities); Optimization of Existing Assets and Organizations; the pooled procurement and sharing of A400M AAR Kits; and the recapitalization of strategic tanker fleets through pooled acquisition.

4.1.2 Pillar 1 – Short term Gap Filling – is an opportunity for those air forces with a current AAR capability gap to explore the potential for commercial AAR providers to bridge the gap until a more-permanent solution materializes. The exploratory nature of this pillar is designed not to immediately contract nations to industry but to boost interoperability levels and AAR clearances between military users and civilian providers. Omega Air has offered a package of AAR compatibility tests with their tanker aircraft and an initial trial of their services at a subsidized rate, but no EU nation has yet to sign on to this offer. The arguments against this pillar include: civilian AAR providers are predominantly probe and drogue tankers and the majority of nations with probe and drogue capability have made provision for any shortfall; and the operating costs of commercial providers is undercut by the cost and availability of US tankers or a third party through the ATARES agreement. Due to the lack of commitment from the nations, the EDA has put this pillar in a dormant status.

4.1.3 Pillar 2 – Optimization of Existing Assets and Organizations – has four sub-pillars each of which are making differing progress.

4.1.3.1 Sub-pillar 2A – Best Use of Assets – is designed to optimize the available resources of the European nations including organizations and aircraft platforms. The challenge facing this sub-pillar is the lack of consensus and standardization across the 27 nations of the EU. The project leader, the EATC, is itself finding difficultly to enforce standardization amongst its (current) five nations.

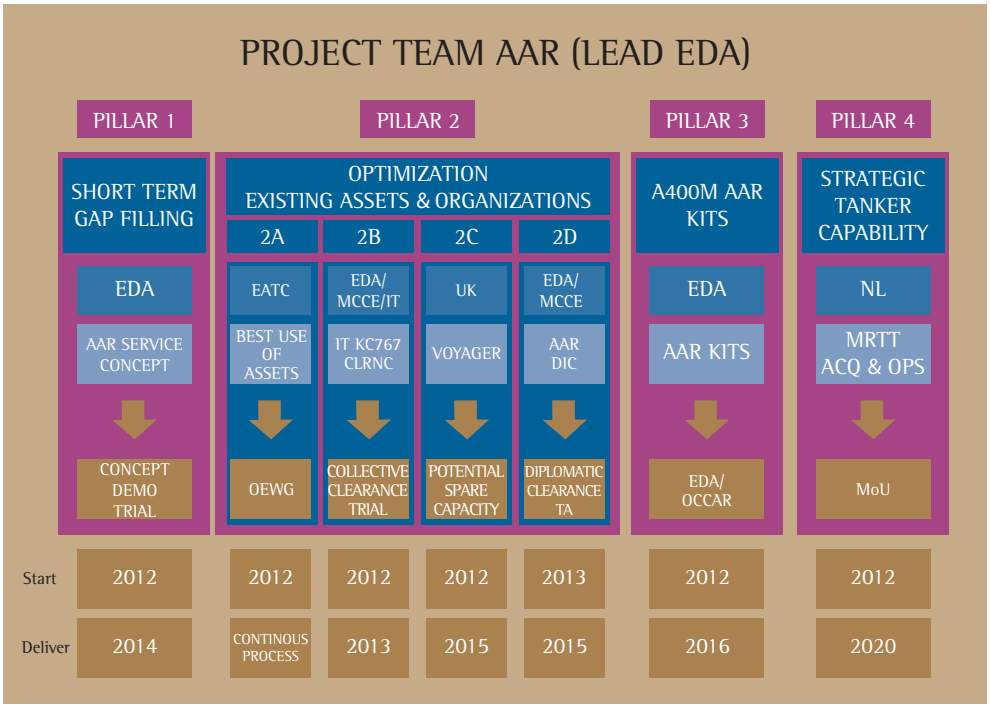

Figure 1: The EDA AAR Initiative.

4.1.3.2 Sub-pillar 2B – AAR Clearances – The Italian Air Force (ITAF) has been extremely proactive by creating a consolidated trials process during which tankers (in this case the ITAF KC-767) and receivers can co-ordinate and execute en masse AAR clearances. The desired output is the actual process, including the sharing of AAR technical data, with the secondary effect of the certification of the ITAF tanker. The process is being carefully watched by the Royal Air Force (RAF) with a view to clearing receiver aircraft on its A330 Voyager.

4.1.3.3 Pillar 2C – Voyager – The RAF has identified spare capacity in Voyager capability (flight and simulator hours, training and maintenance etc.), beyond the UK's national requirement. There is potential for third party use with nations who procure the Airbus MRTT.

