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Improving Acquisition and Sustainment Outcomes for Military Commercial Derived Aircraft

The KC-46A *Pegasus* Experience



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About This Report

This report examines improvement in acquisition and sustainment of commercial derivative aircraft. The authors document a case study of the KC-46A aerial refueling tanker, with emphases on Federal Aviation Administration certification, data rights, and organic-oriented sustainment. This material should be of interest to U.S. Department of Defense and Department of the Air Force acquisition specialists, as well as defense aerospace practitioners. This is a companion report to another 2023 report, *Life Cycle Management of Military Commercial Derivative Aircraft: Improving FAA Certification, Implementation of Digital Engineering and Sustainment Strategy*.

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Chapter 1. Introduction

This report documents a case study of the U.S. Air Force's (USAF's) experience developing the KC-46A *Pegasus* aerial refueling tanker, a military commercially derivative aircraft (MCDA) similar to the Boeing 767. The KC-46A is intended to gradually replace the USAF's aging KC-135 *Stratotanker* and KC-10 *Extender*. This report begins with a brief review of the troubled early history of the KC-46A program. It next focuses on the KC-46A's experiences with Federal Aviation Administration (FAA) certification, data rights, and organic-oriented life cycle sustainment. It concludes each section with lessons for the USAF to consider as it moves ahead with its KC-Y and other MCDA programs.

Background

Aerial refueling constitutes a critical component of the United States' ability to maintain its global force posture and warfighting capabilities.¹ In 2006, the RAND Corporation estimated that the Boeing KC-135 *Stratotanker* airborne refueling tanker provided an estimated 80 percent of all U.S. military air refueling capabilities.² Although subject to several significant avionics and engine upgrades,³ the youngest examples of the KC-135 fleet—the last of which were delivered in 1965—are now nearly 60 years old.⁴ By 2000, corrosion, structural fatigue, and other problems had been identified across the fleet. By 2002, an estimated 25 percent of the KC-135 fleet was in “depot-level heavy maintenance . . . averaging 400 days.”⁵

By 1996, the U.S. Government Accountability Office (GAO) had questioned the KC-135's long-term viability. The U.S. Department of Defense, however, responded that it could maintain

¹ Jeremiah Gertler, *Air Force KC-X Tanker Aircraft Program: Background and Issues for Congress*, Congressional Research Service, RL34398, December 7, 2009, p. 2.

² Michael Kennedy, Laura H. Baldwin, Michael Boito, Katherine M. Calef, James S. Chow, Joan Cornuet, Mel Eisman, Chris Fitzmartin, Jean R. Gebman, Elham Ghashghai, Jeff Hagen, Thomas Hamilton, Gregory G. Hildebrandt, Yool Kim, Robert S. Leonard, Rosalind Lewis, Elvira Loreda, Daniel M. Norton, David T. Orletsky, Harold Scott Perdue, Raymond A. Pyles, Timothy L. Ramey, Charles Robert Roll, Jr., William Stanley, John Stillion, Fred Timson, and John Tonkinson, *Analysis of Alternatives (AoA) for KC-135 Recapitalization: Executive Summary*, RAND Corporation, MG-495-AF, 2006, p. 3.

³ Gertler, 2009, pp. 2–3; Sean Bednarz, Anthony D. Rosello, Shane Tierney, David Cox, Steven C. Isley, Michael Kennedy, Chuck Stelzner, and Fred Timson, *Modernizing the Mobility Air Force for Tomorrow's Air Traffic Management System*, RAND Corporation, MG-1194-AF, 2012, p. 45.

⁴ Kennedy et al., 2006, p. 3.

⁵ Robert C. Owen, *Air Mobility: A Brief History of the American Experience*, University of Nebraska Press, 2013, p. 289.

the fleet through 2031.⁶ By 2001, the USAF warned that although the KC-135 fleet was “structurally viable to 2040,” it “would incur increasingly ‘significant cost increases’” to maintain.⁷ In 2002, the USAF proposed commercially leasing converted 767s—Boeing’s widebody successor to the 707—to replace the KC-135. In 2003, the USAF revised this deal to directly purchase 80 converted 767s and lease the remaining 20.⁸ In 2003, however, federal investigators learned that the Principal Under Secretary of the USAF for Acquisition had illegally aided Boeing in obtaining this deal.⁹ The USAF canceled the contract and asked RAND to undertake an analysis-of-alternatives study to determine the best path forward.

RAND researchers determined that “a fleet of new medium to large commercial derivatives is the most cost-effective” solution, identifying Boeing’s 747, 767, 787 Dreamliner, and 777 and Airbus’ A330 and A340 as all potentially suitable aircraft.¹⁰ In response, the USAF announced a request for proposal (RFP) in April 2006.¹¹ Airbus, jointly partnered with Northrop Grumman, questioned the RFP, arguing that the USAF’s RFP favored the Boeing 767. The USAF consequently adjusted the RFP in January 2007.¹² Airbus-Northrop Grumman’s A330 MRTT (Multi Role Tanker Transport) won this competition on February 29, 2008.¹³ Boeing immediately protested the selection.

GAO investigated and generally concurred with Boeing that the USAF had not fairly conducted the competition. Notably, the USAF had not “indicate[d] that any consideration would be given to by how much [the proposed aircraft] exceeded” the KC-135 performance benchmarks. This had benefited Airbus-Northrop Grumman, whose A330 MRRT was substantially larger than Boeing’s 767.¹⁴ Secretary of Defense Robert Gates vacated the decision on September 10, 2008, and ordered the USAF to pause the KC-X program so that the next administration could make a decision.¹⁵ The USAF released a fresh RFP in September 2009 for

⁶ Gertler, 2009, p. 78, fn. 70, sourced from GAO, *U.S. Combat Airpower: Aging Refueling Aircraft Are Costly to Maintain and Operate*, GAO/NSIAD-96-160, August 1996.

⁷ Gertler, 2009, p. 78, fn. 72.

⁸ John A. Tirpak, “Tanker Twilight Zone,” *Air and Space Forces Magazine*, February 1, 2004.

⁹ Owen, 2013, p. 290; and Allison Stanger, *One Nation Under Contract: The Outsourcing of American Power and the Future of Foreign Policy*, Yale University Press, 2009, p. 3; and Deborah Kidwell, “OSI’s \$615M Fraud Recovery,” Department of the Air Force Office of Special Investigations, July 30, 2020.

¹⁰ Kennedy et al., 2006, p. 1.

¹¹ Owen, 2013, p. 290.

¹² Gertler, 2009, p. 79.

¹³ GAO, *Defense Acquisitions: Assessments of Selected Weapons Program*, GAO-09-326SP, March 2009, p. 156.

¹⁴ Bruce R. Harmon, *Competition Among Near-Substitutable Systems*, Institute for Defense Analyses, NS D-4660, July 2012, pp. 14–15.

¹⁵ GAO, 2009, p. 156; and Robert M. Gates, *Duty: Memoirs of a Secretary at War*, Alfred A. Knopf, 2014, p. 248.

179 refueling tankers.¹⁶ Boeing's 767 ultimately won this competition—reaching Milestone B—on February 24, 2011, for a contract worth around \$35 billion.¹⁷

The KC-46A is designed to refuel any fixed-wing USAF aircraft capable of aerial refueling, as well as many fixed-wing aircraft of allies and partners. It provides fuel through three system types: a centerline boom modified from the KC-10; a centerline hose and drogue system; and two Wing Air Refueling Pods (WARPs), each with hose and drogue systems.¹⁸ The KC-46A can be configured in a variety of refueling, passenger, and cargo combinations through continuous tracks running through the aircraft.¹⁹

The Fixed-Price Incentive Firm Contract

The USAF awarded Boeing a contract to develop and test the first four engineering and manufacturing development (EMD) KC-46A aircraft under a Fixed-Price Incentive Firm (FPIF) contract.²⁰ The USAF contracted to pay a target price of \$4.4 billion for the EMD aircraft. Any development costs under \$4.4 billion would be covered by the USAF. Any development costs between \$4.4 billion and \$4.9 billion would be covered 60 percent by the USAF and 40 percent by Boeing.²¹ Boeing would be responsible for all research, development, testing, and evaluation (RDT&E) costs over \$4.9 billion.²² Boeing agreed to the deal, hedging that it could recoup any KC-46A RDT&E costs through foreign sales.

