RAND PROJECT AIR FORCE

THE ARTS
CHILD POLICY
CIVIL JUSTICE
EDUCATION
ENERGY AND ENVIRONMENT
HEALTH AND HEALTH CARE
INTERNATIONAL AFFAIRS
NATIONAL SECURITY
POPULATION AND AGING
PUBLIC SAFETY
SCIENCE AND TECHNOLOGY
SUBSTANCE ABUSE
TERRORISM AND HOMELAND SECURITY
TRANSPORTATION AND INFRASTRUCTURE
WORKFORCE AND WORKPLACE

This PDF document was made available from www.rand.org as a public service of the RAND Corporation.

Jump down to document

The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world.

Support RAND

Purchase this document
Browse Books & Publications
Make a charitable contribution

For More Information

Visit RAND at www.rand.org
Explore RAND Project AIR FORCE
View document details

Limited Electronic Distribution Rights

This document and trademark(s) contained herein are protected by law as indicated in a notice appearing later in this work. This electronic representation of RAND intellectual property is provided for non-commercial use only. Permission is required from RAND to reproduce, or reuse in another form, any of our research documents.

This product is part of the RAND Corporation monograph series. RAND monographs present major research findings that address the challenges facing the public and private sectors. All RAND monographs undergo rigorous peer review to ensure high standards for research quality and objectivity.

Supporting Air and Space Expeditionary Forces

Capabilities and Sustainability of Air and Space Expeditionary Forces

Don Snyder, Patrick Mills, Manuel Carrillo, Adam Resnick

Prepared for the United States Air Force

Approved for public release; distribution unlimited

RAND PROJECT AIR FORCE

The research described in this report was sponsored by the United States Air Force under Contract F49642-01-C-0003. Further information may be obtained from the Strategic Planning Division, Directorate of Plans, Hq USAF.

Library of Congress Cataloging-in-Publication Data

Supporting air and space expeditionary forces : capabilities and sustainability of air and space expeditionary forces / Don Snyder ... [et al.].
p. cm.
"MG-303."
Includes bibliographical references.
ISBN 0-8330-3861-3 (pbk. : alk. paper)
1. United States. Air Force—Supplies and stores. 2. Deployment (Strategy) 3. Airlift, Military—United States. I. Snyder, Don, 1962–

UG1103.S82 2006
358.4'14110973—dc22

2005028137

The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors.

RAND® is a registered trademark.

© Copyright 2006 RAND Corporation

All rights reserved. No part of this book may be reproduced in any form by any electronic or mechanical means (including photocopying, recording, or information storage and retrieval) without permission in writing from RAND.

Published 2006 by the RAND Corporation
1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
201 North Craig Street, Suite 202, Pittsburgh, PA 15213-1516
RAND URL: http://www.rand.org/
To order RAND documents or to obtain additional information, contact
Distribution Services: Telephone: (310) 451-7002;
Fax: (310) 451-6915; Email: order@rand.org

Preface

The Department of Defense in recent years has shifted from a focus on sizing and shaping its forces to meet specific war plans to policies based on capabilities that can be directed toward a spectrum of missions. Concurrently, the Air Force has developed new policies governing deployments. Under these policies, Air Force personnel and materiel are organized into Air and Space Expeditionary Forces (AEFs). The AEF policies specify which personnel are expected to deploy if they are needed at some time, how long those personnel will remain deployed, and when they will be expected to deploy again. This shift to capabilities-based planning and AEF deployments has dramatically changed the manner in which the Air Force organizes and deploys its forces.

Given these changes, the need has arisen for new methods to assess Air Force deployment capabilities. This monograph describes a method for assessing deployment capabilities in light of the new AEF policies. This analytical approach can be used to evaluate a range of policy issues, which are described here, including expressing the deployment capabilities of the Air Force in terms of AEF policies, comparing alternative AEF policies with the current set of policies, sizing and balancing manpower positions among the combat support functional areas to meet specific deployment scenarios, and examining the impact of basing structures on the burden of deployment for Air Force personnel in certain support positions. Research for this report was completed in October 2004.

This report should be of interest to a range of policy analysts throughout the Air Force, including logistics planners, operations planners, manpower analysts, and all those dealing with Air and Space Expeditionary Force policies. Comments are welcome and should be sent to the report's lead author, Don Synder, at snyder@rand.org.

This work was conducted by the Resource Management Program of RAND Project AIR FORCE and was jointly sponsored by the Commander, Air Combat Command (ACC/CC) and the United States Air Force Deputy Chief of Staff of Installations and Logistics (AF/IL). It is part of a series of studies entitled "Supporting Air and Space Expeditionary Forces" (formerly "Supporting Expeditionary Aerospace Forces"). Other RAND Corporation reports in this series are the following:

- *Supporting Expeditionary Aerospace Forces: An Integrated Strategic Agile Combat Support Planning Framework,* Robert S. Tripp, Lionel A. Galway, Paul S. Killingsworth, Eric Peltz, Timothy L. Ramey, and John G. Drew, MR-1056-AF, 1999
- *Supporting Expeditionary Aerospace Forces: New Agile Combat Support Postures,* Lionel A. Galway, Robert S. Tripp, Timothy L. Ramey, and John G. Drew, MR-1075-AF, 2000
- *Supporting Expeditionary Aerospace Forces: An Analysis of F-15 Avionics Options,* Eric Peltz, H. L. Shulman, Robert S. Tripp, Timothy L. Ramey, Randy King, and John G. Drew, MR-1174-AF, 2000
- *Supporting Expeditionary Aerospace Forces: A Concept for Evolving the Agile Combat Support/Mobility System of the Future,* Robert S. Tripp, Lionel A. Galway, Timothy L. Ramey, Mahyar A. Amouzegar, and Eric Peltz MR-1179-AF, 2000
- *Supporting Expeditionary Aerospace Forces: Expanded Analysis of LANTIRN Options,* Amatzia Feinberg, H. L. Shulman, L. W. Miller, and Robert S. Tripp, MR-1225-AF, 2001
- *Supporting Expeditionary Aerospace Forces: Lessons from the Air War over Serbia,* Amatzia Feinberg, James Leftwich, Eric Peltz, Robert S. Tripp, Mahyar Amouzegar, Russell Grunch, John

Drew, Tom LaTourrette, and Charles Robert Roll, Jr., MR-1263-AF, 2002 (For Official Use Only)

- *Supporting Expeditionary Aerospace Forces: Alternatives for Jet Engine Intermediate Maintenance,* Mahyar A. Amouzegar, Lionel A. Galway, and Amanda Geller**,** MR-1431-AF, 2002
- *Supporting Expeditionary Aerospace Forces: An Operational Architecture for Combat Support Execution Planning and Control,* James Leftwich, Robert S. Tripp, Amanda Geller, Patrick H. Mills, Tom LaTourrette, Charles Robert Roll Jr., Cauley Von Hoffman, and David Johansen**,** MR-1536-AF, 2002
- *Supporting Air and Space Expeditionary Forces: Lessons from Operation Enduring Freedom,* Robert S. Tripp, Kristin F. Lynch, John G. Drew, and Edward Wei-Min Chan, MR-1819-AF, 2004
- *Supporting Air and Space Expeditionary Forces: A Methodology for Determining Air Force Deployment Requirements,* Don Snyder and Patrick H. Mills, MG-176-AF, 2004.

RAND Project AIR FORCE

RAND Project AIR FORCE (PAF), a division of the RAND Corporation, is the U.S. Air Force's federally funded research and development center for studies and analyses. PAF provides the Air Force with independent analyses of policy alternatives affecting the development, employment, combat readiness, and support of current and future aerospace forces. Research is conducted in four programs: Aerospace Force Development; Manpower, Personnel, and Training; Resource Management; and Strategy and Doctrine.

Additional information about PAF is available on our Web site at http://www.rand.org/paf.

Contents

Preface iii
Figures ix
Tables xi
Summary xiii
Acknowledgments xxiii
Acronyms xxv

CHAPTER ONE
Introduction 1
Policies for an Expeditionary Air Force 2
Scope of This Study 5
Organization of This Report 6

CHAPTER TWO
Measuring AEF Capabilities 7
Defining Deployment Capabilities 8
Determining Resource Requirements for Deployment Capabilities 13
The START Model 15
Assessing AEF Capabilities 16
Incorporating Air National Guard and Air Force Reserve Call-Up Status 18
Assessing Availability Based on Authorized Force Levels Versus UTC Readiness Status 18
Assessing Availability of UTCs for Deployment 19
Measuring Capabilities by UTCs and AFSCs 20
Using Multiple Metrics to Assess AEF Capabilities 22

AEF Deployment Planning 23

CHAPTER THREE
AEF DCAT—A Decision Support Tool for AEF Capability Analysis ... 27
Databases 27
AEF Libraries 27
Manpower Force Packaging System 32
AEF UTC Reporting Tool 32
Equipment Databases 34
The AEF Deployment Capabilities Assessment Tool 34
AEF DCAT's Relational Database 38
Manpower Resources, Manpower AEF Rotational Limits, and AEF DCAT 40

CHAPTER FOUR
Illustrative Applications of AEF Capabilities and Sustainment Analysis 43
Creating Fighter Bare Bases 43
Supporting Theater Operations 51
Conclusions from Sample Calculations 55
Provides a Vocabulary for Articulating AEF Capabilities 55
Helps Identify Factors That Limit Deployment Capabilities 55
Provides an Analytic Basis for Balancing Resources 56
Provides an Analytical Foundation for Exploring Alternative AEF Policies 56
Permits Analyses to Guide Both Planning and Execution of Plans 56

CHAPTER FIVE
Conclusions and Recommendations 59

APPENDIX
A. Computer Hardware and Software Requirements for START and AEF DCAT 63
B. Architecture of AEF DCAT 65

Bibliography 73

Figures

1.1. Distribution of UTCs Between AEFs and Enablers for Several Functional Areas 5
2.1. Numbers and Types of Aircraft for 30 Recent Deployments 11
2.2. Methodology for "Optimistic" Estimate and "Pessimistic" Estimate of Manpower Capability 21
2.3. Analytical Tools to Support AEF Planning 24
3.1. Number of Security Forces UTCs Grouped by NSUTC for Each MAJCOM 31
3.2. AEF DCAT System's Analytic Environment 35
3.3. Sample AEF DCAT Resource Summary, Graph Format 37
3.4. Sample AEF DCAT Resource Summary, Data Table Format ... 38
3.5. Sample AEF DCAT AEF Capability Measure: Manpower 39
3.6. Sample AEF DCAT AEF Capability Measure: Equipment UTCs 40
3.7. Sample AEF DCAT Database Query 41
4.1. UTC-Constrained Manpower Fuels-Support Deployment Capability, One Sortie per Day per Aircraft for Average AEF Pair 45
4.2. AFSC-Constrained Manpower Fuels-Support Deployment Capability, One Sortie per Day per Aircraft for Average AEF Pair 46
4.3. UTC-Constrained Manpower Fuels-Support Deployment Capability, Two Sorties per Day per Aircraft for an Average AEF Pair 48

4.4. Equipment-Constrained Fuels-Support Deployment Capability, One Sortie per Day per Aircraft 49
4.5. Steady-State–Coded, UTC-Constrained Manpower Deployment Capability for Six Functional Areas for an Average AEF Pair 50
4.6. UTC-Constrained, Steady-State Residual Fire Protection Deployment Capability for an Average AEF Pair as a Function of Basing Structure 52
4.7. AFSC-Constrained, Steady-State Residual Fire Protection Deployment Capability for an Average AEF Pair as a Function of Basing Structure 53
A.1. AEF DCAT in the Web Environment 64
B.1. Flowchart of AEF DCAT Actions in Response to User Queries 66
B.2. Initial Screen of AEF DCAT Graphical User Interface 67
B.3. Example of a Second Screen in the AEF DCAT User Interface 68
B.4. Prompt for Importing User-Provided START File 69
B.5. Design of AEF DCAT Web Server Scripts 70
B.6. Section of the AEF DCAT Relational Database Schema 71

Tables

2.1. Functional Areas Covered by START Model 17
3.1. UTC Availability Codes 30
3.2. Manpower Functional Areas Covered by AEF DCAT 36
3.3. Partial List of AEF DCAT Database Tables 39
4.1. Aircraft for Notional Theater-Base Deployment Capability..... 51

Summary

Two recent transformations have radically affected the way the Air Force organizes and deploys its forces. The first is the shift by the Department of Defense (DoD) from threat-based planning to capabilities-based planning.[1] Prior to this change, the Air Force shaped and sized its forces to meet the requirements of specific operational plans, plus whatever the home station and training needs were to fulfill those plans. Current DoD guidance states that the Air Force now shapes and sizes its forces around "a portfolio of capabilities that is robust across the spectrum of possible force requirements, both functional and geographical."[2] The second transformation is the shift in the late 1990s by the Air Force to Air and Space Expeditionary Force policies,[3] which are intended to enable the Air Force to respond quickly to any national security situation with a tailored, sustainable force.

These new policies arose out of a need to provide greater predictability in the deployment of Air Force personnel and to distribute deployments more fairly across the Air Force. A secondary goal of Air and Space Expeditionary Force policies was to provide a more flexible means to specify the forces that the Air Force has in terms of their capabilities rather than as numbers of squadrons or wings of aircraft.