4.1.3.4 Pillar 2D – Diplomatic Clearances – aimed to standardize, or deregulate, the Diplomatic Clearance process in order for tankers and receivers to cross national airspace boundaries under a single diplomatic clearance, rather than multiple clearances. Upon further research, it was concluded that the problem was not the fact that AAR was being conducted across borders, but that the receivers in trail were fighter or attack aircraft. It was decided to close this sub-pillar of the AAR initiative and shift the issue of cross border fighter/attack aircraft to another office in the EDA.

4.1.4 Pillar 3 – AAR kits – under this pillar, the EDA (in cooperation with the Organisation Conjointe de Coopération en matière d'Armement (OCCAR[2]) has drafted a business model to cost the procurement of an additional 31 AAR kits (31 underwing pods and 15 centreline Hose Drogue Units (HDU)) for Airbus A400M user nations. Under current plans, only 29 AAR kits have been procured (Germany 10, France 10 and Spain 9) to equip a European fleet of 160[3] A400M aircraft. It is uncertain at this stage if agreement can be reached to fund (cost circa. € 350M) these additional kits and whether this option is a viable solution to Europe's requirement. Whilst the EDA is keen to facilitate a multinational approach, it appears that any formal agreement will be decided along national lines; and thus this pillar has been put in a dormant status.

4.1.5 Pillar 4 – Pooled Acquisition and Pooled Operation – Aims to increase the numbers of medium-to-large sized strategic tankers through pooled procurement and/or pooled operation. This pillar has progressed, under the leadership of the Netherlands, from a Letter of Intent to the drafting of a MoU between the participating nations (Belgium, Greece, Hungary, Luxembourg, the Netherlands, Norway, Poland, Portugal and Spain). The MoU, to be signed in 2015, will seek to establish the respective level of nations' participation. Under pooled acquisition the first aircraft will be delivered by 2020. The option for pooled operation could potentially see the formation of a multinational unit and/or common logistic support. As of now, only The Netherlands, Norway and Poland are still committed to pooled operation of new aircraft. Belgium has committed to purchase dedicated flight hours on the new tanker but will not operate them. Spain is committed to pooled acquisition but will operate its tankers independently.

4.1.6 But still, after all this effort, Europe will, according to current national procurement plans, field less than 100 tankers and less than 40 % of NATO's stated requirement. One interim solution would be for European nations to operate a multinational unit flying ex USAF KC-135Rs. But the nations have already expressed their desire for only new aircraft and with the USAF proposed retirement of the KC-10A, the US will probably be less inclined to 'give' away KC-135Rs.

4.2 One Size Fits All?

A potential solution to address Europe's shortfall is to revert to a single system – probe and drogue. The majority of European future receivers will be probe, not boom, equipped; and whilst it would be beneficial for European interoperability, nations are questioning whether to buy new tankers with both systems (Italy being the notable exception having already bought the KC-767 with both systems). Any European move to probe and drogue would however harm interoperability with the largest supplier of AAR capability – the United States. The US will continue with both systems; the boom receptacle system is needed to refuel their large cargo and bomber aircraft and the probe and drogue system is needed to support predominantly the US Navy and Special Operations community.

4.3 Commercial AAR Services

4.3.1 The use of commercial industry to fill shortfalls in military AAR capability is well established in both the US and the UK and a potential short term solution to Europe's capability gap. Omega Air Refueling Services is contracted to the meet the operational needs of the US Navy and Marine Corps, as well as Foreign Military or specialized industry Research and Development projects. In the UK, AirTanker delivers the RAF's Voyager MRTT capability with aircraft, infrastructure, service and training.

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4.3.2 Civilian contractors are being used to backfill training whilst military resources are utilized on combat operations. However, should the argument that civilian companies cannot provide warfighting AAR capability be investigated? Furthermore, tankers routinely operate in benign areas outside of the threat area. Does this require military aircraft and aircrews?

4.3.3 Even if the previous questions are answered favourably, there is still a reluctance by nations to contract for AAR services from a private company. The obvious problem is cost; many nations in peacetime can access spare AAR capacity relatively cheaply through the MCCE and the ATARES mechanism or purchase spare US capacity through an FMS case. The problem is that during contingency operations or other times when there is no spare capacity, contract AAR may be the only alternative. But it is not in the interest of the commercial AAR firms to provide this service only at these times since it is very unpredictable when and how often this service will be needed. Commercial AAR firms must have stable contracts to provide their services on a regular basis so they can plan to have the resources (crews and aircraft) to meet this need. Any surge capability must be located in the nation's AAR fleets, since nations do not have the same financial restraints that corporations have.