The USAF selected an FPIF EMD contract to limit the taxpayer's liability in a major defense acquisition program that had already proven controversial. The USAF believed that an FPIF EMD contract would incentivize Boeing to minimize development issues, especially with a proven commercial aircraft design.²³ An FPIF contract was additionally awarded for KC-46A

¹⁶ Owen, 2013, p. 290.

¹⁷ Jeremiah Gertler, *Air Force KC-46A Pegasus Tanker Aircraft Program*, Congressional Research Service, RL34398, April 21, 2020, p. 1.

¹⁸ Duke Z. Richardson, *Selected Acquisition Report (SAR): KC-46A Tanker Modernization (KC-46A)*, U.S. Department of Defense, DD-A&T(Q&A)823-387, March 22, 2016, p. 6.

¹⁹ Richardson, 2016, p. 6.

²⁰ For a relatively contemporaneous example of the use of an FPIF, see Sandra I. Erwin, "Army Truck Program a Test Case for Cutting Costs, and Profits," *National Defense*, Vol. 96, No. 694, September 2011, pp. 23–24. Also see Andrew Hunter, *Transforming the Business Model for Defense Research and Development*, Center for Strategic and International Studies, 2016, p. 2; and Thomas Light, Robert S. Leonard, Meagan L. Smith, Akilah Wallace, and Mark V. Arena, *Benchmarking Schedules for Major Defense Acquisition Programs*, RAND Corporation, RR-2144-AF, 2018, p. 21.

²¹ Garrett Reim, "USAF Explains Why Fixed-Price Contract Caused Problems for Boeing KC-46A Tanker," *FlightGlobal*, February 26, 2021.

²² Valerie Insinna, "Boeing's Cost Overruns on KC-46 Now Exceed Initial Contract with US Air Force," *Defense News*, January 27, 2021a.

²³ Frank Kendall, "KC-46 Tanker Problems Call for a Rethink of Fixed-Price Development Programs," *Forbes*, March 31, 2020.

low-rate initial production (LRIP) lots one and two, and not-to-exceed contracts (“with economic price adjustment”) for lots three through 13 of full production.²⁴ Boeing stated it could deliver the first 18 LRIP aircraft with amended and supplemental FAA certifications in August 2017, with military certification to follow.²⁵

Debate continues over whether the FPIF contract is more beneficial than cost-based contracts. Historically, the pendulum has swung back and forth between the two contracting approaches.²⁶ It is too early to tell whether the USAF will pursue FPIF contracts in future MCDA projects. Although the FPIF contract undoubtedly saved the taxpayer \$5 billion in the development of the KC-46A, it left Boeing to pay the bill. Questions remain about whether it is a good strategy to place so much of the financial burden on the industrial base. Air Force Secretary Frank Kendall has suggested that a cost-plus contract places most of the development overrun risk on the USAF, which may allow it to “direct the contractor to take prudent risk reduction steps and potentially avoid costly mistakes.”²⁷ Furthermore, as previous RAND research has found, the USAF historically has not saved money in FPIF contracts over cost-based contracts: “Sooner or later, through one mechanism or the other, the government has ended up paying for much of the cost growth originally absorbed by the contractor.”²⁸

²⁴ Richardson, 2016, pp. 8–9.

²⁵ U.S. Department of Defense Inspector General, *Evaluation of the Air Force Systems Engineering Process Used in the Development of the Refueling Boom for the KC-46 Tanker*, U.S. Department of Defense, DODIG-2021-088, May 21, 2021, p. 1.

²⁶ Laura Baldwin, Mark Lorell, and Obaid Younossi, “RAND Finds Little Hope Fixed Price Deals Control Costs,” *Breaking Defense*, September 16, 2015.

²⁷ Kendall, 2020.

²⁸ Baldwin, Lorell, and Younossi, 2015.

Chapter 2. FAA Certification

The USAF sought to obtain FAA certifications for as many KC-46A components as possible. They desired FAA certification to access the global 767 parts and upgrades pool, increase the aircraft platform's safety threshold,²⁹ and use the "maintenance and training data needed for sustainment that have been validated and verified by the commercial industry."³⁰ In theory, accessing the global 767 parts and data pool would release the USAF from relying solely on the original equipment manufacturer (OEM), Boeing, long after the company had stopped 767 production, as the USAF generally uses aircraft types far longer than commercial airlines. However, because the USAF depots will not be FAA certified, combined with the perception that USAF-used aircraft parts experience greater wear and tear than their commercial counterparts, the USAF will not be able to return parts to the global 767 parts pool unless they have been certified in an FAA Part 145–approved facility.³¹

The USAF sought FAA certification for as many KC-46A components as possible, exceeding the extent of any previously heavily modified MCDA. The USAF hoped that by doing this, it would allow the USAF to access a significantly greater portion of the global 767 parts pool, upgrades, and experiential and maintenance knowledge.³² Because the USAF cannot return parts to the parts pool, it does not participate in, or contribute to, the global parts pool. However, the USAF can use any supplier that meets FAA certification requirements. Like the KC-10,³³ the USAF also intended to maintain FAA certification throughout the KC-46A's life cycle to ensure access to the global parts pool for as long as possible.³⁴

FAA certification for the KC-46A required two steps. First, a modified version of the 767, the 767-2C, was to be constructed on the 767-400 freighter line at Boeing's assembly plant in Renton, Washington. This version incorporated the 767-400 flight deck, the 787 Rockwell-Collins glass cockpit, the 767-200 fuselage, the 767-300 landing gear, and a freighter cargo door and floor. After successful testing and analysis of the 767-2C, the FAA would award an amended type certificate. Boeing would then move the 767-2C to its own "finishing center" for the 767-

²⁹ Program office official, interview with the authors, May 26, 2022.

³⁰ GAO, *KC-46 Modernization: Aircraft Delivery Has Begun, but Deficiencies Could Affect Operations and Will Take Time to Correct*, GAO-19-480, June 2019, p. 5.

³¹ Air Force Life Cycle Management Center, "AFLCMC Leadership Log Episode 67: KC-46 Pegasus Sustainment," video, December 17, 2021.

³² GAO, 2019, p. 5.

³³ GAO, *Weapon System Sustainment: Aircraft Mission Capable Rates Generally Did Not Meet Goals and Cost of Sustaining Selected Weapon Systems Varied Widely*, GAO-21-101SP, November 2020, p. 32.

³⁴ Levi Almond, "EWI Fellow Participates in Boeing KC-46A Planning Meetings," Air Force Institute of Technology, January 8, 2019.

2C's final conversion into the KC-46A.³⁵ This would include installing the external refueling systems, including the centerline boom,³⁶ hose and drogue systems, WARPs, a new remotely controlled operator refueling system with three-dimensional vision, and classified and unclassified military hardware and software.³⁷ The FAA would then test and provide a supplemental type certificate for the KC-46A, including for all of the refueling and most of the military components.³⁸ Once the EMD aircraft had been handed over to the USAF, it would test the aircraft for military certification. Boeing sought to accelerate the certification process by parallelly conducting the FAA's amended and supplemental type certification processes.³⁹ In both amended and supplemental instances, FAA certification required that the plane meet Part 121 requirements—normal for commercial aircraft—that prioritized safety to pass its airworthiness standards instead of needing to meet military specifications.

Boeing and the USAF intended that FAA certification would not slow down the EMD process; rather, they hoped it would accelerate it, given that many systems (such as the Rockwell Collins glass cockpit) were already FAA certified from commercial Boeing aircraft.⁴⁰ However, Boeing's proposed timeline would prove to be too ambitious. A 2011 Office of the Director, Operational Test and Evaluation (DOT&E) analysis predicted that the timeline Boeing proposed for the EMD process was "not executable" for several reasons. The DOT&E analysis articulated that the proposed 42 test hours per month was not achievable given historical military aircraft testing rates of under 30 hours per month.⁴¹ According to the proposed plan, there would be little time to address issues or deficiencies if they arose during this proposed timetable.⁴² The DOT&E

³⁵ Stew Magnuson, "Boeing, Air Force Turn Page on Controversial Tanker Program," *National Defense*, Vol. 97, No. 709, December 2012, p. 24.