---

[1] Rumsfeld, 2001.

[2] Rumsfeld, 2001, p. 17.

[3] They were known at the time as Expeditionary Aerospace Force policies.

Air and Space Expeditionary Force policies have evolved over their short history, but their basic structure has remained constant. Current policy specifies 20-month deployment cycles. Each cycle comprises ten rotational Aerospace Expeditionary Forces (AEFs),[4] and most of the Air Force's deployable assets are divided roughly equally among these AEFs. The goal is for each deployable airman or officer to be assigned to one of these AEFs and, thereby, to be on call for deployment only once during a 20-month cycle. During any 120-day period, a pair of AEFs provides the steady-state deployment requirements. All other AEFs use this time for reconstitution and training. Resources that cannot be reasonably divided among ten equal, deployable AEFs are referred to as *enablers*.

Like many new policy and organizational changes, the transition to AEF policies has had its struggles. Deployments have not been as predictable as desired, and the uncertainties in deployments have not been the same for personnel in all career fields. Further, the understanding of what AEFs are exactly in terms of capabilities has been slow to congeal within the Air Force, and perhaps even more so outside the Air Force. It may seem at first that these two issues are unrelated, but they are linked by the central theme of how capabilities are defined.

Properly defining capabilities for AEFs can facilitate the solution to both of the above problems, if it is done in a manner that clarifies how to adjust AEF deployment policies so that AEF capabilities match the capabilities specified by DoD planning objectives. Defining the capabilities of AEFs directly in terms of DoD planning operations accomplishes this goal because it articulates exactly what AEFs can do in a given situation. And, because the deployment goals of the Air Force are set by DoD planning objectives, defining and measuring AEF capabilities against deployment plans provides a natural framework for anticipating deployment needs and setting AEF policies accordingly. In this report, we show how AEF capabilities can be

[4] The acronym AEF is used to refer to both the Air and Space Expeditionary Force concept and to the Aerospace Expeditionary Forces. In this document, we use this acronym to refer to the Aerospace Expeditionary Forces.

defined and measured, and how these measurements can be used to set AEF policies that provide Air Force personnel, regardless of their career position, with greater deployment predictability.

Currently, the Air Force expresses its capabilities to deploy in the AEFs in two principal ways: at the Unit Type Code (UTC) level and at the Force Module level. A UTC is a unit of capability specified by required manpower and equipment. UTCs range considerably in size. Some UTCs consist of an individual with specified skills (e.g., a chaplain); others include dozens of personnel or hundreds of tons of equipment. UTCs are sufficiently small, modular, and numerous that sets of UTCs can be assembled to express virtually any desired deployment capability that the Air Force requires.

Force Modules specify which UTCs are required to develop a generic bare base to support flight operations. Five Force Modules have been developed: open the base, establish the base, operate the base, provide command and control, and generate the mission. As such, Force Modules provide rules governing which UTCs are necessary for developing a generic bare base. Insofar as the infrastructure (and operations) at deployed locations resemble the type of infrastructure envisioned by the Force Modules, the modules will capture the requirement to open, establish, and operate forces out of deployed locations. By summing up how many Force Modules the Air Force has available, the capabilities to open, establish, and operate such generic bases can be measured. During recent operations, however, the Air Force deployed to numerous locations that differed significantly in character from the locations envisioned in the Force Modules. Measuring the capabilities to create and operate bases with wide-ranging infrastructures by how many Force Modules are available fails to take into account how well the AEFs can operate out of dissimilar locations.

In addition to using individual UTCs and collections of UTCs in the form of Force Modules, the Air Force evaluates its capabilities (for programming purposes) according to quantifiable units in a Master Capabilities Library (MCL), which is an exhaustive list of all Air Force capabilities. MCL specifications are independent of UTCs and

the AEFs; they do not, therefore, provide direct information about AEF deployment capabilities.

Collectively, UTCs, Force Modules, and the MCL fall short of expressing the capabilities of AEFs in ways that relate to planning objectives. Combinations of UTCs can describe any Air Force capabilities that can be deployed, but these combinations are determined ad hoc as needed. Force Modules specify which UTCs are needed for deploying fighter squadrons to bare bases, but the Air Force deploys to an enormous range of locations with an equally large range of types and numbers of aircraft. Force Modules do not necessarily capture these ranges. Therefore, the need remains to aggregate these measures in a way that relates to planning objectives and that links to the AEFs in order to express how much capability resides in the AEFs. In other words, a method of assessing AEF capabilities in relation to the new capabilities-based planning policies is needed. Such a method could be used (1) to evaluate the feasibility of implementing particular policies given the available resources, (2) to identify resource needs given policy requirements, and (3) to adjust policies and resources in relation to each other.

This report introduces an analytical framework for quantifying the capabilities that AEFs furnish, and it illustrates potential applications of the framework. The framework specifies a two-step analysis: (1) defining AEF capabilities and (2) analyzing AEF capabilities.

Defining AEF Capabilities

The first step in this analysis is to define an appropriate way to measure capability—one that captures the range of Air Force deployments and that is broad enough in its scope to be relevant to defense plans. To do this, we define a measure that is similar to UTCs and Force Modules but is broader in scope and is a function of relevant parameters, such as types of aircraft, aircraft missions, and base infrastructure. We call requirements and capabilities that are explicit functions of such parameters *parameterized* requirements or capabilities (see pages 8–15).

As with UTCs and Force Modules, we use the availability of sets of resources as a measure of capability. For example, in the case of UTCs, mission capability (MISCAP) statements specify capabilities, and, in the case of Force Modules, capabilities are defined to set up and perform operations at a bare base. Resources to support these capabilities are then determined, with the designation of a one-to-one relationship between resources and capabilities. As such, the number of sets of available resources defines the corresponding Air Force capabilities.

Similarly, a broader set of measures of capability can be defined based on the set of all required resources for a deployed operation as specified by a parameterization of a small set of driving factors—measures that offer additional perspectives on Air Force capabilities. This class of measures captures a broader, more nuanced view of capabilities than either UTCs or Force Modules alone. We quantify AEF capabilities by such a metric, which we call *deployment capability*. We define deployment capability (of an AEF) as the capacity to deploy specified numbers and types of aircraft (in the AEF) to specified numbers and types of bases with the ability to perform their designed missions at some specified sortie rate. We also use the term *marginal deployment capability* to denote the capacity of an individual functional area (e.g., fuels support) to support its component of the overall specified deployment capability.

Defined in this way, deployment capability is a function of more than just the availability of aircraft and the directly associated manpower (pilots, maintainers, and such). Deployment capability also depends on the expeditionary combat support (ECS) necessary to operate and support those aircraft, such as the manpower and equipment for civil engineering and fuel storage and distribution. The type and level of the required ECS will depend on the operational tempo, the number of deployed sites, and the range of infrastructure at those sites.

The ability of an AEF to provide a specified deployment capability, therefore, depends on the availability of aircraft and ECS within the AEF relative to the aviation and ECS requirements. Three elements in combination determine AEF capabilities:

- a set of AEF policies
- a way to specify resource demands that correspond to deployment capabilities
- an algorithm that can manipulate policies and resource demands to assess capabilities for and constraints in supporting specified deployments.

By assigning specific Air Force personnel and other resources to a given number of AEFs and setting nominal rules for how often and under what circumstances the AEFs should deploy, the Air Force establishes what is referred to in this report as *AEF policies*. The policies that most constrain Air Force deployment capabilities are the number of AEFs, how many AEFs are slated for deployment at any given time, the deployment duration for each AEF, and how resources are distributed among the AEFs and enablers. Other policies also impact the capabilities that AEFs can deliver. For example, Air Force policy now states that all personnel stationed at a given base must be placed in no more than two AEF pairs. This policy prevents a base from losing manpower due to deployment more than twice during an AEF cycle. At the same time, the policy also constrains the Air Force's ability to evenly distribute personnel with certain skills across all AEFs. Hence, this policy influences the degree to which each AEF has resources similar to those of the other AEFS and, by extension, the balance of capabilities across AEFs. Clearly, AEF policies play a leading role in defining the capabilities that AEFs can provide.

What the AEFs and associated policies can provide in terms of deployment depends on what resources are needed for deployments. To address the fact that deployment locations and their requirements vary considerably, RAND developed a prototype analytical tool called the Strategic Tool for the Analysis of Required Transportation (START).[5] START employs a parameterized, rules-based algorithm to generate a list of UTCs that are necessary to support a user-specified deployment capability. Needed resources are specified as

[5] Snyder and Mills, 2004.

UTCs depending on the characteristics of a base, the threat to which the base is exposed, and the numbers and types of aircraft at the base. The results are consistent with the results that would be obtained using Force Modules, yet, by being parameterized and rules-based, START can extend an analysis to locations other than bare bases and to bases with any number and mix of aircraft types.

Analyzing AEF Capabilities

The next step in quantifying AEF capabilities is to compare the parameterized requirements—in the form of UTC lists—with AEF deployment policies and the levels of resources assigned to AEFs. Information on resource levels resides in several Air Force databases. The primary databases are the AEF libraries, which apportion all Air Force UTCs into ten AEFs and enablers. Plan identifiers (PIDs) in the AEF libraries indicate AEF and cycle numbers; other database fields provide the units that are assigned to the UTCs and related information, such as one of eight distinct codes that indicate deployment priority. A separate database, the AEF UTC Reporting Tool (ART), has information on the readiness status of each UTC.

The logic needed to assess the capabilities and constraints associated with available resources is in the form of prototype software called the AEF Deployment Capabilities Assessment Tool (AEF DCAT), which was developed for this study (see pages 27–42). This software uses current AEF policies to determine capabilities, but it can easily be modified to explore alternative AEF policies. The logic within the AEF DCAT program allows a user to specify an operation in terms of the number and type of aircraft deployed, operational tempo, and number of bases. This set of operation specifications, or "deployment unit," is then used as a deployment capability metric. An example of such a metric is the capability to build up and operate a bare base to host a squadron of 18 F-16CGs at a specified operational tempo. The goal is to measure the capability of an AEF pair in terms of how many deployment units it can support.

AEF DCAT outputs measures in both tabular and graphical formats and includes details that provide insight into factors limiting deployment. The analyses can be constrained by either available UTCs or Air Force Specialty Codes (AFSCs), and resource levels can be expressed in terms of the priority of UTCs for deployment, as specified by their availability codes in the AEF libraries. By querying the ART database, AEF DCAT can also express capabilities filtered by readiness status. The outputs provide levels of deployment capability for a specified expeditionary combat support area (such as civil engineering, fuels support, or bare base support).

Applications

The method for quantifying AEF capabilities described in the previous section has many potential applications in policy analysis. Here, we provide brief descriptions of five of the most likely ways this method can be used and how this approach can be useful in both planning and execution.

Provides a Vocabulary for Articulating AEF Capabilities

The approach described here provides a flexible, expansive, and easily comprehensible vocabulary for articulating AEF capabilities. Quantifying and communicating Air Force capabilities within the AEF framework is a necessary step in the transition to capabilities-based planning. Capability expressed in terms of wings or squadrons of aircraft does not capture whether sufficient expeditionary combat support resources have been authorized to support operations. The more expansive view that includes support resources more accurately indicates what capabilities can be generated within a set of AEF policies (see pages 43–55).

Helps Identify Factors That Limit Deployment Capabilities

In addition to providing a means of articulating AEF capabilities, this approach to analyzing the relationship between policies and resources can help to identify factors that limit deployment capabilities for cur-

rent resource levels. Examining a wide spectrum of perspectives on each deployment capability provides insight into whether capability in a given area is restricted because of resource levels, availability of UTCs, readiness status, or how UTCs are assigned to AEFs. Further, for a given deployment capability, this approach can reveal which UTCs and AFSCs are the limiting resources (see pages 51–55).

Provides an Analytic Basis for Balancing Resources

If authorized resource levels in disparate areas, such as civil engineering and fuels support, are set independently, they may not be balanced; that is, they may not provide similar deployment capabilities with respect to one another. By analyzing deployment capabilities using a range of metrics derived from a portfolio of deployment scenarios, planners could combine results from this approach with independently derived home-station and training requirements to provide a robust analytical evaluation that balances manpower resources. This balancing could also be done among UTCs or AFSCs within a single functional area, as well as among the various functional areas (see pages 43–51).

Provides an Analytical Foundation for Exploring Alternative AEF Policies

AEF policies provide the Air Force and combatant commanders with a supply of deployable forces. The policies do not express resource demands calibrated to meet planning objectives. If AEF policies do not meet Air Force objectives, the policies can be revised or the force can be resized or reshaped. The approach described in this chapter provides an analytical basis to guide such an analysis. In this way, the ramifications of alternative AEF policies can be surveyed against a portfolio of deployment scenarios and home-station and training requirements (see page 35).

Permits Analyses to Guide Both Planning and Execution of Plans

All the examples of applications would be useful during both planning and execution. During crisis-action planning, the above insights

would provide planners and Air Force leadership with the ability to do the following (see pages 51–55):

- quickly explore resource deficiencies relative to specified deployment capabilities
- determine the extent to which various courses of action strain already tight resources
- quantify what capabilities remain if candidate plans are executed.

Recommendations

In light of the above observations and the work reported here on the prototype AEF DCAT, we recommend that the Air Force implement and maintain an analytical tool to assess AEF capabilities using a parameterized approach.

