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Analysis of the Air Force Logistics Enterprise

Evaluation of Global Repair Network Options for Supporting the F-16 and KC-135

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Summary

Background and Purpose

The Air Force has implemented a number of transformational initiatives since the advent of the AEF concept in 1998. Many of these initiatives have focused on incremental changes to the Air Force's logistics infrastructure and concepts of operation. In 2007, senior Air Force logisticians asked RAND to undertake a strategic reassessment of the Air Force's logistics enterprise to identify, using projections for the future operating environment, alternatives for appropriately rebalancing logistics resources and capabilities between operating units and support network nodes across the TF, including not only active duty (AD) forces but also the AFRC and ANG.

To meet this broad request, the Logistics Enterprise Analysis (LEA) project has been organized around the following four tasks:

- a review of OSD programming guidance to determine projected logistics system workloads
- a structured analysis of scheduled and unscheduled maintenance tasks to strategically rebalance workloads among operating units and supporting network nodes
- a strategic reevaluation of the objectives and proper roles of contract and organic support in the logistics enterprise
- a top-down review of the management of logistics transformation initiatives to ensure that they are aligned with broader logistics objectives.

The research presented in this monograph addresses only a part of the broader LEA project, namely, the first two tasks applied to the F-16 and KC-135 fleets. Subsequent publications will address the last two tasks and present enterprise rebalancing analyses for other weapon systems.

The strategic decisions made in these areas should recognize that key management options and important resource trade-offs occur in the following areas:

- **"Stockage" solutions versus "response" solutions.** Support of deployed and engaged forces has historically involved a blend of stocks (readiness spares packages, war readiness engines, prepositioned war reserve materiel, etc.) and responsive support (resupply, deployed intermediate-level maintenance, CIRF support, etc.). Strategic issues here involve our ability to forecast usage rates and requirements, in-theater footprint issues, and unit "ownership" versus "sharing" of assets.
- **Local maintenance versus network maintenance.** Flexibility exists in the location of maintenance activities that are not directly tied to sortie generation and recovery. For example, off-equipment component repair can be conducted on base in backshops[3] or off base at AFMC depot facilities, at CRFs, or at contractor facilities. This geographic dimension has important strategic considerations, including the extent of reliance on transportation, the speed of deployment, and maintenance manpower requirements, with differing risks associated with "self-sufficient" and "network" maintenance postures.

This study identifies alternatives that reallocate workload and resources between maintenance that is provided at the aircraft's operating location and maintenance that is provided from a flexible and robust network of CRFs. These alternatives provide equal or greater capability than the current system, with equal or fewer resources. Thus, the Air Force could use any savings either to increase its operational

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[3] *Backshops* refers to one of three levels of Air Force aircraft maintenance. Historically, backshops perform intermediate-level maintenance; depots perform the highest level; and organizational, or "flightline," the lowest.

capability at no additional cost or to provide the same capability at less cost, capturing the savings associated with these economies to support other, more stressed areas than aircraft maintenance. An important aspect of this research is a commitment to identifying trade-offs among alternative solutions rather than advocating any single “best” option. Our goal is to inform Air Force leaders of the capability implications associated with varying levels of resource investment.

This monograph details the analysis that we performed to identify alternatives for rebalancing aircraft maintenance capabilities between unit-specific and network sources of repair for the F-16 and KC-135. The focus is on wing-level maintenance tasks, including sortie launch and recovery workloads, aircraft inspections, on-equipment maintenance to support removals and replacement of aircraft components, shop repair of replaceable components, and time-change technical orders. The analysis examined network-based alternatives, wherein each operational unit retains maintenance capabilities for performing aircraft launch and recovery and removal and replacement of failed components, with an enterprise network of CRFs providing major aircraft inspections (such as F-16 phase inspections) and component repair. We evaluated repair network options for supporting the TF and also alternatives for which the repair network supports only the AD and AFRC forces. The key trade-offs in this analysis occur between potential manpower economies of scale that can be realized via consolidation of workloads into a smaller number of sites and the transportation and facility costs associated with moving maintenance tasks away from the aircraft’s operating location. We chose the F-16 and the KC-135 because of their dissimilarities in both logistics support requirements (e.g., F-16s have a relatively short phase-inspection interval and a limited flying range, while KC-135s have a relatively long inspection interval and a much longer flying range) and projected demands in support of future deployment scenarios (e.g., humanitarian relief operations require few, if any, F-16s but often have considerable demand for KC-135s).