1. European Defence Agency, **Defence Ministers' Political Declaration Regarding Air-to-Air Refuelling Capabilities**, 22 Mar. 2012 (Brussels, 2012).
2. OCCAR, established in 1996, is an international organization whose core-business is the through life management of collaborative defence equipment programmes. The organization currently comprises 6 members: Belgium, France, Germany, the United Kingdom, Italy and Spain.
3. Germany has announced that 13 of the original 53 aircraft procured are surplus to their national requirement.


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CHAPTER V

Recommended Reading

5.1 Strategic Level Doctrine

5.1.1 Military Committee Memorandum (MCM) 217 Alliance Air-to-Air Refuelling Concept dated 23 September 1998. The North Atlantic Military Committee approved the Alliance AAR Concept in 1998; however, the International Military Staff recognized, in December 2005, the concept was grossly out of date and no longer adequately addressed the subject. Allied Command Transformation (ACT) was assigned to lead a revision.

Recommendation 7: NATO's Strategic-level AAR Concept should be revised.

5.1.2 Allied Joint Publication (AJP)-3.3 Joint Air & Space Operations is currently under revision and the new version will contain updated AAR content.

5.2 Operational Level Doctrine

5.2.1 Allied Tactical Publication (ATP)-3.3.4 Vol.I Air Transport Doctrine **and** ATP-3.3.4 Vol.II Air-to-Air Refuelling Doctrine**.**

5.2.2 The current, ratified doctrine covers both AT and AAR but as separate disciplines and not when simultaneously employed in a single mission in support of a multinational coalition. A study is in progress to disband ATP-3.3.4 Volume I & II, to incorporate them into AJP-3.3 and in the pertinent tactical procedures (ATP-3.3.4.2 & ATP-3.3.4.3).

5.2.3 The requirement for multinational Simultaneous AT/AAR Doctrine has been investigated by both the Air Transport Working Group and the Air-to-Air Refuelling Working Group, but no agreement could be reached as to the need to further develop this doctrine. The likely action is for nations to include more informantion in their National SRDs to ATP-3.3.4.2 as to what type of AT missions are allowed in conjunction

with AAR. This concept of simultaneous AT/AAR is not new; specific countries have been operating their tankers in this manner but only at a national level, or at best at a limited bilateral level. The challenge is to make optimum use of all tankers in the multinational environment.

5.3 Tactical Level Procedures

5.3.1 NATO's 'book' for AAR procedures is ATP-3.3.4.2 (STANAG 3971, formerly known as ATP-56). It must be stressed that this is a procedural document and not an authority to conduct AAR operations. This authority remains a bilateral issue between the tanker and receiver nations.

5.3.1.1 ATP-3.3.4.2 Edition (C) Version 1 was promulgated in November of 2013. Edition (C) incorporates the changes required to the STANAG format, including the replacement of Annexes with SRD, and changes to the ratification and promulgation criteria. Edition (C) also includes the addition of a new chapter for Tilt Rotor AAR. The intent (by 2020) is to add a future chapter for AAR involving Unmanned Aerial Systems, whether unmanned tankers or receivers.

5.3.1.2 SRDs are a useful tool to disseminate ideas and information without the need to substantially change the STANAG (the agreement and associated Allied Publication) which would require re-submission for ratification. The following SRDs have been proposed for inclusion to ATP-3.3.4.2:

- Guide to the Multinational AAR Clearance Process. The AAR Clearance Process remains a national (bilateral) task agreed between the tanker and receiver nations. There is currently no common, multinational methodology to the clearance process with poor communication and data sharing between nations with the same tankers and receivers.
- Multinational AAR Qualifications and Currency. Similar to the AAR Clearance Process, the minimum acceptable standards (for safe AAR operations) remains the responsibility of the risk holder i.e. the national authority. There is currently no common multinational standard for receiver aircrews and boom operators; this lack of interoperability further complicates multinational planning and flexibility during operations.
- Technical Compatibility Matrix. A key Lesson Identified by the CAOC planners during OUP was the difficulty in cross referencing tanker and receiver data from the paper copy ATP-3.3.4.2. The national data has been replicated in an electronic matrix for easier access by CAOC planners and operational users.

Recommendation 8: Nations should aid in the revision and implementation of the proposed SRDs to ATP-3.3.4.2.