To facilitate the implementation of such a tool, we recommend that the Air Force do the following:

- develop and implement a rules-based, parameterized tool to quantify deployment requirements
- consider assigning all unit equipment and nonconsumable war reserve materiel to UTCs
- consider placing all equipment UTCs into the AEF libraries
- consider assigning availability coding and a readiness status to the equipment UTCs
- develop the analytic tool in such a manner that it integrates effectively with existing tools.

Implementing these recommendations should facilitate the Air Force's continuing transformation from a threat-based to a capabilities-based planning posture, provide senior leadership and combatant commanders with greater visibility of deployment capability, and further advance the mission of the Aerospace Expeditionary Forces.

Acknowledgments

This study could not have been done without the support of Brig Gen Anthony Przybyslawski (AEFC/CC) and his staff at the Aerospace Expeditionary Force Center (AEFC). Especially helpful were Col John Posner (AEFC/CV) and the Chief of the Plans Division at the AEFC, Lt Col Bill Price (AEFC/AEP). Many members of that division provided us with data and answered numerous questions about the data; they include Maj Bryan (Keith) Brown (AEFC/AEPJ), Capt James Struckmeyer (AEFC/AEPX), Tony Betsill (AEFC/AEXP), and Victor Scott (AEFC/AEPI). We also thank Lt Col Walter "Buddy" Fulda (AF/XOA) for information about AEF policies and Force Modules.

We have had the opportunity to brief this work at various stages of development, and without exception, dialog at those briefings has improved this study. The briefings were presented to Lt Gen Michael Zettler (AF/IL), Susan O'Neal (AF/IL), Col Ronne Mercer (AFLMA/CC), Col Michael Scott (AF/XOXW), Col Sidney Evans, Jr. (AF/DPMR), Col Mel Brooks (AFSAA/SAC), Col Kevin "Kid" Curry (ACC/DRY), and their respective staffs.

Within RAND, we thank the following colleagues for their discussions, suggestions, and feedback on this work: Mahyar Amouzegar, Jolene Galegher, Lionel Galway, Edward Keating, Robert Kerchner, Gary Massey, Charles Robert Roll Jr., Lt Col Stephen Sheehy, and Robert Tripp.

The authors take responsibility for any errors or omissions in this report.

Acronyms

ACC	Air Combat Command
ADO	ActiveX Data Object
AEF	Aerospace Expeditionary Force
AEFC	AEF Center
AETC	Air Education and Training Command
AEW	Air Expeditionary Wing
AFI	Air Force Instruction
AFM	Air Force Manual
AFMC	Air Force Materiel Command
AFPAM	Air Force Pamphlet
AFRES	Air Force Reserves
AFSC	Air Force Specialty Code
AFSOC	Air Force Special Operations Command
AFSPC	Air Force Space Command
AFWUS	Air Force–Wide UTC Availability System
AMC	Air Mobility Command
ANG	Air National Guard
ARC	Air Reserve Component
ART	AEF UTC Reporting Tool
ASP	Active Server Pages

AWACS	Airborne Warning and Control System
CRRA	Capabilities Review and Risk Assessment
DCAT	Deployment Capabilities Assessment Tool
DoD	Department of Defense
ECS	expeditionary combat support
EOD	explosive ordnance disposal
FAC	functional account code
FMSE	Fuels Mobility Support Equipment
GUI	graphical user interface
HTML	Hyper-Text Markup Language
IIS	Internet Information Server
JFAST	Joint Feasibility Analysis System for Transportation
JSTARS	Joint Surveillance Target Attack Radar System
LAN	local area network
LDHD	low-density, high-demand
LIN	liquid nitrogen
LOGFOR	Logistics Force Packaging
LOX	liquid oxygen
MAJCOM	Major Command
MANFOR	manpower force packaging
MCL	Master Capabilities Library
MEFPAK	Manpower and Equipment Force Packaging System
MISCAP	mission capability
MS IE	Microsoft Internet Explorer
MTW	major theater war
NSUTC	non-sourced UTC

OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OWC	Office Web Components
PAA	Primary Aircraft Authorization
PACAF	Pacific Air Forces
PAF	Project AIR FORCE
PID	plan identifier
RAT	Risk Assessment Team
RED HORSE	Rapid Engineer Deployable Heavy Operations Repair Squadron
SEAD	suppression of enemy air defenses
SEI	Special Experience Identifier
SIPRNET	Secret Internet Protocol Routing Network
SOF	Special Operations Forces
SORTS	Status of Resources and Training System
SQL	Structured Query Language
SSC	small-scale contingency
START	Strategic Tool for the Analysis of Required Transportation
TDY	temporary duty
TPFDD	time-phased force deployment data (list)
TUCHA	Type Units Characteristics (Detail File)
UAV	unmanned aerial vehicle
ULN	Unit Line Number
USAFA	United States Air Force Academy
USAFE	United States Air Forces in Europe
UTC	Unit Type Code
VBS	Visual Basic Script

CHAPTER ONE

Introduction

At the end of the Cold War, the United States reduced the number of its overseas bases, stationed a greater proportion of personnel in the United States, and cut the overall number of military personnel. In the Air Force, these changes, coupled with increased deployment demands to enforce the Southern and Northern no-flight zones over Iraq in the aftermath of the first Gulf War, caused considerable personnel turbulence during the 1990s. In response, the Air Force restructured the way it deploys its forces with the primary goals of providing Air Force personnel with greater predictability in when they deploy and distributing the burden of deployment more evenly across the Air Force.

This restructuring led to a new set of policies governing the deployment of Air Force personnel and materiel. Designed around the idea that the deployment of military assets should be organized in a way to provide certain capabilities (i.e., capabilities-based planning as opposed to threat-based planning), the new policies have, in turn, given rise to questions regarding the assessment of capabilities. In this report, we argue that the Air Force needs improved means of assessing its deployment capabilities, and we propose a systematic approach for conducting such assessments. The purpose of this method for assessing capabilities is to provide a way to evaluate policies and capabilities in relation to each other. The approach we have developed can be used to evaluate the feasibility of implementing particular policies given certain resources, to identify resource needs given certain policy

requirements, and to adjust those policies and resources in relation to each other.

In this chapter, we describe the new policies governing deployment of Air Force assets—both manpower and materiel—and discuss briefly some of the issues associated with the measurement of capabilities that have emerged as these policies have been implemented. This discussion provides the foundation for the subsequent chapters, in which we describe our approach to assessing AEF capabilities.

Policies for an Expeditionary Air Force

A fairly recent Air Force policy, called the Air and Space Expeditionary Force policy,[1] defines deployment guidelines according to 20-month cycles. The policy provides for ten Aerospace Expeditionary Forces (AEFs), and most of the Air Force's deployable assets are divided roughly equally among these AEFs.[2] The goal of dividing assets in this way is to ensure that each deployable airman or officer is assigned to one of these AEFs and, thus, is on call for deployment only once during a 20-month cycle. Each cycle is divided into five 120-day periods; during each of these periods, a pair of AEFs provides the steady-state deployment requirements. All other AEFs use this time for reconstitution and training.

If deployment requirements at some juncture exceed the capability of the on-call AEFs, the requirements are fulfilled by tapping resources from the next AEFs, or, in some circumstances, by extending the tour lengths of the already deployed personnel in the on-call AEFs. In this way, the AEF policies provide predictability to Air Force personnel deploying to support steady-state requirements and also provide a predictable transition to satisfying the deployment requirements of larger-scale contingencies.

Some forces, however, are not amenable to division into ten AEFs, and, as such, they deploy under different rules within the AEF

---

[1] Formerly called the Expeditionary Aerospace Force policy.

[2] See Air Force Instruction (AFI) 10-400, 2002, for details on the AEF policies.

policies. In addition to the ten AEFs, remaining forces are on call at all times. These remaining forces are called *enablers.* Examples of enablers are strategic mobility aircraft, special operations aircraft, and resources that are frequently deployed but that are low in numbers—often called *low-density, high-demand* (LDHD) assets.[3] These enabling forces deploy according to a combination of AEF policies and the Global Military Force Policy.

In the years since the AEF policies were first implemented, in October 1999,[4] the AEFs have been continuously evolving and maturing. When this study began in October 2002, the third 15-month cycle was in progress; the fourth cycle was highly accelerated in spring 2003 to support Operation Iraqi Freedom in accordance with the AEF construct.[5] Throughout the evolution of the policies over the first cycles, the mix of forces in the AEFs has changed, but the common underlying principle has been to divide the capabilities of the inventory of combat-coded aircraft approximately equally among the ten AEFs. For example, during Cycle 4 when two AEFs were vulnerable for deployment during any given 90-day period, the nominal aircraft and associated combat support available for steady-state operations during a given 90-day period was given by an average AEF pair. An average AEF pair contained about two air-superiority fighter squadrons, five multi-role fighter squadrons, two bomber squadrons, two theater airlift squadrons, and two air refueling squadrons. When additional enablers are included, this amounts to some 400 aircraft.

Expeditionary combat support (ECS)[6] is likewise divided among the AEFs. As much as possible, the ECS deploys at the same time as

---

[3] Examples are E-3 Airborne Warning and Control System (AWACS) aircraft and the E-8 Joint Surveillance Target Attack Radar System (JSTARS) aircraft.

[4] See Correll, 2002, and Cook, Allardice, and Michael, 2000, for overviews and brief histories of the AEFs and related policies.

[5] Unless otherwise noted, we use Cycle 4 AEF structure and policies for the analysis in this report.

[6] In this document, we use ECS to refer to all non-aviation combat support. Examples of ECS are the manpower and equipment for storage and distribution of fuel, fire protection, and so forth.

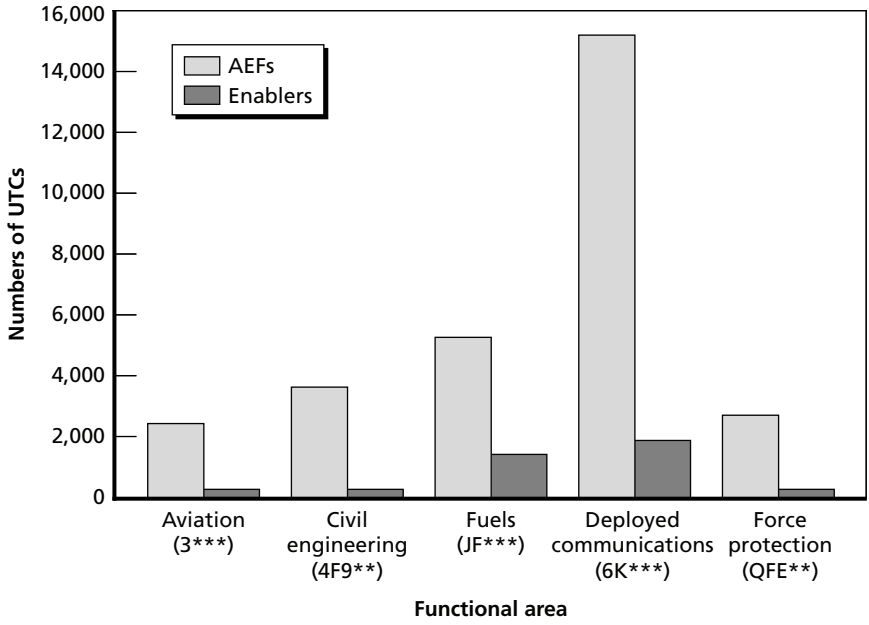
the associated aviation units. In general, the Air Force seeks a deployment pattern in which no home base is in more than two deployment windows per AEF cycle. Like aviation assets, ECS assets are generally assigned to AEFs, not to enablers. This distribution of resources tends to hold even if the resources support enabler aviation assets at their home bases. For example, most of the ECS assets at Tinker Air Force Base are not considered LDHD assets and are consequently assigned to AEFs, even though the E-3 AWACS aircraft (and associated aviation personnel and maintenance units) they support at Tinker are LDHD and are, consequently, considered enablers.

Although ECS is most commonly in the AEFs, there are exceptions. Typically, ECS units associated with Special Operations Forces (SOF) are either unique to SOF or are integral to SOF deployments and are, hence, considered to be enablers. They are not assigned to AEFs. And some ECS assets are themselves LDHD. One example is a Rapid Engineer Deployable Heavy Operations Repair Squadron (RED HORSE), which performs heavy construction duties. All RED HORSE units throughout the Air Force are enablers. Figure 1.1 illustrates the distribution of capabilities between the AEF pairs and the enablers for several typical support areas, including aviation. As the figure shows, capability is measured by the number of Unit Type Codes (UTCs). (UTCs are discussed further in Chapter Two.) Note that most of the capability resides within the AEFs.[7]

We refer to the entire set of rules for the constitution of UTCs in the AEF deployment concept and how those UTCs are expected to deploy as *AEF policies*. The policies that most constrain the capabilities of the Air Force to deploy are the number of AEFs, how many AEFs are earmarked for deployment at any time, the deployment duration for each AEF, and how resources are distributed among the AEFs and the enablers. Other policies—such as the policy that no base should host resources that are in more than two AEF pairs—

[7] Note that the UTC size and number required for a given deployment vary among the functional areas. Comparing the number of UTCs among functional areas is, therefore, not a reliable way to assess relative capabilities.