³⁶ Gareth Jennings, "KC-46 Tanker Passes Key Design Milestone," *Jane's Defence Weekly*, May 10, 2012.

³⁷ GAO, 2019, p. 6; and GAO, *KC-46 Tanker Aircraft: Program Generally on Track, but Upcoming Schedule Remains Challenging*, GAO-14-190, April 2014, p. 4.

³⁸ GAO, 2019, p. 5.

³⁹ Christopher C. Bogdan, testimony before the Subcommittee on Seapower and Projection Forces of the Committee on Armed Services, House of Representatives, 112th Congress, 1st Session, hearing on the Update on KC-46A and Legacy Aerial Refueling Aircraft Programs, U.S. Government Printing Office, October 13, 2011, pp. 9–10.

⁴⁰ Shay Assad, testimony before the Subcommittee on Seapower and Projection Forces of the Committee on Armed Services, House of Representatives, 112th Congress, 1st Session, hearing on the Update on KC-46A and Legacy Aerial Refueling Aircraft Programs, U.S. Government Printing Office, October 13, 2011, p. 8.

⁴¹ DOT&E, "Air Force Programs: KC-46A," 2011. For similar concerns, see Bogdan, 2012, pp. 9–10.

⁴² Also see GAO, *KC-46 Tanker Aircraft: Acquisition Plans Have Good Features but Contain Schedule Risk*, GAO-12-366, March 2012, p. 15.

concluded that a 2017 delivery schedule was unfeasible, and GAO agreed with this concern.⁴³ Boeing replied that it was “confiden[t]” it would meet the KC-46A’s “cost and time targets.”⁴⁴

Complexities and Setbacks Lengthened Certification Process

Complexities began soon after Boeing was awarded the KC-46A contract in February 2011. In September 2011, Boeing announced that more than 800 subcontractors would provide parts for the KC-46A.⁴⁵ This included both established U.S. aerospace companies, such as General Electric Aviation Systems and Honeywell, as well as such foreign suppliers as British-based Cobham.⁴⁶ Nearly all of these subcontractors would provide components that would need to be FAA certified. Although many subcontractors were familiar with FAA certification practices, some providers—such as Cobham—were not, which is an issue discussed later in this report.

The KC-46A passed its preliminary design review in May 2012.⁴⁷ However, in January 2013, the DOT&E determined that Raytheon’s ALR-69A radar early warning system failed to adequately “distinguish between friend and foe in the air.”⁴⁸ This issue was presumably resolved by September 2019, when Boeing ordered 111 additional ALR-69As to complement the 50 it already possessed for the KC-46A.⁴⁹

Boeing began building its first 767-2C in June 2013.⁵⁰ The aircraft entered its critical design review (CDR) on July 18, 2013; review was successfully completed on September 4 of the same year; and Boeing conducted the first 767-2C test flight at the end of September.⁵¹ Completion of the KC-46A’s CDR effectively “locked in” the “integration, verification, and production” designs.⁵²

⁴³ GAO, 2012, p. i.

⁴⁴ Caitlin Harrington Lee, “USAF Tanker Programme Set to Meet Cost and Time Targets,” *Jane’s Defence Weekly*, August 30, 2011.

⁴⁵ It is normal for major aircraft programs to have hundreds or even thousands of subcontractors. See, for instance, David Slotnick, “Boeing’s Move to Halt 737 Production Could Hurt the 600 Suppliers That Make Parts for the Plane Despite Its Promise Not to Cut Its Own Workforce,” *Business Insider*, December 17, 2019.

⁴⁶ Marina Malenic, “Boeing Announced KC-46 Tanker Suppliers,” *Jane’s Defence Weekly*, June 23, 2011.

⁴⁷ “KC-46A Preliminary Design Review Completed,” *Air Force Magazine*, May 10, 2012.

⁴⁸ Caitlin Lee, “Pentagon Testers: KC-46 Could Suffer Radar, Integration Issues,” *Jane’s Defence Weekly*, January 17, 2013a.

⁴⁹ Military and Aerospace Electronics, “KC-46 to Be Outfitted with New All-Digital Radar Warning Receivers,” September 24, 2019.

⁵⁰ Gareth Jennings, “Boeing Begins KC-46A Build,” *Jane’s Defence Weekly*, June 27, 2013a.

⁵¹ Gareth Jennings, “KC-46A Tanker CDR Initiated,” *Jane’s Defence Weekly*, July 23, 2013b; Caitlin Lee, “USAF, Boeing Complete KC-46 Critical Design Review,” *Jane’s Defence Weekly*, September 5, 2013b; and Jon Harper, “KC-46 Tanker Program Contract in Jeopardy,” *National Defense*, Vol. 100, No. 744, November 2015, p. 11.

⁵² Lee, 2013a.

However, technical issues soon slowed down the KC-46A EMD FAA certification process. In September 2014, FAA and Boeing officials discovered that up to 45 percent of the KC-46A's 1,700 "wiring bundles" were installed too close to redundancy wiring bundles required in case the primary bundles were damaged or otherwise failed to properly function.⁵³ This safety issue meant that the FAA could not certify the 767-2C's wiring and threatened to derail Boeing's and the USAF's desire for the aircraft to reach Milestone C, permitting LRIP, within six months and reaching the 2017 delivery goal.⁵⁴

As a result, in October 2014, Boeing "revise[d] its development schedule" to account for the delays, but still expected to deliver 18 LRIP KC-46As by August 2017.⁵⁵ However, the USAF received this schedule with some skepticism. Gen Ellen Pawlikowski, (Ret.), then the Military Deputy at the Office of the Assistant of the Air Force for Acquisition, argued that the wiring issue, along with broader slower-than-expected integration and testing of components, had "eaten away the margin for delays."⁵⁶ Boeing paid approximately \$272 million out of its own pocket to pay for the rewiring.⁵⁷ The USAF estimated that Boeing would ultimately be hit with a \$1 billion overrun bill.⁵⁸ The KC-46A with all military modifications missed its initial planned air worthiness test flight date, scheduled for April 2014.⁵⁹ The first KC-46A instead undertook its first flight in September 2015.⁶⁰

That same year, the FAA also found issues with the WARPs—then under construction by Cobham. Specifically, they determined that the two systems had not been developed according to FAA processes. The FAA informed Cobham that it would "need to inspect the individual parts" to provide certification.⁶¹ In late 2014, Cobham admitted that there was a fundamental "design flaw" within the WARPs, pushing FAA certification for them to at least July 2017.⁶² To help

⁵³ GAO, *KC-46 Tanker Aircraft: Challenging Testing and Delivery Schedules Lie Ahead*, GAO-16-346, April 2016, p. 6.

⁵⁴ Malenic, 2011.

⁵⁵ Marina Malenic, "Boeing to Revise KC-46A Schedule, but Key USAF Milestones Unchanged," *Jane's Defence Weekly*, October 22, 2014.

⁵⁶ Marina Malenic, "Further Tanker Schedule Slips Could Derail Key Milestones, Says USAF," *Jane's Defence Weekly*, November 20, 2021; and USAF, "General Ellen M. Pawlikowski," webpage, September 2018.

⁵⁷ Valerie Insinna, "Boeing Under Mounting Pressure to Deliver New Tanker," *National Defense*, Vol. 99, No. 736, March 2015, p. 19.

⁵⁸ Insinna, 2015, p. 19.

⁵⁹ Marina Malenic, "First KC-46A Test Aircraft Resume Air Worthiness Flights," *Jane's Defence Weekly*, June 3, 2015a.

⁶⁰ Charles Ramey, "Boeing, U.S. Air Force Aircrews Make History with First KC-46A Tanker Refueling Flight," Boeing, January 26, 2016.

⁶¹ Marina Malenic, "USAF Awards First KC-46A Production Contract," *Jane's Defence Weekly*, August 19, 2016c.