We used a number of analytic tools to identify the resource requirements associated with these alternative maintenance constructs. The manpower requirements for unit-based “mission generation” (MG) maintenance were developed using a variety of sources, including

Unit Manning Document (UMD) and Unit Type Code (UTC) data describing the MG manpower as currently configured, along with extensive new simulation results obtained from the Logistics Composite Model (LCOM) to determine additional manpower requirements necessary to support our proposed maintenance restructuring. LCOM simulation results were also used to determine the CRF manpower requirements. We identified alternative repair network designs, consisting of the number, location, and size of CRFs, using an optimization model that minimizes the sum of the CRF manpower, transportation, and facility construction costs, subject to a variety of constraints. This optimization model considers the full range of CRF network alternatives, from fully decentralized solutions that retain CRF maintenance capabilities at all sites to fully centralized alternatives that consolidate all CRF capabilities at one site, and identifies the alternative that minimizes the total cost.

Results

F-16

Our analysis (see pp. 15–63) presents a method for optimizing resource allocations to provide a range of maintenance capabilities that either match or exceed those provided by the current structure. Suppose that the desired capability was the support of (1) a steady-state deployment of 10 percent of the combat-coded (CC) F-16 fleet into two theaters for an indefinite duration and (2) a surge deployment of 80 percent of the same fleet into two theaters. For this case, we identify an alternative, presented in Table S.1, that enhances the capability of F-16 maintenance units by transferring 1,900 manpower positions out of backshop maintenance,[4] made possible by centralizing certain backshop workloads, and moving these positions into MG maintenance, giving each CC squadron the ability to conduct split operations, in which F-16 squadrons have

[4] In Table S.1, these positions are in the shaded cell in the "TF Repair Network" column.

Table S.1
Option 1: F-16 Increased Operational Effectiveness

	Manpower Authorization		
Operation	**Current System**	**AD/AFRC-Only Repair Network**	**TF Repair Network**
Group and MOS: FY 2008 UMD	3,363	3,363	3,363
AMXS			
FY 2008 UMD	11,143	11,143	11,143
Moved from CMS and EMS		1,046	1,884
Split operations plus-up		844	1,896
CMS and EMS			
Propulsion and avionics: FY 2008 UMD	2,863	2,863	2,863
Age and munitions: FY 2008 UMD	4,093	4,093	4,093
Phase and related: FY 2008 UMD	6,221	2,714	
CRF network		1,741	2,532
Total	27,683	27,807	27,774

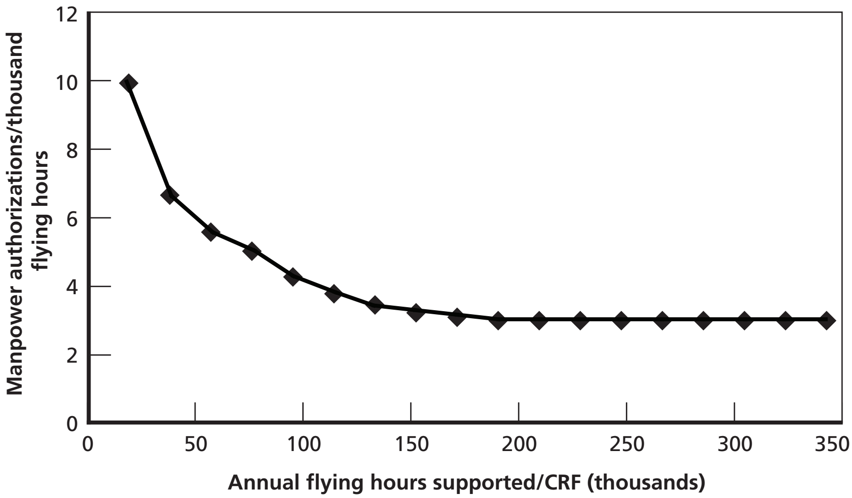
NOTE: MOS = maintenance operations squadron; AMXS = aircraft maintenance squadron; CMS = component maintenance squadron; EMS = equipment maintenance squadron.