Figure 1.1
Distribution of UTCs Between AEFs and Enablers for Several Functional Areas



NOTE: The numbers and letters in parentheses in the figure represent five-character codes for UTCs. The asterisks are "wildcards" for numbers or letters within functional areas.

influence the degree to which each AEF has similar resources, and by extension, the balance of capabilities across AEFs. Clearly, AEF policies play the leading role in defining the capabilities that AEFs provide. In this report, we focus on the AEF policies of Cycles 3 and 4, with the understanding that alternative and future policies can be evaluated with the same methodology.

Scope of This Study

Given that Air Force deployments are now structured by AEFs and AEF policies, several important issues arise. It is important to deter-

mine, for instance, what deployment capabilities an AEF (and its associated enablers) provide to the unified combatant commander, what residual deployment capabilities remain within the on-call AEFs, and how AEF policies might be altered to satisfy uncertain and changing deployment requirements. We introduce an analytical framework to address these questions and to present preliminary results that illustrate how this framework can shed more light on certain policy decisions. This work builds on a prototype decision-support tool called START (Strategic Tool for the Analysis of Required Transportation), which was developed at RAND.[8] In the approach described here, results derived from START are integrated with AEF data to quantify deployment capabilities given specific AEF policies.

Although this report quantifies deployment capabilities of AEFs, it focuses in particular on the deployment capabilities of ECS functional areas. ECS is worthy of close attention because the ECS personnel have borne a heavy deployment burden in the past several years. An understanding of the levels of deployment capabilities the AEFs possess for expeditionary combat support functional areas is imperative for planning that will generate a more predictable and balanced distribution of deployment duties across all career fields.

Organization of This Report

Chapter Two outlines a method for quantifying AEF capabilities and illustrates the role this method plays in the new capabilities-based planning environment. Chapter Three gives more detail on AEF policies and databases and provides a detailed description of an analytical tool for quantifying deployment capabilities in AEFs. Chapter Four explains uses of the method and presents illustrative results. Finally, in the last chapter, we recommend strategies to facilitate the implementation of such an analysis framework.

---

[8] See Snyder and Mills, 2004, for more information on START.

CHAPTER TWO

Measuring AEF Capabilities

One of the tenets of the current U.S. defense strategy is to transform planning from a threat-based posture to a capabilities-based posture. In practice, this transition means that Air Force planning is shifting from preparing to fight specific enemies in known geographic regions to possessing a "portfolio of capabilities" that can perform a range of specified missions in a broad range of locations.[1] For both deliberate and crisis-action planning, this transition implies an increase in the number of deployment scenarios to be defined and analyzed.[2] This shift in planning priorities has two significant implications for setting and evaluating AEF policies.

First, capabilities-based planning highlights the need to articulate how AEF policies shape deployment capabilities. Currently, in addition to expressing capabilities in terms of the manpower and equipment available for deployment, measures of AEF capabilities are task-oriented. For example, a given AEF is said to have a certain defensive counter-air capability, a certain suppression of enemy air defenses (SEAD) capability, and so forth. Comparable expressions of AEF combat support capability, such as how many bases can be opened or augmented, have not been as clearly articulated. When AEF policies are analyzed in terms of the deployment capabilities that they define, it becomes easier to determine whether the policies meet

[1] Rumsfeld, 2001.

[2] Davis, 2002.

desired steady-state deployment capabilities specified by national military objectives.

Second, as the number of deployment scenarios considered in the planning process increases, the need arises for tools that can assist in the analysis of force structure, capabilities, and risk. For AEF planning, an automated analysis tool would express how well AEF resources could meet a variety of specified deployment goals. This chapter outlines our basic strategy in developing such a tool.

Our approach to quantifying and evaluating AEF capabilities involves the following three steps, which are explored in the following sections:

- defining metrics of deployment capabilities
- identifying the manpower and equipment required to generate those deployment capabilities
- comparing the identified required resources against the resources that are authorized or available for deployment.

Defining Deployment Capabilities

The term *capability* refers to the maximum capacity to execute a specified mission. The term is very broad in scope, and, consequently, within the Air Force, many measures of capability are used. Capabilities cover areas as widely dispersed as operations, management, planning, training, and combat support. For an AEF, the relevant capability is deploying a force to meet the needs of combatant commanders.

Currently, the Air Force quantifies its capability to deploy with two principal units of measure: (1) UTCs and (2) sets of UTCs called *Force Modules.*[3] UTCs are units of capability specified by required manpower and equipment. UTCs range considerably in size and composition. Some UTCs consist of an individual airman with speci-

[3] Force Modules are currently being developed and refined. Responsibility for them now resides in AF/XOXW.

fied skills; other UTCs include dozens of personnel and hundreds of tons of equipment. UTCs are designed to be the building blocks for deployment; they may be equipment only, manpower only, or a mix of the two. Typically, because Air Force UTCs are small units of capability, the full capability for a given functional area will consist of a set of UTCs. For example, setting up fueling operations at a bare base requires about 15 different UTCs. None of these UTCs alone provides the full fueling storage and distribution capability, but, together, a set of fuels UTCs can support, for example, a squadron of F-16CJs flying a sortie rate of two sorties per day per aircraft at a single base with a specified fuels infrastructure. A different type of aircraft, different numbers of aircraft, a different base infrastructure, or a different sortie rate would result in a different deployed capability and, thus, would require a different and distinct set of UTCs. UTCs are sufficiently small, modular, and numerous that sets of UTCs can express virtually any desired deployment capability that the Air Force requires.

Recently developed sets of UTCs to develop a generic bare base to support flight operations have been codified as Force Modules. Five Force Modules are being developed: to open a base, to provide command and control, to establish a base, to generate the mission, and to operate the base.[4] Each of these modules comprises about 30 to 120 different UTCs. The idea is that these sets of UTCs will be as lean as possible, but sufficient to perform the stated mission. The process of constructing the Force Modules led to a refinement of a number of UTCs, especially to resize them for smaller deployments and to integrate them across functional areas. Although Force Modules incorporate implicit rules regarding which UTCs are necessary for the specified missions, Force Modules explicitly specify a common requirement for all missions and all types of deployed locations.

Although both UTCs and Force Modules constitute sets of resources, they are specifically defined to have a corresponding capability, and, in this way, they also present one way to express Air Force

[4] Elliott, 2003.

capabilities.[5] For example, in the case of UTCs, mission capability (MISCAP) statements specify desired capabilities, and, in the case of Force Modules, the capabilities that enable the setup and performance of operations at a bare base are defined. Subject-matter experts determine what resources are needed to achieve these capabilities, an equivalence that designates a one-to-one relationship between resources and capabilities. In this manner, the number of available sets of resources constitutes a measure of corresponding Air Force capabilities.

In addition to individual UTCs and collections of UTCs in the form of Force Modules, the Air Force evaluates its capabilities according to quantifiable units in a Master Capabilities Library (MCL). The Master Capabilities Library exhaustively lists all the capabilities that the Air Force possesses, broken down to a level that enables them to be quantified. For example, one capability within the expeditionary combat support area is the provision of warm meals. This capability is quantified by measures of proficiency (how long it takes to provide warm meals at a base after deployment) and sufficiency (how many bases can be supported).

These capabilities are currently evaluated annually by Risk Assessment Teams (RATs) to support the Capabilities Review and Risk Assessment (CRRA), for which the MCL was devised. The CRRA is a process for evaluating Air Force capabilities for programming purposes. As such, the MCL and the CRRA analyze at levels independent of UTCs and the AEFs; they do not, therefore, provide information directly relevant to AEF deployment capabilities, nor have sets of required resources been determined for these Air Force capabilities. Collectively, UTCs, Force Modules, and the MCL fall short of expressing the capabilities of AEFs in ways that relate to planning objectives, and they do not express the full range of recent Air Force deployments.

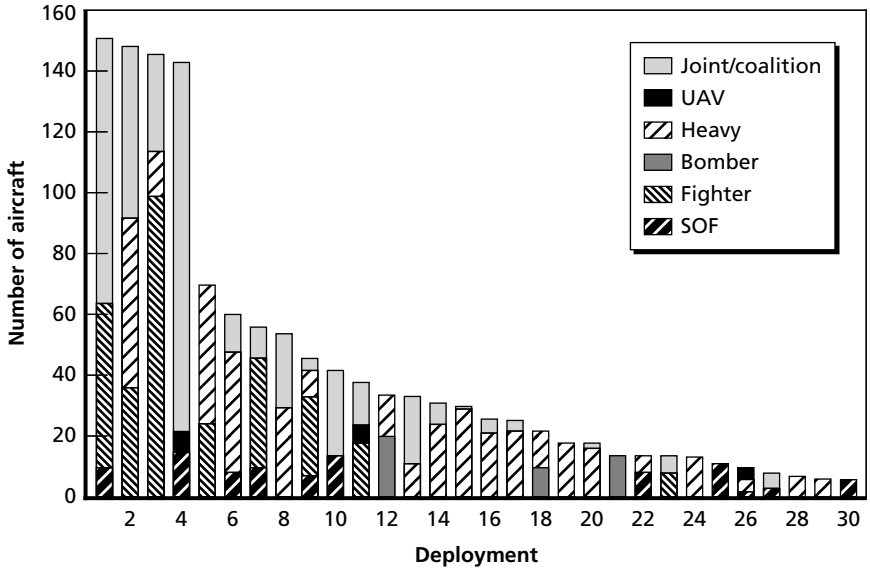
---

[5] The Air Force defines Agile Combat Support capability as "the combined capacity of personnel, materiel, equipment and information in measured quantities that, acting together in a prescribed process (singular and/or combined tasks), can be used to achieve desired effects" ("Agile Combat Support CONOPS," 2005, p. 11).

In the years since the end of the Cold War, no typical Air Force deployment has emerged. During this period, the Air Force has deployed a wide range of numbers and types of aircraft to a variety of locations. Air Force aircraft often shared deployed locations with other services or coalition partners, and those locations have a wide range of support structures. Figure 2.1 shows the numbers of each type of aircraft deployed to 30 different locations to support Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF).

Note that the bases to which the aircraft were deployed support anywhere from fewer than ten to about 150 aircraft, and, in 17 of the 30 cases illustrated, the Air Force shared the deployed location with another service or with coalition partners. Although not depicted in the figure, these bases also span the range of available support infrastructure, from nearly true bare bases to fairly well-equipped inter-

Figure 2.1
Numbers and Types of Aircraft for 30 Recent Deployments



NOTES: UAV = unmanned aerial vehicle; "heavy" aircraft include all C-130 and larger aircraft, excluding bombers, which are grouped separately. Fighters include A-10s.

national airports and coalition-partner military air bases. Note also that the bases support nearly every aircraft mix, with very few sites supporting only one airframe type.

The more that a measure of deployment capability subsumes this range of deployed aircraft, missions, and types of locations, the more relevant that measure is to evaluating how well the Air Force can meet planning objectives. The first step in determining whether objectives can be met is to establish a suitable definition of deployment capability—one that captures the range of Air Force deployments and is broad enough in scope to be relevant to defense plans. To accomplish this step, we define a measure in the spirit of UTCs and Force Modules, but one that is broader in scope and is a function of relevant parameters, such as types of aircraft, their missions, and base infrastructure. Deployment requirements and capabilities that are explicit functions of such parameters we term *parameterized* requirements or capabilities. This approach is in contrast with approaches that approximate the requirements at all locations identically. As with UTCs and Force Modules, the parameterized measure of capability is defined by the availability of sets of resources to perform a corresponding capability. This parameterized measure is expressed as sets of UTCs, but is more reflective of the varieties of deployments that the Air Force makes than those expressed by Force Modules.

Because deployment requirements are largely driven by a limited number of factors—the number of aircraft, type of aircraft, missions flown by aircraft, base population, the threat to which the base is exposed, and any pre-existing infrastructure—those factors naturally describe a set of parameters for defining deployment requirements. The relationship of all required resources for a deployed operation, as specified by a parameterization of this set of driving factors, provides a more-nuanced definition of Air Force capabilities than either UTCs or Force Modules alone. We quantify AEF capabilities by such a metric, which we call *deployment capability*.

From this point on in this report, we use the term deployment capability (of an AEF) to mean, specifically, the capacity to deploy a specified mix (i.e., number and type) of aircraft (in an AEF) that have

the ability to perform their designated missions at some specified sortie rate to a specified number and specified types of bases. Examples of this metric include the capability to open a bare base in a high-threat environment to support a squadron of 18 A-10s and the ability to enforce a no-flight zone out of two coalition military airfields, using a range of fighter and heavy support aircraft operating at a specified tempo. A deployment capability may express the capacity to deploy any mix of aircraft to one or more locations with varying infrastructures and levels of risk.

As a corollary metric, we define *marginal deployment capability* as the capacity of an individual functional area to support its component of the overall specified deployment capability. For example, one marginal capability might be the capability of the fuels functional area to support a squadron of fighters and several support aircraft flying a certain sortie rate out of an international airport where access to the fuel hydrant system is denied. Note that in the case of fuels support, to specify the capability requires a specified operational tempo (i.e., sortie rate). The sum of the set of the marginal deployment capabilities gives the deployment capability.