⁶² GAO, 2016, pp. 10–11.

move the program along, the FAA permitted Boeing to continue testing the KC-46A while still pending FAA approval for the Cobham subsystems.⁶³

In July 2015, FAA and Boeing officials identified issues with the KC-46A's integrated fuel system, necessitating \$536 million in repairs to meet FAA certification standards.⁶⁴ The first fully converted KC-46A undertook its first air worthiness flight on September 25, 2015. On January 24, 2016, it successfully refueled an F-16 *Fighting Falcon* with its centerline boom.⁶⁵ The KC-46A used Rockwell Collins' Remote Vision System (RVS) to refuel the aircraft, with the operator using a three-dimensional visualization system from the cockpit.⁶⁶ This constituted a departure from the KC-135 and KC-10, where the operator, laying down (in the KC-135) or sitting (in the KC-10) in the rear of the aircraft, would manually maneuver the centerline boom into position.

Another issue, however, was soon revealed: Some aircraft could not meet a "higher-than-expected" *axial load*, or the pressure required to activate the boom's refueling function. This higher-than-expected axial load requirement could result in the boom striking as the plane accelerated to activate fuel flow and potentially damaging the aircraft being refueled, including scraping radar-absorbing coatings.⁶⁷ Boeing sought to mitigate the issue with software changes and, in June 2016, added a new bypass valve based on the type used in the KC-10,⁶⁸ but the boom axial load continued to be an issue.⁶⁹ Boeing also admitted that LRIP delivery would now begin in January 2018 at the earliest.⁷⁰ At this point, Boeing had spent an additional \$1.3 billion to \$1.5 billion developing the KC-46A.⁷¹ Later tests revealed similar axial load issues with refueling the C-17 heavy lift aircraft and A-10 *Warthog* ground attack aircraft.⁷²

The USAF authorized LRIP for the KC-46—passing it through the Milestone C stage—on August 12, 2016, while the aircraft awaited FAA certifications and awarded two LRIP lots

⁶³ GAO, 2016, pp. 10–11.

⁶⁴ Marina Malenic, "Boeing to Take Second Major Change for USAF Tanker 'Rework,'" *Jane's Defence Weekly*, July 20, 2015b.

⁶⁵ Marina Melanic, "AFA 2015: KC-46 First Flight Back on Schedule," *Jane's Defence Weekly*, September 16, 2015c.

⁶⁶ Defense Industry Press Releases, "Rockwell Collins Technology Aids in Historic First KC-46A Tanker Refueling Flight," *Jane's Defence Weekly*, January 26, 2016.

⁶⁷ U.S. Department of Defense Inspector General, 2021, pp. 5, 11.

⁶⁸ Marcus Weisgerber, "Here's How Boeing Aims to Fix Its Broken Tanker," *Defense One*, June 8, 2016; Charles Forrester, "Farnborough 2016: Boeing Outlines Fix for KC-46 Refueling Boom Issues," *Jane's Defence Weekly*, July 20, 2016.

⁶⁹ U.S. Department of Defense Inspector General, 2021, p. 6; and Marina Malenic, "KC-46A Refuels C-17, F-16 with Re-Engineered Boom," *Jane's Defence Weekly*, July 13, 2016a.

⁷⁰ Malenic, 2016a.

⁷¹ Malenic, 2016a; and Mark F. Cancian, *U.S. Military Forces in FY 2017: Stable Plans, Disruptive Threats, and Strategic Inflection Points*, Center for Strategic and International Studies, 2016, p. 38.

⁷² Valerie Insinna, "Boeing Rakes in \$2.8B Contract for First Two KC-46 Lots," *Defense News*, August 18, 2016.

totaling \$2.8 billion.⁷³ In January 2017, the USAF awarded Boeing a third lot for an additional 15 KC-46As for \$2.9 billion.⁷⁴ KC-46A program office officials remained skeptical that Boeing would achieve its “test completion rate until it obtains FAA approval for the design of all the parts, including pods.”⁷⁵ By April 2017, Gen Darren McDew, then Director of the U.S. Transportation Command, acknowledged that he believed that LRIP delivery would not likely begin until 2020.⁷⁶ Boeing, however, argued that LRIP delivery could still occur beginning 2018.⁷⁷

On September 22, 2017, Brig Gen Donna Shipton, then Program Executive Officer for Tankers, suggested KC-46A deliveries would be delayed. This was “solely related to Boeing’s challenges achieving FAA certification.”⁷⁸ In 2017, DOT&E identified another issue with the centerline boom refueling system. Under certain weather and lighting conditions, the RVS could provide false visual information, resulting in the operator missing the receptacle of the aircraft to be refueled and potentially causing damage. The image also became blurry at around one foot away from the aircraft to be refueled, further escalating the chance of a scrape.⁷⁹ The GAO report noted these issues were “especially problematic” for aircraft such as the F-22 *Raptor* with “radar-absorbing coatings.”⁸⁰ It is likely that Boeing had rushed testing of RVS 1.0 to meet delivery targets and stop spiraling out-of-pocket costs.⁸¹

The FAA nonetheless awarded an amended type certificate for the 767-2C on December 21, 2017, after “verifying [that] the fundamental design of the tanker is safe.”⁸² Despite achieving this milestone, USAF officials estimated that the first LRIP aircraft would not be delivered until

⁷³ Marina Malenic, “Pentagon Clears New USAF Tanker for Production,” *Jane’s Defence Weekly*, August 15, 2016b.

⁷⁴ Pat Host, “US Air Force Awards Boeing USD 2.9 Billion for Fourth KC-46 Production Lot,” *Jane’s Defence Weekly*, September 12, 2018f.

⁷⁵ Jon Harper, “Estimated Cost of KC-46 Tanker Coming Down,” *National Defense*, Vol. 101, No. 762, May 2017, p. 16.

⁷⁶ Gareth Jennings, “Pentagon Leadership ‘Losing Sleep’ over Aerial Tanker Shortfall,” *Jane’s Defence Weekly*, April 4, 2017.

⁷⁷ Pat Host, “Boeing KC-46 Tanker Test Aircraft Takes Second Flight,” *Jane’s Defence Weekly*, May 4, 2017a.

⁷⁸ Pat Host, “US Air Force Expecting KC-46 Tanker Deliveries in Spring 2018,” *Jane’s Defence Industry*, September 25, 2017b; GAO, 2019, p. 24.

⁷⁹ Thomas Newdick, “KC-46A’s Long-Troubled Vision System Can’t Even Reliably Show the End of the Refueling Boom,” *The Drive*, May 27, 2021.

⁸⁰ GAO, *KC-46 Modernization: Program Cost Is Stable, but Schedule May Be Further Delayed*, GAO-18-353, April 2018, p. 9; and Yasmin Tadjdeh, “Boeing Looks to Put KC-46 Tanker Woes Behind It,” *National Defense*, Vol. 103, No. 776, July 2018, pp. 22–23.

⁸¹ GAO, *KC-46 Tanker: Air Force Needs to Mature Critical Technologies in New Aerial Refueling System Design*, GAO-22-104530, January 2022, pp. 21–22.

⁸² Charlsy Panzino, “KC-46 Refueling Tanker Receives One of Two FAA Certifications,” *Air Force Times*, January 3, 2018.

at least the end of 2018.⁸³ Boeing also continued to reconfigure EMD KC-46As with revised wiring bundles.⁸⁴ In April 2018, GAO assessed that Boeing still needed to fix wiring, software, and refueling systems in order for the KC-46A to receive its FAA supplemental type certificate and be handed over to the USAF to begin the military certification process.⁸⁵ In particular, it highlighted continuing issues with the WARPs. Cobham and its subcontractors had spent four years redesigning the WARPs and completing the required FAA documentation. Boeing had even sent some of its own experts to Cobham in an attempt to accelerate the process and predicted that the issue would soon be resolved.⁸⁶ Boeing was also still failing to achieve its optimistic rate of flight hours per month toward certification.⁸⁷

Boeing achieved a key milestone in April 2018, when the KC-46A demonstrated it could receive fuel from another KC-46A, a KC-135, or a KC-10.⁸⁸ Nevertheless, on April 28, 2018, Air Force Secretary Dr. Heather Wilson informed the Senate Armed Services Committee that “Boeing[’s schedule] . . . is overly ambitious and we’d like to get an agreement on a delivery date and drive to that delivery date.”⁸⁹

Boeing completed required supplemental type certification testing in late April 2018 and submitted its data to the FAA for review.⁹⁰ Nevertheless, in May 2018 the OEM admitted that the KC-46A would be delivered to the USAF separately from the WARPs, as Boeing and Cobham continued to complete the pods’ redesign and required paperwork.⁹¹ The FAA granted the KC-46A its supplemental type certificate on September 4, 2018.⁹² But it still needed to pass military type certification.⁹³

Despite FAA supplemental type certification (with the exception of the WARPs), several issues continued to plague the KC-46A as the USAF began its military type certification review.