5.3.1.3 AAR Equipment STANAGs. It is assumed that, no matter the tanker or receiver platform, manned or unmanned, the boom and the probe and drogue systems will remain as the two principle AAR systems for the foreseeable future (until 2050). The NATO STANAGs for AAR materiel are:

- STANAG 3447 Ed. 4, AAR Equipment: Probe-Drogue Interface Characteristics;
- STANAG 7191 Ed. 1, (ATP-3.3.4.5), AAR Equipment: Boom-Receptacle System and Interface Requirements;
- STANAG 7215 Ed. 1 (ATP-3.3.4.7), AAR Signal Lights in Probe and Drogue Systems;
- STANAG 7218, Hose Colour and Markings in Probe and Drogue Systems, is still in the study phase prior to submission and consideration for ratification.

CHAPTER VI

Recommendations/ Conclusions

6.1 List of Recommendations

- Recommendation 1: A permanent office or advocate for AAR capability within AIRCOM is required to ensure coherence between Allied Command Operations, Allied Command Transformation and the Alliance nations.

- Recommendation 2: Air Chiefs should impress upon their Airworthiness/Release-to-Service staffs the importance of the 'need to share' technical data with respect to AAR clearances.

- Recommendation 3: Air Commanders should ensure JFAC staffs are fully trained (qualified and current) for their assigned task and conversant with the organizational and command structures.

- Recommendation 4: NATO should introduce a common training programme for AAR Planning staff as a pre-employment course in a NATO Air Operations Centre.

- Recommendation 5: NATO should adopt common minimum qualification and currency standards in order to mitigate risk during multinational AAR operations.

- Recommendation 6: NATO Joint Collective Training should be reviewed to:

  – Identify training/exercise opportunities to integrate AAR planning and execution.

  – Establish the minimum safe level of live AAR training required and the potential for the increased use of complementary synthetic training.

- Recommendation 7: NATO's Strategic-level AAR Concept is outdated, no longer relevant and should be revised.

- Recommendation 8: Nations should aid in the revision and implementation of the proposed SRDs to ATP-3.3.4.2.

6.2 Conclusions

NATO, AIRCOM and the Allied Nations must act on these recommendations if they hope to address the three key issues facing the AAR capability of NATO, namely: the resources required to meet the level of ambition; the lack of 'ownership' of AAR within the NATO Command Structure; and improving the level of interoperability between tanker and receiver aircraft. If these issues are not properly addressed, NATO risks not being able to support future operations with the same level of AAR support it has in the past and AAR may shift from a key enabler to a limiting factor. While the current economic situation has had a negative effect on military budgets, there is much the nations and NATO can do with little or no additional funding that can improve efficiency and effectiveness in the AAR community and ensure the Alliance has the fuel in the air it needs to protect our nations.

ANNEX A

Acronyms and Abbreviations

AAR	Air-to-Air Refuelling
AARWG	Air-to-Air Refuelling Working Group
ACO	Allied Command Operations
ACT	Allied Command Transformation
AE	Aeromedical Evacuation
AIRCOM	Air Command
AJP	Allied Joint Publication
AOC	Air Operations Centre
AP	Allied Publication
ARSAG	Aerial Refueling Systems Advisory Group
AT	Air Transport
ATARES	Air Transport and AAR Refuelling Exchange of Services
ATO	Air Tasking Order
ATP	Allied Tactical Publication
BDA	Boom Drogue Adaptor
C2	Command and Control
CAOC	Combined Air Operations Centre
CSDP	Common Security and Defence Policy
DoD	Department of Defense
EAC	European Airlift Centre
EATC	European Air Transport Command
EDA	European Defence Agency
FTAR	Future Technologies Aerial Refueling
HDU	Hose Drogue Unit
ISR	Intelligence, Surveillance and Reconnaissance
IST	Inland Surface Transportation
ITAF	Italian Air Force
JAFC	Joint Air Force Component
JAPCC	Joint Air Power Competence Centre
LOA	Level of Ambition
MCASB	Military Committee Air Standardization Board
MCCE	Movement Coordination Centre Europe
MCM	Military Committee Memorandum
MJO	Major Joint Operation
MMTT	Multi-Mission Tanker Transport
MoU	Memorandum of Understanding
MRTT	Multi-Role Tanker Transport
NASA	National Aeronautical and Space Administration

NATO	North Atlantic Treaty Organization
NCS	NATO Command Structure
NDPP	NATO Defence Planning Process
OCCAR	Organisation Conjointe de Coopération en matière d'Armement
OPCON	Operational Control
PCM	Partnership Cooperation Menu
RAF	Royal Air Force
RW	Rotary Wing
SCC	Sealift Coordination Cell
SJO	Small Joint Operation
ST	Surface Transportation
STANAG	Standardization Agreement
TG	Technical Group
TT	Tanker Transport
UAS	Unmanned Aerial Systems
USAFE	US Air Forces Europe

Joint Air Power Competence Centre

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