Defined this way, deployment capability is a function of more than the availability of aircraft and their directly associated manpower (pilots, maintainers, and such). It is also a function of the ECS necessary to operate and support those aircraft. The nature and levels of the required ECS will depend on the following parameters: the operational tempo, the number of deployed sites, the range of infrastructure at those sites, and the threat environment. As of this writing, the Air Force has not yet developed and implemented an analysis tool to quantify deployment capability as a function of these parameters.

Determining Resource Requirements for Deployment Capabilities

A method for translating deployment capabilities into required manpower and equipment resources is needed to establish the capabilities of resource levels in the AEFs in terms of deployment capabilities. As

much as possible, the calculated resources should express a total rather than a partial capability. For example, although a UTC consisting of F-16CJs can be said to have a SEAD capability, that UTC can provide that capability only if other support areas, such as fuels and intelligence, are present. The term deployment capability, as used in this report, is meant to embrace the sum of the support needed across all functional areas at a deployed location.[6] And, it should also represent as much as possible the range of deployment types shown in Figure 2.1.

There are two options for quantifying the equipment and manpower resources required to support deployment capabilities in terms of UTCs: (1) the Air Force's Force Modules and (2) the Strategic Tool for Analysis of Required Transportation, the parameterized (computer) model developed by RAND researchers.[7] We used the START model for all the analyses in this study. Although START is not Air Force policy, it provides a degree of parameterization that illuminates deployment capabilities not captured in the current Force Modules. Additionally, although they are now well vetted, the Force Modules were not fully defined at the time of this study, precluding their use.

While Force Modules were designed to establish a list of required "lead" UTCs and "follow-on" UTCs that augment the capabilities of the lead UTCs, the modules themselves are conceptually discrete, with the exception of the multiple "vignettes" of the "generate-the-mission" module. Still, despite the recent introduction of Force Modules, Air Force planners must work with a discrete, albeit large, set of deployed force options rather than a parameterized, rules-based model.

We emphasize that the two approaches, Force Modules and START, are compatible estimates of resource requirements. For a given deployment capability, a set of manpower and equipment

---

[6] The term deployment capability refers to a given site or set of sites and, hence, excludes some support that might lie outside those sites, such as AWACS.

[7] See Snyder and Mills, 2004.

UTCs is needed, regardless of whether the requirements are expressed as Force Modules or as lists of UTCs generated by a parameterized model. By being parameterized, however, START allows detailed analysis at a level not possible with the Force Modules. That is, all of the following analysis could have been done using Force Modules as estimates of required resources, but the analysis would not have answered as many questions regarding deployment capability as the modeling approach described here. We point out such examples as they are presented.

The START Model

In this section, we give a brief overview of the START model.[8] START calculates, for each deployed location, a list of the principal UTCs needed to support operations at that location. The UTCs are determined by a set of rules that are specific to each functional area. The UTCs are determined by the number of aircraft, type of aircraft, missions flown by aircraft, the base population, the conventional and unconventional threats to which the base might be exposed, and the infrastructure already existing at the base or that is readily available on the local market. Each of these inputs is specified by the user by means of a checklist, with the exception of the base population input, which is estimated from Air Force planning factors.[9] A base is specified as either a bare base or a base with infrastructure beyond a bare base. For the latter, the user specifies on a checklist the nature of the existing infrastructure.

START automates the logic used in generating UTC requirements; it captures the various rules typically used by subject-matter experts in the Air Force when they build a list of UTCs needed for a

[8] For a full description of START, see Snyder and Mills, 2004. For START's computer hardware and software requirements, see Appendix A of this report.

[9] See Air Force Pamphlet (AFPAM) 10-219, 1996, p. 34.

certain deployment capability.[10] RAND compiled these rules from discussions with senior noncommissioned officers at Major Command (MAJCOM) and Air Staff levels and from rules already codified in Air Force publications. Calculations for a number of sites can be summed to give the total theater requirements for a specified deployment capability. The calculations result in a list of UTCs that are required to support the specified deployment. In just a few seconds, the START tool can produce a list of the UTCs to support a deployment requirement—a task that, done manually, can take weeks. START accomplishes this task using an embedded knowledge base that can be updated as needed when modernization results in changes in deployment requirements. It also integrates the task of estimating deployment requirements for many functional areas. The functional areas modeled by START are listed in Table 2.1.

The START model also provides requirement summaries by functional area in terms of weight (in short tons) and volume (in cubic feet).[11] These results are displayed in both tabular and graphical formats. Finally, START provides an overall total of weight and volume of the requirements in terms of C-17 aircraft equivalents.

Assessing AEF Capabilities

In this section, we describe a method designed to express the capabilities inherent in AEFs. We begin with an overview of the aspects of AEF policies that play a role in determining how AEF capabilities can be articulated. In doing so, we focus on four issues that affect capabilities metrics: whether the Air National Guard (ANG) and Air

[10] Such lists, after each UTC is sourced to a specific unit and assigned times for embarkation and debarkation, are referred to as Time-Phased Force Deployment Data (TPFDD).

[11] In addition to breaking out requirements by UTC, START provides both total cargo weight and a breakout of cargo weight by bulk, oversized, outsized, and non–air-transportable cargo. Data for weight and size come from the Manpower and Equipment Force Packaging System (MEFPAK) and Logistics Force Packaging (LOGFOR) databases, which are maintained by AF/XOXW.

Table 2.1
Functional Areas Covered by START Model

UTC	Description
3****	Aviation
HE***	Intermediate maintenance
HF*** [a]	Intermediate maintenance, excluding battle damage repair
HG***	Munitions maintenance squadrons
HH***	Munitions maintenance squadrons
JFA**	Maintenance readiness spares packages
	Sortie generation equipment
UFB**	Aerial port operations
4F9E*	Civil Engineering craftsman
4F9D*	Civil Engineering readiness
4F9F*	Civil Engineering fire protection
4F9X*	Civil Engineering explosive ordnance disposal
4F9R*	Civil Engineering RED HORSE
XFB**	Bare base support
	Munitions (excluding chaff, flares, and ammunition)
JF***	Fuels
6K***	Deployed communications
QFE**	Security forces
FF***	Medical
	General-purpose vehicles

[a] Excluding HFU** UTCs.
NOTE: Some equipment listed in this table does not fall within UTC categories.

Force Reserves (AFRES) are called up to active duty, the readiness status of UTCs, the effects of home-station needs on the availability of UTCs for deployment, and whether capabilities are limited by the availability of manpower and equipment expressed by UTCs or by the availability of manpower as expressed by Air Force Specialty Codes (AFSCs).[12]

[12] An AFSC groups personnel who have similar skills, qualifications, and experience. When a UTC specifies the need for a manpower position, it does so by way of an AFSC. For example, all aircrew operations personnel have an AFSC that begins with 1A, followed by three digits that specify their specific skills. One example within aircrew operations is an aircraft loadmaster. Loadmasters at an apprentice level have an AFSC of 1A231, with the second-to-last digit indicating a skill level of 3. Journeymen loadmasters (skill level 5) have an AFSC of 1A251, and so forth.

Incorporating Air National Guard and Air Force Reserve Call-Up Status

Under the Cycle 4 AEF policies analyzed in this report, the Air Force was organized into ten AEFs and a set of enabler forces. The ten AEFs were scheduled to provide forces and support in AEF rotational pairs, and each AEF pair was scheduled to cover a 90-day period in meeting the peacetime Small-Scale Contingencies (SSCs). The ten AEFs covered a 15-month period, called an *AEF cycle.* Prior to cycle 4, which began June 1, 2003, AEF policies had, in addition, called for two Aerospace Expeditionary Wings (AEWs), which were scheduled to alternate to cover a 120-day on-call period.

Air National Guard and Air Force Reserve UTCs are assigned to AEFs as well as enablers. Cycle 4 AEF policies stipulated that, in the absence of an Air Reserve Component (ARC) call-up, active-duty personnel deployed 90 days per 15-month cycle and Reserve and Guard personnel volunteers deployed for 15 days per 15-month cycle. ARC personnel served more than 15 days if they were needed and were willing to serve longer. These limits do not apply when ARC personnel were called up to active duty, as happened in OEF in Afghanistan and OIF, when they deployed according to the same rules as active duty personnel.

Assessing Availability Based on Authorized Force Levels Versus UTC Readiness Status

An *AEF library* is a list that assigns UTCs to one of the ten AEFs or to one of the two enablers. Actual demand for forces and support is to be met by the resources in the AEF libraries. The AEF libraries are generated at sourcing conferences attended by Air Staff and MAJCOM functional area managers.[13] At these conferences, integrated process teams meet to develop the AEF UTC schedule that specifies which UTCs will meet which rotational deployment requirements. These policies assign UTCs to specific AEFs and enablers. The AEF libraries are not fixed during a cycle; they are up-

[13] See AFI 10-400, 2002, for more information.

dated as needed. These libraries are composed of UTCs specified by the MAJCOMs to meet AEF requirements based on authorized levels of manpower, not actual staffing levels. Thus, the AEF libraries list all UTCs that theoretically are available for use under AEF policies, and, as such, the AEF libraries provide an upper bound on the AEF capabilities.

To address the issue of readiness, the AEF Center (AEFC) maintains a separate database that monitors the readiness status of each UTC in the AEF libraries. This classified database, called the AEF UTC Reporting Tool (ART), lists the status of each UTC as fully mission capable, partially mission capable, or not mission capable, as reported by the responsible unit every 30 days.[14] More-detailed fields designate specific reasons for the UTC's not being fully mission capable.[15] In this fashion, the ART database provides a dynamic summary of an AEF's readiness capabilities, in contrast to the AEF libraries, which give a dynamic summary of an AEF's authorized capabilities.

Assessing Availability of UTCs for Deployment

Currently, the vast majority of Air Force personnel appears in an AEF library UTC, yet it is not practical for each UTC to have the same vulnerability for deployment. Because of home station, Air Staff, and other requirements that persist during deployments, a coding system has been developed to prioritize the selection of UTCs for deployment. This system is called *non-sourced UTC* (NSUTC) coding, or as it is more commonly known, the "availability coding." This code is assigned by the relevant MAJCOM following Air Staff guidance[16] to each UTC in the AEF libraries.

Availability coding distinguishes, first, between UTCs that are not generally considered deployable (e.g., Air Staff positions, field

---

[14] If a UTC is not updated for 30 days, the UTC's status is listed as "not reporting."

[15] See AFI 10-244, 2002, for more information on ART.

[16] The guidance is imprecise enough that the MAJCOMs appear to assign their NSUTC codes slightly differently.

operating agencies, teaching posts) and those that are generally deployable. UTCs are further distinguished based on whether they are available for steady-state deployments, available for full major-theater war, or needed for home-station requirements. We discuss these codes in more detail in the next chapter.[17]

Measuring Capabilities by UTCs and AFSCs

There are many potential metrics for the capabilities of an AEF. We explore two—a pair of metrics that effectively bound estimates of capability. The lower bound, or "pessimistic" estimate, is derived from a comparison of UTCs in the AEF libraries with UTCs required for a deployment. The upper bound, or "optimistic" estimate, does the same with AFSCs. We call the first metric the "UTC-constrained metric" and the second the "AFSC-constrained metric."

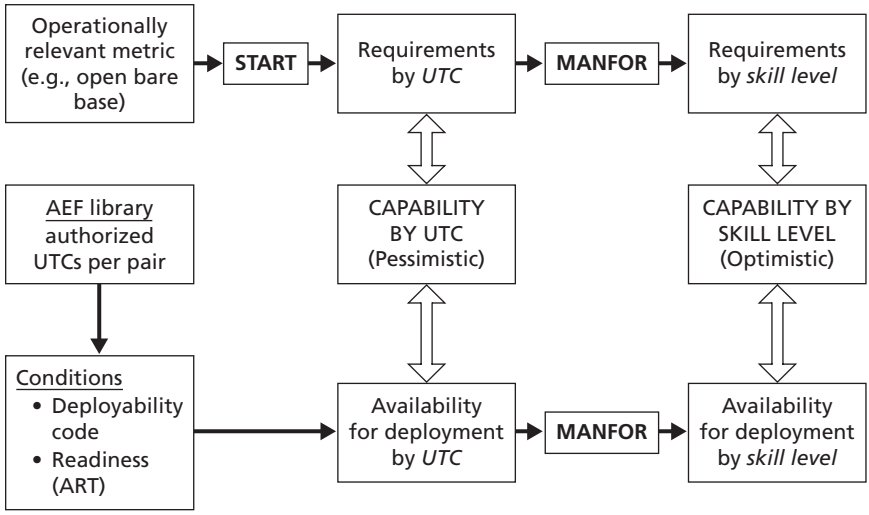
Figure 2.2 illustrates these two measures. The upper row of boxes depicts the requirements to perform a deployment capability. First, deployment capability is specified by some operationally relevant metric. Then, the RAND START model generates the list of UTCs needed for this capability (i.e., the requirements by UTC). The manpower force packaging (MANFOR) database further specifies the AFSC (i.e., requirements by skill level) for each manpower slot in each UTC. Hence, the requirements for each deployment capability can be specified at either the UTC or AFSC level.

The lower row of boxes depicts the availability of resources in the AEF libraries. The AEF libraries list the available resources by UTC, and these resources can be culled according to various classifications (discussed later in this chapter). Like the deployment requirements, the available resources can be specified at the UTC or the AFSC level by reference to the MANFOR.