some fraction of their primary authorized aircraft deployed and the remainder operating at the home station.[5]

Figure S.1 presents the economies of scale that demonstrate how the consolidation of backshop workloads and manpower into a small number of CRFs can achieve such reductions in manpower. The left endpoint of the curve demonstrates that, for a relatively small facility supporting a relatively small amount of flying, approximately ten manpower authorizations are required per 1,000 annual flying hours. The rightmost portion of this curve indicates that a CRF supporting a much larger workload volume is able to achieve the same levels of performance (in terms of phase throughput times and simulated not-mission-capable-for-supply rates) with significantly less manpower. This suggests that, if a repair network with a small number of relatively

[5] In our review of the OSD guidance and our discussions with Air Combat Command (ACC) personnel, it became apparent that the ability to conduct split operations for F-16 units is consistent with both programming guidance and recent experience.

Figure S.1
F-16 CRF Manning Requirements, Home Station



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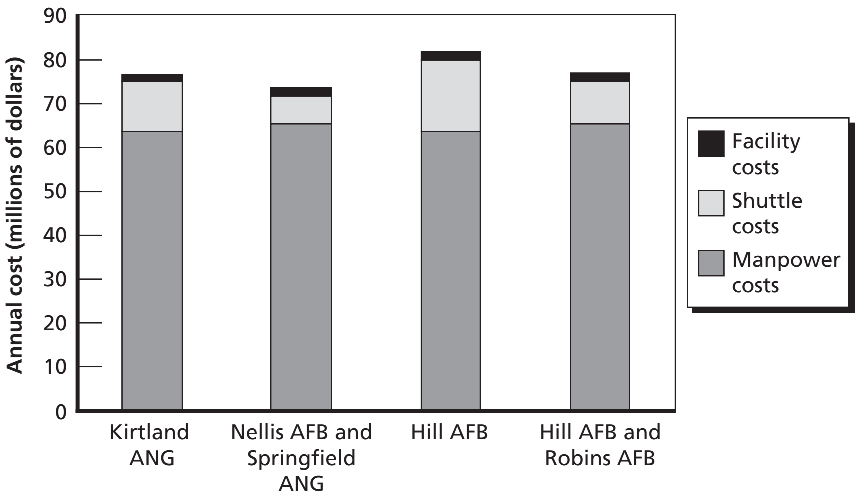
large CRFs is implemented, the total manpower requirement for these non-MG workloads can be significantly reduced.

Figure S.2 presents details on the specific CRF networks supporting CONUS aircraft that were identified by our optimization model for support of the TF F-16 fleet.[6] The two bars on the left side of the figure present the performance of the minimum-cost solution networks that have one and two CONUS CRFs. These are contrasted with two alternative networks: a maintenance network with a single CRF established at Hill AFB, and a two-CRF solution with CRFs established at Hill AFB and Robins AFB. Figure S.2 demonstrates that CONUS F-16 CRF support is somewhat insensitive to the precise number of locations that are established (it is possible to establish either one or two locations with little effect on cost performance); it also demonstrates relative insensitivity to the precise locations for CRFs. This allows for

[6] We also identified requirements for a CRF in each of U.S. Air Forces in Europe (USAFE) and Pacific Air Forces (PACAF); these requirements are not presented in Figure S.2 but are assumed to be constant across all CRF options for CONUS aircraft.