⁸³ Pat Host, “US Air Force Expects Another KC-46 Delivery Delay,” *Jane’s Defence Weekly*, March 7, 2018a.

⁸⁴ Pat Host, “Boeing to Produce First KC-46 Without Post-Build Modifications Later This Month,” *Jane’s Defence Weekly*, May 10, 2018d.

⁸⁵ GAO, 2018, p. 10.

⁸⁶ GAO, 2018, p. 10.

⁸⁷ GAO, 2018, pp. 11–12.

⁸⁸ Charles Ramey, “Boeing KC-46 Tanker Program Completes Fuel On-Load Certification Testing,” Boeing, April 4, 2018a.

⁸⁹ Pat Host, “US Air Force, Boeing Remain Out of Sync on KC-46 Delivery Date,” *Jane’s Defence Weekly*, April 25, 2018b.

⁹⁰ Courtney E. Howard, “Boeing KC-46 Tanker Program Completes Flight Tests, Awaits FAA Certification,” *Military and Aerospace Electronics*, April 27, 2018.

⁹¹ Pat Host, “Boeing’s Caret Vows Delivery of 18 KC-46s, and Wing Aerial Refueling Pods, in 2018,” *Jane’s Defence Weekly*, May 4, 2018c.

⁹² Charles Ramey, “Boeing KC-46 Tanker Program Completes FAA Certification,” Boeing, September 4, 2018b; and Greg Waldron, “Boeing KC-46 Attains FAA Supplemental Type Certificate,” *FlightGlobal*, September 5, 2018.

⁹³ Pat Host, “KC-46 Achieves US FAA Certification,” *Jane’s Defence Weekly*, September 7, 2018e.

Despite Boeing's software and hardware efforts, the boom axial load still presented a dangerous problem for certain military aircraft, notably the F-16 and A-10. Boom strikes could also damage the radar-absorbing coating on the F-22 and F-35 *Lightning II*. The USAF was also still experiencing difficulties with the RVS system. Under certain lighting and weather conditions, the RVS image could become washed out or distorted, impairing the operator's ability to maneuver the boom and potentially damaging the aircraft to be refueled. Even with these Category 1 issues,⁹⁴ the USAF, in need of new aerial refueling tankers, "conditionally accepted" its first KC-46A on January 10, 2019.⁹⁵ The USAF did not expect the KC-46A to reach minimum required assets available status until 2020 however. In particular, the KC-46As that were being delivered arrived without their WARPs because they still required FAA certification.⁹⁶

Boeing admitted in January 2019 that the KC-46A's RVS system would require substantial "hardware and software upgrades" to be fully usable. In another report, GAO suggested that Boeing knew the RVS technologies were immature when they had entered the USAF's preliminary design review.⁹⁷

As Boeing began to fix the RVS system, the USAF invoked a purchase clause to withhold \$26.5 million to \$28 million per aircraft until the RVS issue was resolved. The production withhold addressed the 201 military specification noncompliances associated with delivered aircraft.⁹⁸ Meanwhile, Cobham agreed to pay \$207 million in damages to Boeing for ongoing losses associated with the WARP system. Cobham also admitted that the WARP testing program would not be completed until at least 2020.⁹⁹

The centerline boom axial load, WARP, and RVS issues continued into 2020. At a House Armed Services Committee meeting on March 11, 2020, Lt Gen David S. Nahom, then Deputy Chief of Staff for Air Force Plans and Programs, admitted that it would take three to four years

⁹⁴ A *Category 1 issue* means that "the government has identified risk that jeopardizes lives or critical assets." See Lee Hudson, "Refueling Revisited," *Aviation Week & Space Technology*, February 24–March 8, 2020, p. 43.

⁹⁵ Sebastian Roblin, "The Air Force's New KC-46 Pegasus Tanker Has a Problem: It Could 'Unstealth' a Bomber," *National Interest*, January 11, 2019; GAO, 2019, p. 11.

⁹⁶ Valerie Insinna, "Air Force Secretary Confirms Key KC-46 Milestone Won't Occur Until 2020," *Defense News*, January 25, 2019.

⁹⁷ GAO, 2022, pp. 21–22.

⁹⁸ Pat Host, "Boeing Eyes 'Rather Significant' KC-46A Remote Vision System Upgrade," *Jane's Defence Weekly*, January 25, 2019.

⁹⁹ Beth Stevenson, "Cobham and Boeing Settle on Damages for Delays in KC-46 Programme," *Jane's Defence Weekly*, February 20, 2019.

to properly fix all systems and achieve certifications for them.¹⁰⁰ In late March, a fuel tank leak issue arose, hampering the military type certification process.¹⁰¹

In April 2020, the USAF and Boeing finally agreed on a deal for Boeing to develop RVS 2.0 to completely replace RVS 1.0. Boeing would continue to provide “incremental improvements to software and hardware” for RVS 1.0, known as “enhanced RVS,”¹⁰² while RVS 2.0 was undergoing development. The new RVS would constitute “new color cameras, advanced displays[,] and improved computer technology.” Under the terms of the FPIF contract, Boeing would be held entirely liable for the costs of developing RVS 2.0, although this deal would change in 2022.¹⁰³ In return, the USAF would release funds totaling \$882 million it had withheld on KC-46As Boeing had so far delivered.¹⁰⁴

The USAF also agreed to pay \$100 million to redesign the centerline boom to fix the axial load problem.¹⁰⁵ The USAF assumed responsibility for this charge because it had provided the specifications for each receiver aircraft to Boeing using boom technologies used on the KC-10 and the control laws of the Italian and Japanese versions of the KC-46A,¹⁰⁶ which both parties later determined to be what the Congressional Research Service termed “unsuitable.”¹⁰⁷ In 2011, the Assistant Secretary of Defense for Research and Engineering had determined that the refueling boom was not a “critical technology” because “no new or novel technology” had been used.¹⁰⁸ Therefore, they did not require additional testing to ensure its operational compliance with the KC-46A.¹⁰⁹ Retrofitting will not begin until 2024, limiting the KC-46A’s utility for up to five years, according to the U.S. Department of Defense Inspector General.¹¹⁰ For its part, Boeing assumed at least \$5 billion in development costs for the KC-46A.¹¹¹

¹⁰⁰ David S. Nahom, testimony before the Subcommittee on Seapower and Projection Forces, Subcommittee on Readiness of the House Armed Services Committee, House of Representatives, hearing on the Sealift and Mobility Requirements in Support of the National Defense Strategy, March 11, 2020, p. 4.

¹⁰¹ Kyle Mizokami, “Boeing’s Troubled K-46 Tanker Aircraft Can’t Catch a Break,” *Popular Mechanics*, April 1, 2020.

¹⁰² Gareth Jennings, “USAF to Field Interim ERVS Solution for KC-46 Tanker,” *Jane’s Defence Weekly*, December 7, 2020.

¹⁰³ Valerie Insinna, “Done Deal: Boeing Will Have to Rip and Replace KC-46 Sensor and Camera Systems On Its Own Dime,” *Defense News*, April 2, 2020.

¹⁰⁴ Gertler, 2020, p. 1.

¹⁰⁵ U.S. Department of Defense Inspector General, 2021, p. ii.

¹⁰⁶ U.S. Department of Defense Inspector General, 2021, p. 11; and Newdick, 2021.

¹⁰⁷ Gertler, 2020, p. 3.

¹⁰⁸ U.S. Department of Defense Inspector General, 2021, p. 11.

¹⁰⁹ U.S. Department of Defense Inspector General, 2021, p. 11.

¹¹⁰ U.S. Department of Defense Inspector General, 2021, p. ii.

¹¹¹ Garrett Reim, “Boeing Takes \$67M Loss on KC-46 Tanker, but Sees Reason for Optimism,” *FlightGlobal*, October 28, 2020.