At first glance, it might appear that comparing requirements with available resources at the UTC and the AFSC levels would give the same answers, only differing by degrees of detail. Such is not

[17] See AFI 10-400, 2002, for more information on the NSUTC codes.

Figure 2.2
Methodology for "Optimistic" Estimate and "Pessimistic" Estimate of Manpower Capability



always the case, however, because of the multiple potential ways in which manpower positions can be assembled into UTCs in the AEF libraries. The following example helps to explain the distinction between resources at the UTC level and the AFSC level.

According to AEF policies, each member of the Air Force is assigned to a UTC, but in many cases, personnel with a given AFSC could, in principal, serve in more than one UTC, because many AFSCs appear in multiple UTCs.[18] For example, an airman with 3P051 specialty code might be assigned to either of the two principal security forces UTCs: the QFEBS flight leadership element or the QFEB2 security forces squad.

Each Major Command has some latitude, given the manpower, in determining the ratio of flight leadership elements to security forces squads. Decisions such as this are generally based on expecta-

[18] For some functional areas, there are few opportunities for such substitutions because of specific training required for the UTC (e.g., medical). In other areas, such substitutions are reasonable (e.g., fuels support and security forces).

tions of need. If plans call for deploying to many small bases, the ratio might favor flight leadership elements. If plans call for deploying to a few large bases, the ratio might favor security forces squads. When assessing AEF capabilities, such as with the process illustrated in Figure 2.2, comparing required and available resources by UTC (i.e., a *UTC-constrained estimate*) and comparing required and available resources by AFSC (i.e., an *AFSC-constrained estimate*) provide two different perspectives of capabilities.

The UTC-constrained estimate indicates how the actual assignment of manpower to UTCs in the AEF libraries would satisfy the deployment requirement. The Air Force can do no worse than this, and hence it is a lower-bound estimate on the capabilities. Or, it is a "pessimistic" estimate in that it assumes a certain inflexibility—that the Air Force is not agile enough to assign personnel during a contingency to any UTC other than the UTC to which the personnel are assigned in the AEF library.

The AFSC-constrained estimate indicates what the Air Force could do if it had assigned its manpower to UTCs specifically to achieve the specified deployment capability. The Air Force can do no better than this, and hence it is an upper-bound estimate. In another sense, it is an "optimistic" estimate in that it supposes that the Air Force can reassign personnel during contingencies, which in practice is time consuming and risks disturbing unit cohesion.

A final note on these two measures: Proposing a measure of capability by AFSCs is not to suggest that UTCs should be discarded in favor of AFSCs in expressing AEF deployment units. Our point is that the full range of capability should be explored, perhaps to guide reassignment of UTCs in the AEF libraries, not that the Air Force should abandon UTCs as fundamental units of deployment. As we show in the next chapter, in most cases, there is little difference between pessimistic and optimistic estimates of AEF capability.

Using Multiple Metrics to Assess AEF Capabilities

From the above observations, the desirability of having a number of ways to quantify the deployment capabilities of an AEF pair becomes evident. For some purposes, it may be informative to examine the

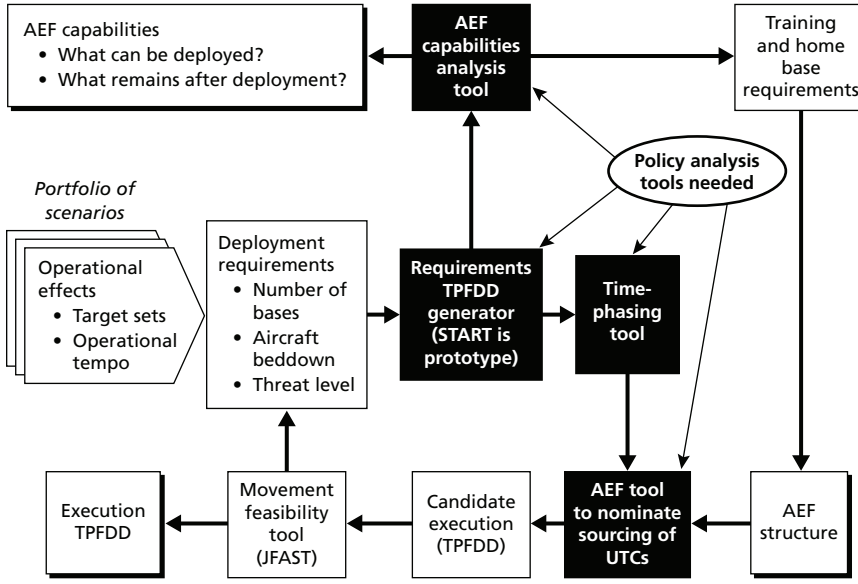
capabilities of the authorized levels in the AEF libraries. But, given that many units are not manned at the authorized levels, the units might not possess the resources to fully man all their UTCs. In these instances, it may be worthwhile to examine the capabilities of fully mission capable UTCs only in an AEF pair. Further, the capabilities could be measured by the availability (NSUTC) coding of the UTCs or by whether or not the Air National Guard and the Air Force Reserves are called into active duty. And, the analysis can be bounded by UTC-constrained and AFSC-constrained estimates. This range of views of AEF capabilities suggests the need for a database tool to integrate requirements for deployment capabilities with a range of queries against the AEF libraries. The next chapter describes such a tool.

AEF Deployment Planning

Before describing a decision-support tool for assessing AEF capabilities, we discuss how such a tool can fit into the overall planning process, and the need for the development, integration, and implementation of a number of associated decision-support tools. We do not address the concepts for these other tools in this report. Nevertheless, we mention them because of the importance of integration—these tools should be developed considering their broader context.

The centerpiece of deployment requirements is a list of UTCs from all the services (the time-phased force deployment data [TPFDD] list). The TPFDD not only lists the UTCs to be deployed but also specifies who will supply the UTCs and many details on their shipment, including the time and place of embarkation and debarkation (i.e., their time-phasing). Figure 2.3 shows a simplified, schematic overview of the TPFDD building process, highlighting some potential areas for increased automation and how such automation might assist in setting AEF policies that are consistent with a broad portfolio of deployment scenarios.

Figure 2.3
Analytical Tools to Support AEF Planning



The layered arrows on the left of Figure 2.3 depict the portfolio of planning scenarios,[19] expressed as sets of desired operational effects. Elements of this set of scenarios might include the ability to conduct an operation such as Operation Southern Watch, the ability to defend the Korean peninsula against attack, the ability to interdict drug smuggling, the ability to conduct a humanitarian relief operation of a given scale, and so forth. For each element of this set of capabilities, operational factors determine which aircraft are needed, their operational tempo, and the beddown distribution. That is, a deployment capability is determined.

The box in the center of the figure depicts an analytical tool that translates this deployment capability into the manpower and equipment needed to generate this capability. In this report, we use the

[19] Rumsfeld, 2001.

START model for this step; Force Modules are a more limited alternative for this step. The manpower and equipment are expressed as a list of required UTCs, which we call a *requirements TPFDD.* Unlike a TPFDD list, a requirements TPFDD list specifies only UTCs with no additional details, such as who will supply the UTCs or when they are to be moved.

In the scheme proposed in Figure 2.3, two other analytical tools perform this function of finding candidate providers of UTCs from specific units (sourcing) and time-phasing the UTCs. The result is a candidate execution TPFDD. For the final step, a tool currently exists to evaluate the feasibility of this TPFDD—the Joint Feasibility Analysis System for Transportation (JFAST). This tool simulates the execution of a TPFDD to estimate when UTCs would arrive at their destinations relative to the desired arrival times. The JFAST is quite detailed, in that it solves for shipping routed by ground, sea, or air, and includes details such as constraining airlift according to available aerial refueling. Of the existing tools depicted in Figure 2.3, it is by far the most detailed and complex.

In practice, the planning process is nonlinear, in the sense that some trial and error and iteration occur when building a candidate execution TPFDD. A proposed TPFDD is made, the individual UTCs are sourced and time-phased, and the result is assessed with the JFAST software. As needed, the TPFDD is revised until a TPFDD that meets operational needs is generated.

The box above the requirements TPFDD box shown in Figure 2.3 depicts the AEF capabilities analysis tool method described in this report. This tool is designed to indicate whether AEF policies and resources are flexible enough to satisfy the entire portfolio of desired capabilities in a manner that also provides predictability of deployments to Air Force personnel. The combination of desired deployment capabilities, home station and training requirements, and resource levels determines AEF policies.

This approach allows one to examine the issue of aligning resources and policies in either of two ways: One may ask how satisfactory a set of AEF resources and AEF policies is at meeting a given deployment capability in the portfolio of desired capabilities. Or, one

may ask how AEF policies can be optimized to satisfy a given set of desired deployment capabilities. The analysis framework described in this report lays the foundation for addressing these two important questions.

CHAPTER THREE

AEF DCAT—A Decision Support Tool for AEF Capability Analysis

Following the method described in Chapter Two, this chapter describes the AEF Deployment Capabilities Assessment Tool (DCAT). This prototype tool is designed to assist with planning by providing metrics for analyzing deployment capabilities given certain AEF policies. This Web-based tool integrates a number of Air Force databases, and, using a variety of filters, compares resource levels with requirements determined by the START tool developed by RAND (see Chapter Two). Given the importance of the Air Force databases in AEF DCAT, we provide an overview of those databases and their main characteristics, followed by a description of AEF DCAT's architecture.

Databases

AEF Libraries

As discussed earlier, to spread capabilities across the AEFs as evenly as possible and to avoid any base being in more than two different AEFs during one AEF deployment cycle, an integrated product team assigns all Air Force UTCs among ten AEFs and two AEWs (through Cycle 3) or as enablers.[1] These assignments of UTCs into AEFs and enablers are stored in the same form as TPFDD lists and constitute the AEF libraries. The AEF libraries form the principal databases for

[1] See AFI 10-400, 2002, for more details.

AEF manpower resource levels used in the AEF DCAT. Plan identifiers (PIDs) in the AEF libraries indicate the AEF and cycle numbers; other fields supply the units that are assigned to the UTCs and related information.

One important attribute of each UTC in the database is the NSUTC. In light of home station requirements, this attribute states the availability of each UTC for deployment and is specified in the AEF libraries by the first character of the Unit Line Number (ULN). Given the importance of this code to understanding the programmed availability of UTCs, it is worth examining the NSUTC in some detail.

Each NSUTC has three characters; together, they specify eight different states of deployability. The MAJCOMs allocate all authorized manpower positions in their units into UTCs regardless of home station and training needs. They then assign an NSUTC to each UTC that specifies the circumstances under which that UTC deploys. The standard elements of a unit's capabilities that can meet the UTC MISCAP statement are called *deployable UTCs,* and capability elements that cannot be specified as such are called *associate UTCs.*[2] Deployable UTCs have "D" as the first character of the NSUTC; associate UTCs have "A" as the first character. The idea is to deploy D-coded UTCs first and fill any D-UTC deficiencies with A-coded UTCs only when requirements cannot be met with D-coded resources.

The purpose of A-coded UTCs is to give planners visibility of every member of the Air Force, even those not serving in a deployable unit. For example, an A-coded UTC is created is when an airman fills a position, such as at a maintenance depot or on the Air Staff. In this case, the unit cannot provide a full UTC that meets a MISCAP statement, but the individual is capable of filling part of that UTC. Placing such an individual in an associate UTC provides this position

[2] The last three characters of an associate UTC as they appear in the AEF library are ZZZ, and the first two characters correspond to a functional area. For example, an associate civil engineering UTC would be "4FZZZ." Associate UTCs are not tracked by the AEF Reporting Tool, which is discussed later in this chapter.

with visibility to the AEFC. Such an individual might be tasked to deploy when a D-coded UTC is short one position, and the position can be filled by an individual in an A-coded UTC.

Although the Air Force has endeavored over the past few years to extend the number of manpower positions included in the AEF libraries, the degree to which this extension of manpower positions increases visibility of deployable manpower is tempered by the lack of detail of A-coded UTCs in the AEF libraries. In some instances, a unit or base will group multiple positions into a single associate UTC that the unit or base does not consider deployable. For example, two wings assign nearly their entire manpower resources to an associate UTC: The 8th Fighter Wing at Kunsan AFB and the 51st Fighter Wing at Osan designate about 3,300 and 4,600 authorizations, respectively, as "3FZZZ" UTCs.

The second and third characters of an NSUTC indicate a UTC's availability for deployment. If the second character is a "W," the UTC is deployable in a major theater war (MTW) scenario. If the second character is an "X," it is not MTW-deployable. If the third character is an "S," the UTC is deployable for steady-state tasking; if the third character is an "X," it is not. Therefore, if a UTC is coded "DWS," it is deployable in any circumstance; if it is coded "DXX," it is not deployable in any situation (see Table 3.1 for a list of such codes).[3] The DXX-coded UTCs at a base essentially represent the minimum number of elements of a given UTC that is required to maintain base operations without creating significant and lasting harm to home base support or training. An example of a "DXS" UTC (steady-state-deployable but not MTW) might be a mixed manpower and equipment UTC that has available manpower but not available equipment. Such a UTC could fulfill a manpower requirement in a steady-state scenario by using another unit's equipment, if

[3] In practice, DXX-coded UTCs are deployed. The coding is, in a sense, an indication of the Air Force's intent for deployment, not doctrine.