Figure S.2
Alternative TF CRF Solutions



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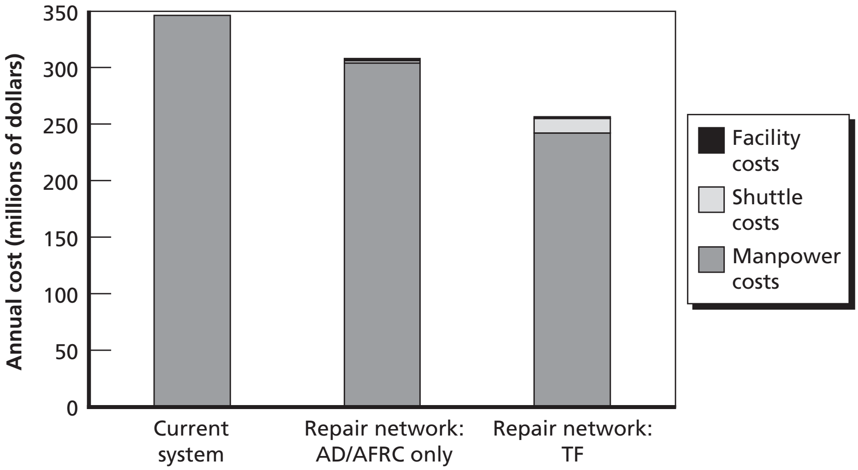
other considerations beyond the scope of this analysis to enter into the final CRF location decision. As an example, the establishment of a CRF at Hill AFB could also provide proximity to the F-16 system program office or to depot personnel.

Alternatively, if the Air Force concluded that its current F-16 maintenance operational capabilities were sufficient, our analysis identifies the potential to realize an annual savings of nearly $90 million by centralizing these backshop workloads across the TF, with no new split-operations capability created, as shown in Figure S.3. The Air Force might decide that, even though F-16 maintenance capabilities-are stressed, these 1,900 backshop positions would be more effectively applied to some other career field.

The bar on the left side of Figure S.3 presents the manpower costs associated with the current system. The center bar presents the total system costs for the CRF maintenance network alternative that supports only the AD and AFRC forces, with no split-operations capability added to the CC squadrons. The bar on the right side of the figure presents the total system costs for the TF CRF network alternative,

Figure S.3
Option 2: F-16 Increased Efficiencies



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again with no split-operations capability added to the CC squadrons. Under the current system, annual costs are $345 million, contrasted with $308 million for the AD/AFRC option ($37 million annual reduction) and $257 million for the TF option ($88 million annual reduction). Note that the manpower requirement dominates costs. The manpower cost in Figure S.3 includes both active and reserve components for the CONUS, PACAF, and USAFE CRFs, supporting both the steady-state and major combat operation surge requirements, along with those personnel who were previously in the CMS or EMS and are now reassigned to the aircraft squadron (AS), as well as the unchanged ANG phase-and-related backshop manpower for the AD/AFRC-only CRF network.

The shuttle cost associated with aircraft movement between the aircraft operating locations and the CRFs is relatively small.[7] Recent large fluctuations in the price of aviation jet fuel led us to conduct addi-

[7] This shuttle cost is presented only for home-station operations, because the deployed operating locations are uncertain.

tional analyses to identify how sensitive these alternative CRF network strategies would be to variations in shuttle cost.

The F-16 cost per flying hour (CPFH) used in this analysis was $6,500.[8] The CPFH includes many logistics costs in addition to aviation fuel, e.g., consumables, depot-level reparable assets, and depot maintenance costs. For the F-16C, aviation fuel constitutes $1,722, or 26 percent of the total CPFH. Because the shuttle costs are small relative to the manpower costs, the TF CRF network would be less expensive than the current system even if CPFH increased up to a factor of eight times the $6,500 value or if the price of aviation fuel increased up to a factor of 28 times the $1,722 figure (holding all other CPFH components constant).