The WARPs remained non-FAA certified at the time of writing in February 2023. Full FAA part and military certifications are pending while RVS 2.0, the boom, and the WARPs are reengineered. The KC-46A, therefore, cannot be used in active operational conditions.¹¹² It is expected that the KC-46A will receive full military certification in 2024 on receipt and testing of RVS 2.0, the fixed centerline boom, and WARPs.¹¹³ In the interim, the USAF has issued a series of incremental capabilities releases to permit use of the centerline hose and drogue system in all weather conditions.

In 2021, the USAF issued an incremental capabilities release to certify the KC-46A to refuel using the centerline boom, “[w]ith varying conditions” and restrictions, on “the B-52, C-17, F-15, F-16, F-35A, HC/MC-130J, E-3G, C-5M, RC/TC-135, F-22, B-1B, and KC-46A.”¹¹⁴ Restrictions apply, in particular, to the F-22 and F-35 that possess low radar signature paint and remains susceptible to damage if the centerline boom axial load does not work properly and strikes the aircraft.¹¹⁵ By the end of 2021, the USAF was expected to have received 60 KC-46As.¹¹⁶ According to GAO, the new centerline boom is expected to be installed on new aircraft; retrofitting on existing aircraft will begin in 2025.¹¹⁷ RVS 2.0 passed its preliminary design review in April 2022. Under a revised deal, Boeing will pay for the engineering, development, and certification testing of new panoramic sensor units, and the USAF will pay to procure the units and retrofit delivered aircraft.¹¹⁸ The FAA will then need to certify the RVS 2.0 system.

Lessons from the FAA Certification Experience

The USAF sought to obtain FAA certification for as many KC-46A components as possible to maximize its ability to obtain parts in the sizeable global 767 parts pool; Boeing has built more than 1,000 767s since its maiden flight in 1978.¹¹⁹ It additionally sought to receive FAA certification on as many KC-46A components as possible to obtain greater data rights, a topic that is explored in more detail in the following section.

¹¹² Brian W. Everstine, “Air Mobility Command to Start Integrating KC-46 into Limited Operations,” *Air Force Magazine*, February 24, 2021.

¹¹³ Theresa Hitchens, “KC-46: Baby Steps to Wider Availability for Operators,” *Breaking Defense*, August 6, 2021; DOT&E, “KC-46A Pegasus,” in *FY 2022 Annual Report*, January 2023, pp. 281–284.

¹¹⁴ Hitchens, 2021.

¹¹⁵ Hitchens, 2021.

¹¹⁶ Valerie Insinna, “Despite Growing Pains, KC-46 Tanker Will Begin ‘Limited Operations,’” *Defense News*, February 24, 2021b.

¹¹⁷ GAO, 2022, p. 12.

¹¹⁸ Brian Everstine, “KC-46 Software Enhancement Stalls as USAF Plans New Camera System,” *Aviation Week*, June 9, 2022.

¹¹⁹ Boeing, “767 Commercial Transport: Historical Snapshot,” webpage, undated.

Boeing set an ambitious timeline for fulfilling the FAA certification process. It set a success-oriented strategy that did not account for unforeseeable risks and problems. But issues with wiring and military components slowed down the FAA certification process. The large base of roughly 800 suppliers producing parts and documentation that needed to meet stringent FAA safety-led certification standards also proved problematic. Several subcontractors, notably Cobham, demonstrated that they possessed little understanding of FAA standards, thresholds, processes, or documentation. They took years to revamp such mission critical systems as the WARPs, ultimately delaying FAA amended and supplemental type certification. This experience shows that it can be difficult for new vendors to integrate FAA certification practices. Cobham was bringing in a 40-year-old design with the WARPs' subsystem, which carried the risk of not being able to find the documentation and artifacts required for FAA certification. Hindsight has shown this could not be accomplished; much of the design and test documentation had to be reaccomplished. This drove the delay in the FAA Supplemental Type Certification timeline.

Delays with suppliers, combined with Boeing's overly optimistic EMD timetable, resulted in a KC-46A that was delivered to the USAF three years late and with several outstanding Category 1 deficiencies, limiting the platform's operational utility. As the USAF considers the KC-Y aerial refueling platform, it should ensure that the OEM and subcontractors set realistic timelines for FAA certification at the beginning of the life cycle process and account for potential issues, as failure to do so can result in expensive delays.

Similarly, the USAF presumed that mildly modifying existing military aircraft parts, notably the centerline boom originating from the KC-10, would not present significant difficulties since they had been operationally tested. They therefore presumed that the modified technology was more mature than it was. In fact, the USAF was forced to pay for redesigning the centerline boom because they had provided Boeing with unsuitable specifications for each receiver aircraft, resulting in Boeing developing a centerline boom with axial load requirements that were too high for such aircraft as the F-16 and A-10.¹²⁰ Going forward, the USAF should recognize that transferring existing technologies and control laws between seemingly similar-use aircraft may present complexities. More broadly, early discussions between parties can help shape program development, goals, expectations, and prepare to take advantage of MCDA FAA certification benefits and timelines.

¹²⁰ Gertler, 2020, p. 3.

Chapter 3. Data Rights

FAA certification can help mitigate the OEM's efforts to impose what the Institute for Defense Analyses (IDA) has described as *vendor lock*, where the OEM can charge potentially exorbitant fees for sustainment, modification, and/or upgrades over the aircraft life cycle.

The federal government requires that the OEM provide the client with “unlimited rights” to technical data that ‘relates to form, fit, or function [FFF] or technical data that is necessary for operation, maintenance, installation, and training [OMIT].’¹²¹ FAA certification, however, also requires that the OEM provide additional “flight worthiness data” to commercial operators “for collective use,” including by third parties. Flight worthiness data, however, is not defined. This opens some life cycle sustainment up for competition or to be filled by organic capabilities.¹²² That being said, the OEM can still retain considerable control over data rights that do not fall under these three categories. Furthermore, the USAF and Boeing disagree as to what constitutes OMIT, FFF, and “additional air worthiness” data.

The USAF did not wish to repeat the data rights mistakes of the U.S. Navy's P-8A *Poseidon* early warning maritime patrol aircraft program.¹²³ In 2004, the Navy had awarded Boeing an LRIP contract for the P-8A with a plan ultimately to purchase 109 aircraft (later expanded to 138 aircraft).¹²⁴ The Navy did not seek FAA certification for the P-8A. The IDA investigation determined that the Navy was unable to secure almost any data rights beyond the legally required FFF and OMIT data because it did not seek to negotiate additional data rights during the contracting process. IDA concluded that

[t]he failure to include IP [intellectual property] data deliverables and rights in the initial competitively awarded development contract has been a major impediment to the Navy's ability to provide organic depot maintenance and competition in sustainment for the system. Even basic OMIT and FFF data appear to be limited. . . . In addition, FRC-SE [Fleet Readiness Center-Southeast] personnel stressed that OMIT and FFF data were insufficient for some repairs, such as a ‘broken wing root, which required design data.’¹²⁵

¹²¹ U.S. Code, Title 10, Section 2320, Rights in Technical Data; Frank Camm, Philip Carter, Sheng Tao Li, and Melissa Shostak, *Managing Intellectual Property Relevant to Operating and Sustaining Major U.S. Air Force Weapons Systems*, RAND Corporation, RR-4252-AF, 2021, p. 4.

¹²² Richard Van Atta, Royce Kneece, Michael Lippitz, and Christina Patterson, *Department of Defense Access to Intellectual Property for Weapons Systems Sustainment*, Institute for Defense Analyses, IDA Paper P-8266, May 2017, p. 38; and Camm, Carter, et al., 2021, p. 6.

¹²³ Van Atta et al., 2017, pp. 43–44.

¹²⁴ Loren Thompson, “U.S. Navy Plans to Stop Buying P-8 Poseidon Sub Hunters Despite Growing Undersea Threat,” *Forbes*, December 2, 2019.

¹²⁵ Van Atta et al., 2017, p. 44.