Table 3.1
UTC Availability Codes

NSUTC Code	First Character of ULN in AEF Libraries	UTC Availability
DWS	1	Available across full spectrum of deployments
AWS	2	Available across full spectrum of deployments
DXS	3	Available for steady-state deployments, but not available for surge
AXS	4	Available for steady-state deployments, but not available for surge
DWX	5	Not available for steady-state deployments, but can be made available for surge
AWX	6	Not available for steady-state deployments, but can be made available for surge
DXX	7	Meets MISCAP statement, but not normally available for deployment due to home station and training needs
AXX	8	For unit commander use only

the unit sourced for deployment lacked its equipment. But during an MTW, not enough equipment exists to fill both UTCs; therefore, the "DXS" UTC could not fulfill the whole requirement.

The AEF DCAT pulls resource levels from the AEF libraries and filters them by NSUTC as specified by the DCAT user. In this way, AEF capabilities can be examined by the planned prioritization of the UTCs for deployment. Several caveats should be kept in mind when looking at data in this manner.

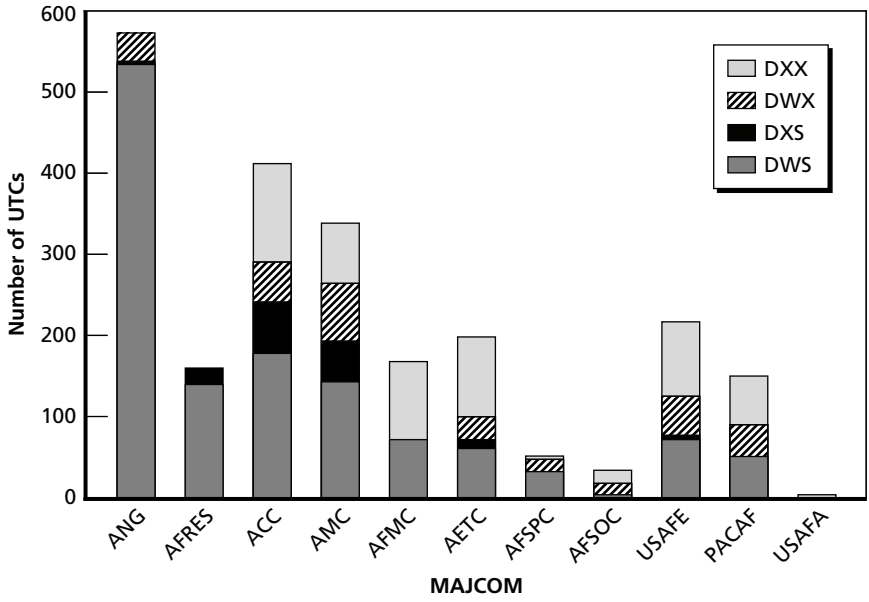
First, availability coding is assigned by each MAJCOM according to guidelines provided by the Air Staff, and those guidelines appear to be interpreted somewhat differently among the MAJCOMs. Much of this variance results from the differing missions of the MAJCOMs, but some variance appears to be arbitrary, especially for combat support areas. One example is security forces, as shown in Figure 3.1. In this case, approximately half of the Air Education and Training Command (AETC) and Air Force Materiel Command (AFMC) UTCs are coded DXX, whereas a significantly smaller fraction are coded DXX by Air Combat Command (ACC) and Air Mo-

bility Command (AMC). We have not been able to explore the reason for all such discrepancies, but it is not obvious why home station needs would vary so widely.[4]

Second, in practice, the coding serves more as a guideline for deployment than as a strict policy. For example, although DXX-coded and associate UTCs should rarely be deployed, they are, in practice, deployed fairly regularly.

Finally, associate UTCs are not captured in a UTC-based analysis of deployment capabilities, because they cannot fill a specific UTC MISCAP statement. With these caveats in mind, however, an analysis of capabilities based on the AEF libraries provides the best current estimate of Air Force deployment capabilities.

Figure 3.1
Number of Security Forces UTCs Grouped by NSUTC for Each MAJCOM



[4] Both the AEFC and AF/XOA are aware of such coding inconsistencies.

The Air Force maintains a related database, the Air Force–wide UTC Availability System (AFWUS). This database lists all approved Air Force UTCs that are listed in the joint Type Units Characteristics (TUCHA) Detail File and the unit to which they are assigned. The TUCHA is a comprehensive list of all approved UTCs from all services; it is the source for all UTCs that go into building a TPFDD list. Unlike the AEF libraries, the AFWUS does not specify the AEF assignment of the UTCs. As of January 2004, there were inconsistencies between the AEF libraries and the AFWUS, although efforts to maintain consistency between these two databases were being undertaken.[5]

Manpower Force Packaging System

The MANFOR provides AFSC and Special Experience Identifier (SEI) information for each UTC.[6] By accessing this database, the AEF DCAT can translate requirements specified as UTCs and resources expressed by UTCs in the AEF libraries into requirements and resources specified by AFSC. This information provides another view of capability, as discussed in the previous chapter.

AEF UTC Reporting Tool

For several reasons, UTCs in the AEF libraries may fail to fulfill their MISCAP statements at some juncture. As mentioned above, UTCs are allocated based on the authorized number of manpower positions. Actual staffing levels may be lower, reducing the capability of the UTC. Further, a unit may be able to supply the manpower to fill a UTC, but the associated equipment may not be available, thus giving the UTC a partial mission capability. Or, a particular airman might be ill or on leave. For these and other reasons, the need has arisen for

---

[5] Lt Col Walter Fulda, AF/XOA, personal communication with RAND, January 28, 2004.

[6] An SEI is a three-character alpha-numeric string specifying an additional level of experience and training beyond that described by the AFSC. For example, the 037 SEI for the personnel working in the fuels area indicates that an individual completed a course in cryogenic liquids and has at least three months experience working in a cryogenic liquids production facility. Not all AFSCs have associated SEIs.

visibility into the actual readiness state of all the UTCs in the AEF libraries, a need that has been filled by the AEF UTC Reporting Tool maintained by the AEFC.[7]

Every 30 days, each unit that is assigned a UTC in one of the AEF libraries is responsible for reporting the readiness status of that UTC in ART. Units report the readiness of their UTCs relative to their mission capability statements in a "stoplight" fashion: "Fully mission capable" is green, "partially mission capable" is yellow, and "not mission capable" is red. Units not reporting after more than 30 days are assigned a "not reported" status automatically by the database. The UTCs that are tasked to deploy are also asked to report whether they can meet specific capabilities requested by the tasking theater commander. Any UTCs that fall short of fully mission capable must list the specific reasons why. Separate data fields in ART provide space for details on manpower and materiel deficiencies. Collectively, the database is classified at the secret level, and anyone with Secret Internet Protocol Routing Network (SIPRNET) access can view the status of every UTC in the AEF libraries.

ART is a dynamic database that is continuously updated in a Web environment. The prototype AEF DCAT is not linked directly to this dynamic database on the SIPRNET, but one version of AEF DCAT links to a static "snapshot" of the ART database from April 2003 for a number of the ECS functional areas. This link enables AEF DCAT to express AEF capabilities in terms of readiness status for UTCs at that juncture, in addition to capability estimates based on authorized manpower levels. No technical limitations prevent AEF DCAT from being linked to the dynamic ART database, giving it an ability to express "real time" AEF capabilities by readiness status.

As with the NSUTC coding, there are some caveats to using ART data to filter AEF capability assessments. First, a substantial fraction of the UTCs are listed as "not reporting" and hence provide

---

[7] As explained in Chapter Two, ART is an Air Force system that reports on the readiness of *individual UTCs*. A similar database, Status of Resources and Training System (SORTS), is a Department of Defense system that reports on the readiness of *units*. For more details on SORTS, see AFI 10-201, 2002.

no readiness information. Second, there have been some growing pains in achieving uniformity of reporting standards. For example, some units that are fully mission capable and meet all expectations but are deployed or tasked to deploy report their status as "green," whereas others that are fully mission capable, meet all expectations, and are deployed report their status as "red," giving the deployment as the reason for their status.[8] Third, no associate UTCs are reported in ART. Nevertheless, ART provides the only assessment of readiness of the AEF libraries.[9]

Equipment Databases

It is important to keep in mind that achieving a specified deployment capability requires a range of equipment in addition to manpower. Although nearly all the authorized manpower is incorporated into the AEF libraries, albeit much of it as associate UTCs, very little of the Air Force's equipment is currently included in the AEF libraries. This omission significantly limits the ability of AEF DCAT to analyze a component of capability determined by equipment resources. Note that equipment must be treated differently than manpower in capability analyses because it does not rotate according to AEF policies as manpower does. AEF DCAT performs an analysis of any equipment in the AEF libraries with the assumption that the equipment need not rotate.

The AEF Deployment Capabilities Assessment Tool

The AEF DCAT system integrates two sets of data: (1) data on requirements to satisfy parameterized deployment capabilities, generated by START, and (2) data on resource levels, as filtered through

---

[8] The AEFC and AF/XOA recognize this problem, and efforts are underway to train units to report their status more consistently. Section 3.4.12 of AFI 10-244, 2002, indicates that fully mission capable UTCs that are deployed should continue to report, and to report their status as "green."

[9] For more information on ART, see AFI 10-244, 2002.

the databases listed in the previous section. Logic that is organic to the program provides a planning and analysis environment. In its prototype form, this logic focuses on AEF Cycle 4 policies. But AEF DCAT can analyze alternative AEF policies and use alternative metrics of deployment capabilities.

As depicted in Figure 3.2, AEF DCAT provides an analytic environment with the programming models, databases, and the graphical user interface (GUI) of a Web browser. The Web provides access to a wide audience and facilitates the structuring and documentation of AEF DCAT and its related data. Appendix A depicts AEF DCAT in the Web environment and lists AEF DCAT's computer hardware and software requirements.

AEF DCAT provides a selected group of measures relating to the availability and capabilities of manpower and equipment resources, all under one integrated Web application interface. Table 3.2

Figure 3.2
AEF DCAT System's Analytic Environment

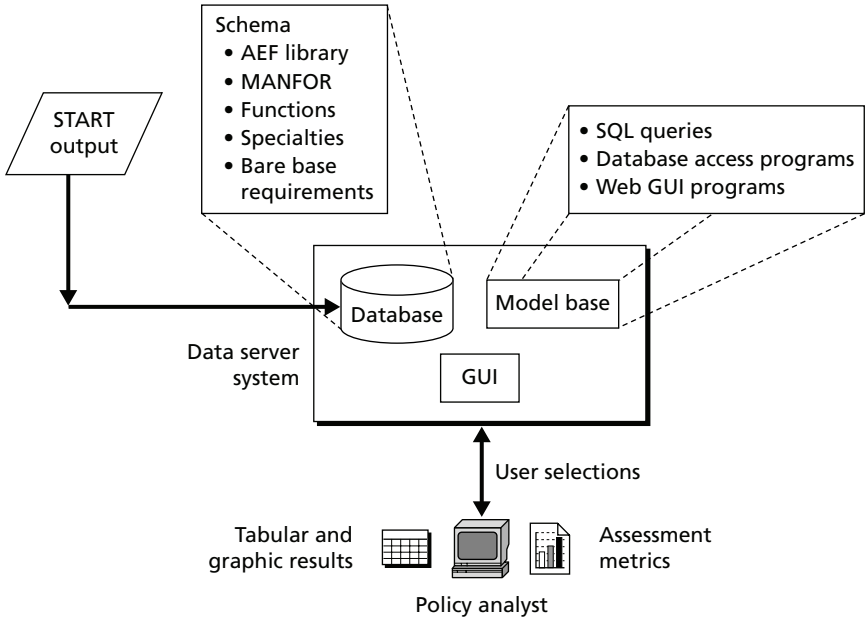


Table 3.2
Manpower Functional Areas Covered by AEF DCAT

Enlisted AFS	Officer AFS	UTC	Unit Type Description
3E*	032E*	4F9**	Civil Engineering
2E*	033S	6****	Communications
2F0*	—	JF***	Fuels
4*	04*	FF***	Medical
3P0*	031P*	QFE**	Security Forces

NOTE: AFS = Air Force Specialty.

summarizes some of the functional areas covered, which were chosen for illustrative purposes. As we describe some of the capabilities of AEF DCAT, it becomes clear that the system's coverage of functional areas can be expanded easily to accommodate queries on manpower resource availability.