The facility costs associated with the establishment of CRFs are also presented for the maintenance network alternatives; however, they amount to a small fraction of the total annualized costs. This suggests that, even if the facility costs computed in this analysis were understated by a factor of 10, they would not be so large as to have a material effect on the conclusions.

Of course, the Air Force could also choose to implement an alternative between enhanced effectiveness and increased efficiency for F-16 maintenance. For example, it could add a split-operations capability to some, but not all, CC squadrons. Yet another alternative for reducing manpower requirements would be to alter the deployment burden or reserve-component participation policies.

The potential for improvements in operational effectiveness and/or system efficiency exists whether the CRF network supports the TF or only the AD/AFRC forces. If the CRF network supports only the AD/AFRC forces, the associated reduction in backshop manpower is large enough to create a split-operations capability at AD and AFRC squadrons without increasing the baseline total maintenance manpower; however, not enough resources would be freed to also generate a split-

[8] This amount was based on U.S. Air Force, 2006, Table A4-1; the precise CPFH values given in this reference vary by F-16 series, with the F-16C, the most common series in the inventory, having a CPFH of $6,543.05 (the F-16A and F-16B had slightly lower CPFH, and the F-16D had slightly higher CPFH).

operations capability at ANG squadrons. For the increased-efficiency option, although the potential savings would be larger for the TF network, there remains an economic rationale for repair network centralization in either case.

This capability level, while broadly consistent with OSD guidance, is presented as an illustration—our analytic approach can be used to identify the resource requirements for any other capability level the Air Force deems appropriate.

KC-135

The analysis for the KC-135 (see pp. 65–90) identified similar potential for increases in effectiveness or efficiency through consolidation of certain backshop maintenance workloads into a flexible maintenance network support concept, by applying the existing Air Mobility Command (AMC) forward operating location (FOL)/regional maintenance facility (RMF) concept that is currently used to provide maintenance support to deployed forces to home-station operations as well. For the purposes of illustration, we assumed that the desired capability was the support of (1) a steady-state deployment of 40 percent of the combat direct support (CA) KC-135 fleet into two theaters for an indefinite duration and (2) a surge deployment of 100 percent of the same fleet into two theaters.

As with the F-16, our analysis identifies alternatives for KC-135 wing-level maintenance that satisfy the capability objective. Table S.2 presents an alternative that enhances the capability of KC-135 maintenance units by transferring 2,400 positions out of backshop maintenance,[9] made possible by consolidation of RMF workloads, and moving them into MG maintenance, giving each CA squadron the ability to conduct split operations. Alternatively, if the Air Force concluded that its current KC-135 maintenance operational capabilities were sufficient, it would be possible to realize an annual savings of $100 million by centralizing these backshop workloads across the TF, with no new split-operations capability created, as shown in Figure S.4.

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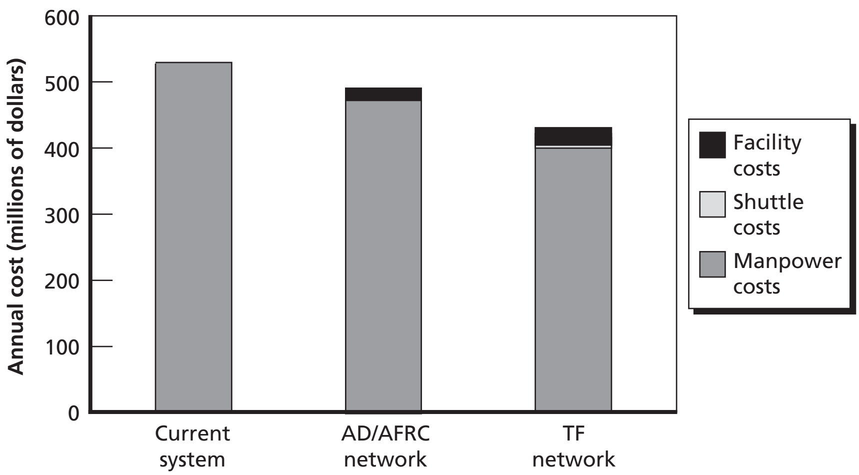
[9] In Table S.2, these positions appear in the shaded cell in the "TF Repair Network" column.