According to the IDA assessment, the Navy declared the P-8A a core capability, therefore requiring organic-oriented depot maintenance as stipulated in Section 2464 of U.S. Code.¹²⁶ Because the OEM maintained all the data rights except required FFF and OMIT data, the only solution for the Navy was to pursue a “public-private partnership agreement.” This permitted the Navy only to conduct organic-oriented depot maintenance on military components and did not provide the service with greater data rights, thus limiting the potential life cycle savings it could have enjoyed had it more vigorously pursued greater data rights during the contract negotiation with the OEM.¹²⁷

The USAF, aware of the Navy’s issues with the P-8A, decided to negotiate for a greater level of data rights during the precontracting phase. According to the IDA investigation, the KC-46A program office inserted “stringent [data rights] provisions” into the competitive RFP, requiring Boeing and Northrop Grumman-Airbus to document what they were willing to cede to the USAF. According to IDA, the USAF required contract line item number (CLIN)-level details of what data rights would be provided, which were assessed as part of the competition.¹²⁸ The contract, which was ultimately awarded to Boeing, required the OEM “to provide technical data and software needed for organic depot maintenance.”¹²⁹ Furthermore, because of the FAA certification requirements, this contract required Boeing to provide the USAF with additional flight airworthiness data that can be used for competitive sustainment, thereby potentially reducing life cycle costs.¹³⁰

Efforts to Gain Greater Data Rights Had Mixed Results

Nonetheless, there existed limitations to what the USAF could obtain in its efforts to gain greater data rights necessary for organic-oriented depot maintenance and sustainment. IDA identified at least two critical areas. First, the contract did not include components that Boeing and numerous subcontractors had developed using private expenses, such as the Rockwell-Collins glass cockpit.¹³¹ IDA noted that the USAF may have to turn to the private sector to procure or repair such parts.¹³² Second, the IDA assessment noted that the OEM was under no obligation to provide “detailed drawings”—USAF-organic depots do not possess “rights to manufacture”—because they are not FAA Part 145 certified. Part numbers also constituted a challenge. Boeing asserted that it did not possess data rights to all of them, limiting the ability of

¹²⁶ U.S. Code, Title 10, Section 2464, Core Logistics Capabilities.

¹²⁷ Van Atta et al., 2017, pp. 44–45.

¹²⁸ Van Atta et al., 2017, pp. 11, 45.

¹²⁹ Van Atta et al., 2017, p. 45.

¹³⁰ Van Atta et al., 2017, p. 47; and Camm, Carter, et al., 2021, p. 6.

¹³¹ Van Atta et al., 2017, p. 46.

¹³² Van Atta et al., 2017, p. 46.

the USAF to execute analyses to determine “which components to repair in the depot.”¹³³ In some instances, part numbers were associated with specific manufacturers, forcing the USAF into a vendor lock with that subcontractor.

A 2021 RAND study articulated that the USAF, despite its commendable efforts to obtain as many data rights as possible during the RFP competition phase, could obtain only limited rights for the KC-46A’s commercially designed systems, which included much of the KC-46A’s 767-based body and avionics.¹³⁴ It also noted disagreements between the USAF and the OEM over what constituted OMIT data and Boeing’s reticence to shed light on around 800 subcontractors’ data rights.¹³⁵ This disagreement over OMIT data ultimately led to litigation, which is ongoing at the time of writing.¹³⁶ Finally, the RAND study noted two key data rights issues moving forward. First, “Boeing [or subcontractors] placed restrictive markings on the software for the KC-46,” effectively imposing vendor lock over much of the KC-46A’s software suite.¹³⁷ It remains unclear how this will be resolved. Second, Boeing’s obfuscation concerning its massive supply chain and the data rights that they possessed, or that could be accessed by the USAF, had led to confusion over what rights the USAF indeed possesses with this vast array of subcontractors.¹³⁸

Lessons in Obtaining Technical Data Rights

The USAF evidently learned some lessons from the Navy’s P-8 experience. It demanded greater data rights during the RFP competition, forcing Boeing and Northrop Grumman-Airbus to disclose at the CLIN detail level which rights they were willing to cede to the USAF for life cycle sustainment and development. The USAF’s pursuit of FAA certification for the KC-46A also required Boeing to agree to provide additional FAA-required flight worthiness data to the USAF, potentially reducing life cycle sustainment costs. It is evident from the KC-46A experience that this approach could be used in future MCDA programs.

Nonetheless, data rights problems continued to complicate the KC-46A program despite the USAF’s efforts. Looking ahead, USAF lawyers and contract experts should be included early and often in the contract negotiations. Additional staff and resources should be added. Boeing refused to hand over detailed parts drawings, citing USAF depots’ inability to manufacture parts because the depots are not FAA certified. In doing so, they ultimately impaired USAF depots’

¹³³ Van Atta et al., 2017, p. 46.

¹³⁴ Frank Camm, Thomas C. Whitmore, Guy Weichenberg, Sheng Tao Li, Philip Carter, Brian Dougherty, Kevin Nalette, Angelena Bohman, and Melissa Shostak, *Data Rights Relevant to Weapons Systems in Air Force Special Operations Command*, RAND Corporation, RR-4298-AF, 2021, pp. 80–81.

¹³⁵ Camm, Whitmore, et al., 2021, pp. 18–20; and Program office official, interview with the authors, January 10, 2022.

¹³⁶ Program office official, interview with the authors, January 10, 2022.

¹³⁷ Camm, Whitmore, et al., 2021, p. 81.

¹³⁸ Camm, Whitmore, et al., 2021, p. 81.

abilities to test “component failures.”¹³⁹ Instead, Boeing provided only scanned blueprint PDFs.¹⁴⁰ Boeing also asserted all but limited data rights over commercial systems that it deemed had been developed privately, either by itself or through subcontractors, notably the Rockwell-Collins glass cockpit, commercial software, and much of the airframe itself.¹⁴¹ As the RAND study noted, this resulted in Boeing still maintaining vendor lock over much of the KC-46A data rights and has led to confusion within the USAF over what rights it possesses with Boeing and subcontractors. As the IDA analysis concluded, however, time will tell what these issues mean for the KC-46A in practice.¹⁴² Litigation between the USAF and Boeing over access to OMIT data is ongoing at the time of writing.

Several key lessons from the KC-46A data rights experience are noteworthy. First, the USAF should seek to obtain as many data rights, including digital engineering data, as possible, and to do so as early as possible during the RFP competition phase of the MCDA life cycle, using data rights specialists. This approach not only demonstrates transparency in the competition but also tells competitors up front what they are expected to provide to the USAF should they win the competition. Data rights requests should be stipulated at the CLIN level to be as specific as possible.

Second, the USAF should remain aware that OEMs will continue to seek control over commercially designed systems, including software and firmware, and might possess differing understandings of what qualifies as OMIT data.¹⁴³ In response, the USAF should clearly define their OMIT requirements to the OEM during the RFP competition phase and negotiate how these data will be handled, ideally with experienced lawyers and USAF data rights specialists. Finally, the USAF should request greater data rights and transparency with OEM subcontractors, make them aware of USAF requirements, and if possible, negotiate data rights from subcontractors during the contracting phase. During the RFP phase, the USAF could require that subcontractors ultimately be bound by the same contractual data rights requirements of the OEM. A modular open systems approach might be one solution, permitting later changes and upgrades with existing or new OEMs. A key question remains: How many data rights can the USAF demand from an OEM before they walk away from the negotiating table?

¹³⁹ Van Atta et al., 2017, p. 46.

¹⁴⁰ Program office official, interview with the authors, January 10, 2022.

¹⁴¹ Camm, Whitmore, et al., 2021, pp. 18–19.

¹⁴² Van Atta et al., 2017, p. 47.

¹⁴³ Program office official, interview with the authors, January 10, 2022.

Chapter 4. Organic-Oriented Sustainment

Contractor Logistics Support (CLS) aircraft depot maintenance costs had been increasing at a rate of 10 percent per year since 1996.¹⁴⁴ In response, the USAF decided that KC-46A sustainment would be organically oriented to be more cost-efficient.¹⁴⁵ This means that the USAF will have to bring all of the KC-46A's maintenance and upgrades in-house.¹⁴⁶ It will not directly return to Boeing for sustainment.¹⁴⁷ Additionally, the USAF declared the KC-46A a *core* capability. This means it must be maintained organically to help meet the *50/50 rule*—a mandate requiring that half of the USAF's total aircraft fleet be maintained organically.