Table S.2
Option 1: KC-135 Increased Operational Effectiveness

	Manpower Authorization		
Operation	**Current System**	**AD/AFRC-Only Repair Network**	**TF Repair Network**
Group and MOS: FY 2008 UMD	1,542	1,542	1,542
AMXS			
FY 2008 UMD	4,622	1,343	
UTC-based AMXS		2,792	4,833
UTC-based moved from MXS		741	1,366
Split operations plus-up		1,213	2,366
MXS			
FY 2008 UMD	5,573	3,351	
CRF Network		876	1,160
Total	11,737	11,858	11,267

NOTE: MXS = maintenance squadron.

Figure S.4
Option 2: KC-135 Increased Efficiencies



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A range of alternatives between these two endpoints also exists, as was the case in the F-16 analysis. As with the F-16, the total costs are dominated by the manpower requirement.

The bar on the left side of Figure S.4 presents the manpower costs associated with the current system. The center bar presents the total system costs for the CRF maintenance network alternative that supports only the AD and AFRC forces, with no split-operations capability added to the CA squadrons. The bar on the right side of the figure presents the total system costs for the TF CRF network alternative, again with no split-operations capability added to the CA squadrons. Under the current system, annual costs are $531 million, contrasted with $488 million for the AD/AFRC option ($43 million annual reduction) and $429 million for the total force option ($102 million annual reduction).

The manpower cost presented here includes both active and reserve components for all AMXS, MXS, AS, and CRF positions capable of supporting both the steady-state and major combat operation scenarios considered. There is a small shuttle cost associated with aircraft movement between the aircraft operating locations and the CRFs.[10] As we did for the F-16, we conducted additional analyses to identify how sensitive these alternative KC-135 CRF network strategies were to variations in the shuttle cost and found that the TF CRF network alternative would be less expensive than the current system even if the CPFH increased up to a factor of 27 times its business year 2008 level or, holding all other CPFH components constant, if the price of aviation fuel increased up to a factor of 43 times its assumed level within the CPFH. Once again, facility construction costs constitute a relatively small fraction of the total system costs.

The KC-135 CRF network concept also offers potential benefits whether the network supports only the AD/AFRC forces or the TF. An AD/AFRC CRF network generates backshop manpower reductions sufficient to create a split-operations capability at AD and AFRC squadrons without increasing the baseline maintenance manpower,

[10] This shuttle cost is presented only for home-station operations because of the uncertainty associated with deployed operating locations.

but it would not achieve sufficient reductions to also generate a split-operations capability at ANG squadrons. On the other hand, if the concepts are applied to the TF, there are sufficient backshop manpower reductions to create split-operations capabilities for all Air Force units, i.e., AD, AFRC, and ANG units. Were the focus instead placed on increased efficiency, the potential savings associated with the TF CRF network would be larger than the savings achieved if only AD/AFRC resources were rebalanced with the network; however, an economic rationale for repair network centralization exists in either case.

A broader view should also consider options for rebalancing resources across mission design series to meet the most pressing needs of the future security environment. Similarly, rebalancing options should also consider the reprogramming of resources between maintenance and other career fields, given projections of relative levels of future demand. Review and assessments of OSD guidance, such as the Steady-State Security Posture, could be used to help the Air Force make such determinations among aircraft and across career fields.