Dividends Possible with Organic Orientation

The depots, however, are not FAA certified; in 2014, the FAA announced it would no longer certify military depots.¹⁴⁸ Therefore, the depots responsible for KC-46A sustainment work to “meet the intent” of FAA sustainment to maintain certification.¹⁴⁹ As discussed earlier in this report, because the depots are not FAA certified, the USAF will not be able to directly return KC-46A parts to the global 767 parts pool. They will only be able to return parts to the pool if they are certified in an FAA-certified Part 145 depot. Nonetheless, organic depots do have benefits. They can, for instance, meet USAF surge needs when necessary and on the USAF's schedule.

KC-46A sustainment will be “an enterprise-wide initiative,” involving the Defense Logistics Agency (DLA); 848th Supply Chain Management Wing; the three air logistics centers at Robins, Ogden, and Tinker Air Force Bases; field units at the USAF, Air National Guard, and Air Force Reserve main operating bases; and Air Force Materiel Command.¹⁵⁰ Contractors will still be involved because the USAF cannot conduct 100 percent of all sustainment requirements.¹⁵¹ The USAF intends for this approach to be more cost-efficient than the relatively expensive CLS

¹⁴⁴ Michael Boito, Thomas Light, Patrick Mills, and Laura H. Baldwin, *Managing U.S. Air Force Aircraft Operating and Support Costs: Insights from Recent RAND Analysis and Opportunities for the Future*, RAND Corporation, RR-1077-AF, 2016, p. 2.

¹⁴⁵ Program office official, interview with the authors, January 10, 2022; Air Force Life Cycle Management Center, 2021.

¹⁴⁶ Research leader, interview with the authors, January 14, 2022.

¹⁴⁷ Air Force Life Cycle Management Center, 2021.

¹⁴⁸ Air Force Life Cycle Management Center, 2021.

¹⁴⁹ Air Force Life Cycle Management Center, 2021.

¹⁵⁰ Air Force Life Cycle Management Center, 2021.

¹⁵¹ Air Force Life Cycle Management Center, 2021.

approach it had generally employed from the 1990s through the 2010s. It is also collaborating with FedEx, United Postal Service, and Delta TechOps to learn more about KC-46A sustainment, especially preventative maintenance.¹⁵²

For the short term at least, Boeing will remain involved in KC-46A organic support. But it is by no means guaranteed that Boeing will win subsequent sustainment contracts through the DLA. The USAF will become responsible for aircraft and software maintenance.¹⁵³ “Selected depot-level reparable parts,” according to IDA, “will be repaired organically.”¹⁵⁴ However, KC-46A officials have admitted that they will have to continue to rely on Boeing for sustainment of some systems.¹⁵⁵

Because the depots were stood up two years before delivery, there was a risk that some parts or processes would become obsolete. However, in 2021, the USAF successfully undertook 23 C checks of KC-46As at Tinker Air Force Base in its first major sustainment operation on the platform.¹⁵⁶ A *C check* is a “heavy maintenance” check that “requires an aviation maintenance technician to perform a deep inspection of a majority of the aircraft parts” over a roughly 35-day period.¹⁵⁷ This feat was even more remarkable given that, because the USAF was able to complete the depots two years ahead of schedule, the maintenance manuals were still being updated.¹⁵⁸ The USAF plans to follow commercial maintenance approaches, bringing in the KC-46A for heavy maintenance every two years, instead of every five years as it has done with the KC-135.¹⁵⁹

Lessons from Sustainment Planning

It is too early to tell whether the USAF’s KC-46A’s 100-percent organic-oriented support plan will be successful and cost-effective. The USAF decided to follow this approach to obtain and maintain parts cost-competitively, instead of relying on Boeing as sole supplier and sustainer. According to at least one account, this approach saves the USAF sustainment funding.¹⁶⁰ However, the decision to pursue organic-oriented sustainment could present problems

¹⁵² Air Force Life Cycle Management Center, 2021.

¹⁵³ Air Force Life Cycle Management Center, 2021.

¹⁵⁴ Van Atta et al., 2017, p. 46.

¹⁵⁵ Air Force Life Cycle Management Center, 2021.

¹⁵⁶ Air Force Life Cycle Management Center, 2021.

¹⁵⁷ National Aviation Academy, “Types of Aviation Maintenance Checks,” webpage, undated; and Air Force Life Cycle Management Center, 2021.

¹⁵⁸ Air Force Life Cycle Management Center, 2021.

¹⁵⁹ Air Force Life Cycle Management Center, 2021.

¹⁶⁰ Jared Serbu, “Faced with Dearth of Replacement Part Suppliers, Air Force Aims to Make Itself More Self-Sufficient,” *Federal News Network*, July 31, 2018.

if the USAF decides that CLS can provide more cost-efficient maintenance or repair for specific systems. According to one interviewee, current policies prevent the KC-46A from going to a parts manufacturer to receive approved parts if “they hit a [depot] bottleneck.”¹⁶¹ Additionally, a 2016 RAND study determined that applying commercial airline sustainment practices, specifically designated engineering representative repair shops (e.g., Delta TechOps) and using parts manufacturer approved parts from third parties, might be a more cost-efficient approach for the USAF in the KC-46A program.

As a risk mitigation strategy, USAF programs should consider keeping the OEM on contract until the organic depot is fully established—an approach that will prevent any delayed maintenance of initial overhauls of accepted aircraft. The KC-46A also had very generic language in its contract, effectively stating that the depots should be activated in accordance with AFI-21-101. Future contracts should specify such requirements as a level-of-repair analysis within the contract data requirements list.

In many respects, the KC-46A is a landmark aircraft for the USAF. It will provide critical global refueling capabilities to the USAF’s entire fleet and those of allies and partners. Its ability to refuel multiple aircraft at once will undoubtedly help facilitate USAF logistical capabilities for the next generation. But its development has been beset by scandal, delays, and continued questions over the use of an FPIF contract. Will FAA certification really help the KC-46A when parts are needed over time? Did it unnecessarily slow down the KC-46A development process? Will RVS 2.0 and FAA certification for the WARPs finally bring the KC-46A to full operational capability? What data right lessons should the USAF learn from the KC-46A experience? Finally, time will tell whether organic-oriented maintenance was the right decision.

¹⁶¹ Research leader, interview with the authors, January 14, 2022.

Abbreviations

CLIN	contract line item number
CLS	Contractor Logistics Support
DLA	Defense Logistics Agency
DOT&E	Director, Operational Test and Evaluation
EMD	engineering and manufacturing development
FAA	Federal Aviation Administration
FFF	form, fit, or function
FPIF	Fixed-Price Incentive Firm
GAO	U.S. Government Accountability Office
IDA	Institute for Defense Analyses
LRIP	low-rate initial production
MCDA	military commercially derivative aircraft
OEM	original equipment manufacturer
OMIT	operation, maintenance, installation, and training
RFP	request for proposal
RVS	Remote Vision System
USAF	U.S. Air Force
WARP	Wing Air Refueling Pod

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The KC-46A *Pegasus* is designed to refuel any fixed-wing U.S. Air Force (USAF) aircraft capable of aerial refueling, as well as many fixed-wing aircraft of allies and partners. It provides fuel through three system types: a centerline boom modified from the KC-10; a centerline hose and drogue system; and two Wing Air Refueling Pods, each with hose and drogue systems. The KC-46A can be configured in a variety of refueling, passenger, and cargo combinations through continuous tracks running through the aircraft.

The authors of this report examine improvement in acquisition and sustainment of military commercial derived aircraft using a case study of the KC-46A *Pegasus* aerial refueling tanker. This report begins with a brief review of the troubled early history of the KC-46A program, focusing on Federal Aviation Administration (FAA) certification, data rights, and organic-oriented life cycle sustainment, and provides lessons learned to improve future acquisition and sustainment outcomes. The KC-46A is intended to gradually replace the Air Force's aging KC-135 *Stratotanker* and KC-10 *Extender*.

This is a companion report to another 2023 report, *Life Cycle Management of Military Commercial Derivative Aircraft: Improving FAA Certification, Implementation of Digital Engineering and Sustainment Strategy*.

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