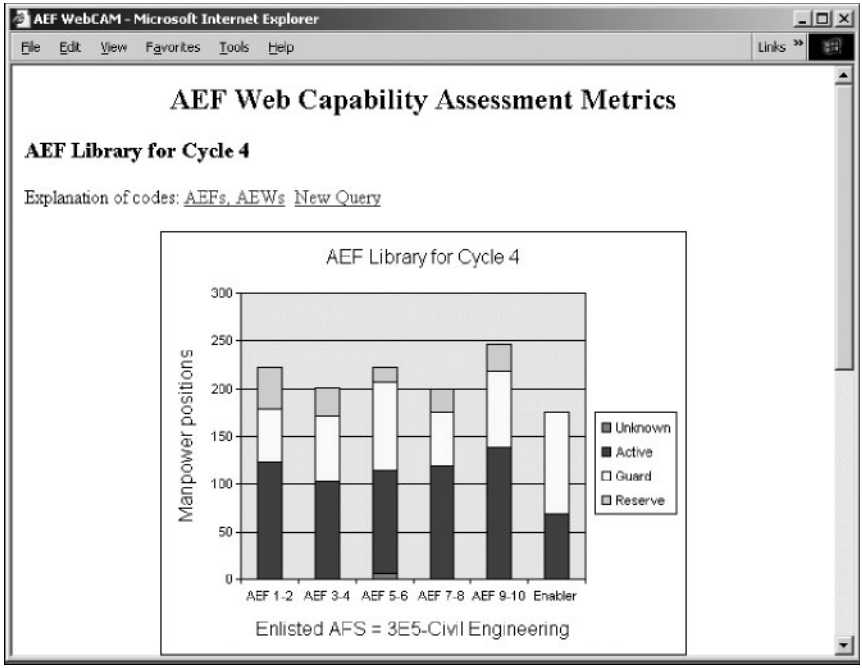
AEF DCAT currently can perform an analysis using two major categories of measures:

- measures of functional manpower resources available by AEF rotational pair (either by component or UTC availability) according to the resources listed in the AEF libraries
- measures of parameterized deployment capabilities for either manpower or equipment resources in the AEF libraries by UTC availability code and ART status reporting.

Both types of measures are restricted by the AEF DCAT's user-specified functional area. The functional selection narrows either the range of AFSCs or UTCs for manpower queries or the range of UTCs for equipment queries.[10] Figure 3.3 shows a sample of the first category of AEF DCAT measure. A corresponding data table is also displayed with each graph; the corresponding table for Figure 3.3 is

[10] Analysis of equipment is limited to the equipment UTCs listed in the AEF libraries.

Figure 3.3
Sample AEF DCAT Resource Summary, Graph Format

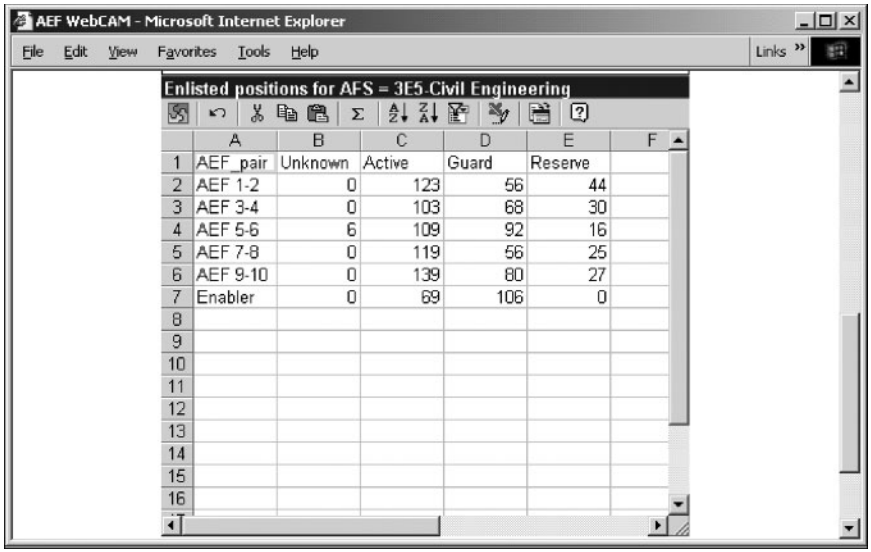


shown in Figure 3.4. The data in the table can be copied from the DCAT window and pasted into files in other applications as needed by the user.

Figure 3.5 shows a sample of the second type of measure used by AEF DCAT. The figure shows a graph of the number of bare bases for an 18-Primary Aircraft Authorization (18-PAA) squadron of F-16CG aircraft that could be opened and established with resources in the AEF libraries under peacetime conditions, if adjustments are made to take into account the different tour lengths of Active, Reserve, and Guard personnel.

Note that both Figure 3.5 and Figure 3.6 show hyperlinks that permit the user to either start a new query or to access corresponding tables or other displays that can help the user to understand the various codes used in the graphs.

Figure 3.4
Sample AEF DCAT Resource Summary, Data Table Format



	A	B	C	D	E	F
1	AEF_pair	Unknown	Active	Guard	Reserve	
2	AEF 1-2	0	123	56	44	
3	AEF 3-4	0	103	68	30	
4	AEF 5-6	6	109	92	16	
5	AEF 7-8	0	119	56	25	
6	AEF 9-10	0	139	80	27	
7	Enabler	0	69	106	0	
8						
9						
10						
11						
12						
13						
14						
15						
16						

AEF DCAT's Relational Database

AEF DCAT's flexibility in creating ad hoc (i.e., user-tailored) queries is achieved through the organization of relevant Air Force data into a relational database that can be manipulated using Structured Query Language (SQL). Table 3.3 lists some of the tables that AEF DCAT uses, and Figure 3.7 shows how they are connected given a query to retrieve manpower resource levels.

Currently, all capability assessment results depend on the user's selection of a UTC requirements file, which can be either the default file provided by AEF DCAT or a START output file specified by the user. START output files define deployment capabilities for one or more bases. The next chapter discusses a number of illustrative examples. AEF DCAT's default UTC requirements file was generated from a number of START model runs, each specifying the UTCs required to open a bare base with a specific number of F-16CJ aircraft

Figure 3.5
Sample AEF DCAT AEF Capability Measure: Manpower

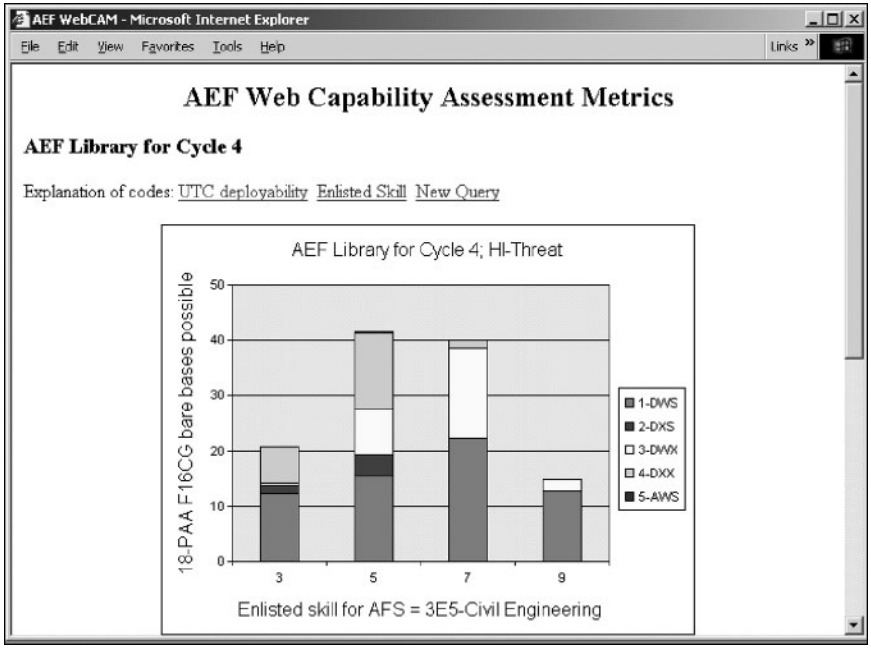
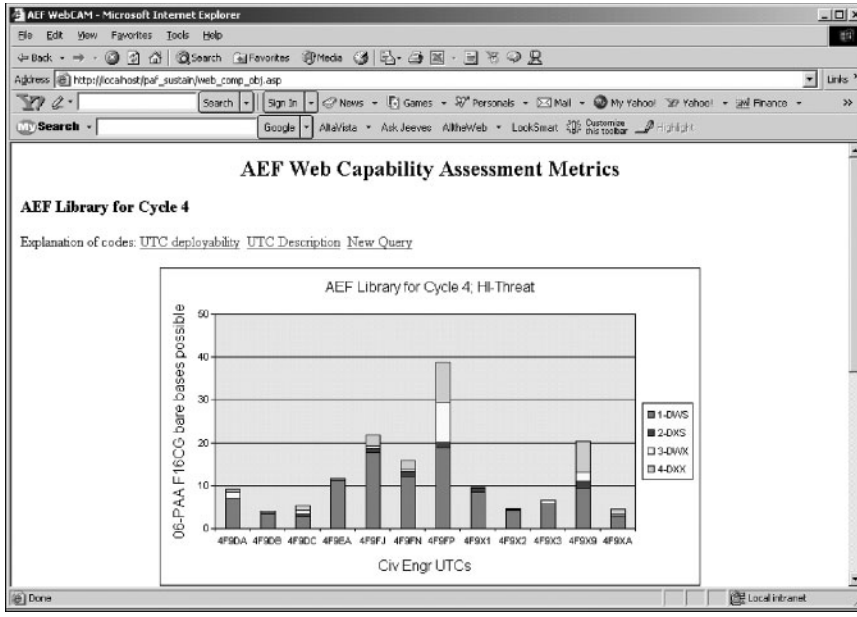


Table 3.3
Partial List of AEF DCAT Database Tables

Table	Primary Key	Air Force Source File	Description
AEFlib_cy4	PID	—	AEF libraries for Cycle 4; December 2002
UTC_detail_manfor_jan02	UTC	MANFOR	MANFOR Type C records; January 2002
Pascodes0109	PAS	PASCODES	PAS codes from Manpower Data System, September 30, 2001
CMD_names	MAJCOMID	—	MAJCOMs
Base_reqs_UTC	UTC, others	Various	Derived from START-generated output
Base_reqs	AFS3, others	MANFOR	Derived from Base_reqs_UTC
ART	—	ART	AEF UTC Reporting Tool

Figure 3.6
Sample AEF DCAT AEF Capability Measure: Equipment UTCs



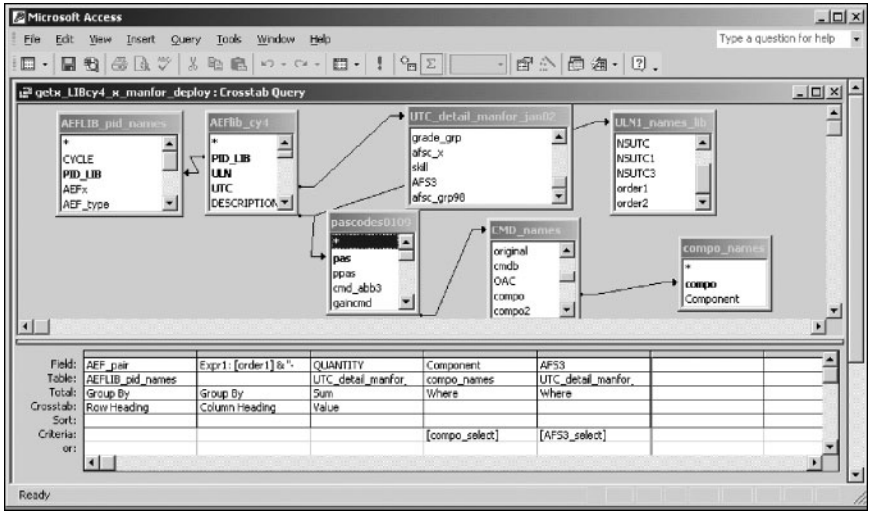
(6, 12, 18, and so forth, up to 72) and the conventional threat to which the base is exposed (high or low).[11] Allowing the user to provide an alternative START-generated file enables a variety of assessment possibilities that are limited only by what the START model can provide.

Manpower Resources, Manpower AEF Rotational Limits, and AEF DCAT

The peacetime rotational limits on manpower distinguish manpower resources from equipment, which did not rotate every 15 or 90 days under AEF Cycle 4 policies. Our measures of capability take this distinction into account. Functional manpower resources may be displayed in AEF DCAT by AEF pair and by component. However, in

[11] For a full discussion of the input parameters for START, see Snyder and Mills, 2004.

Figure 3.7
Sample AEF DCAT Database Query



peacetime small-scale contingencies, an ARC position cannot be counted the same way as an active-duty position because under Cycle 4 rules an active-duty position was available for 90 days in an AEF cycle, but an ARC position was available for only 15 days. To incorporate these rotational limits in our accounting when all components are considered together, we use a suitable normalization approach.

Over the long run, an active-duty position in a rotational AEF during Cycle 4 can deliver an annual average of only 0.2 man-years (three months per 15-month cycle); the comparable figure for an ARC position that does not volunteer or is not called up for more than 15 days per cycle is 0.033 man-years (one-half month per 15-month cycle).

The Cycle 4 90-day limit may not be achievable for the LDHD forces that are part of the enablers. To postulate a number, suppose enablers provide, over the long run, an annual average of one-half man-year. Since this number violates the 120-day annual temporary-duty (TDY) policy, it may be varied parametrically to determine its impact. A comparable number can be assumed for the ARC enablers.

Normalizing active-duty and ARC positions using the above factors enables assessments of long-term demand for deployments. We acknowledge that there is variability in long-term demand. Resource demands depend on the aircraft type deployed and the number of aircraft. The levels of these resources in general vary among AEF pairs.

Once the available manpower resources are normalized, we can generate measures of the ability to meet specific demands—for example, the ability to provide the resources to open a bare base for 12 PAA F-16C/D aircraft. AEF DCAT uses this approach to generate such measures.

CHAPTER FOUR

Illustrative Applications of AEF Capabilities and Sustainment Analysis

In the previous chapters, we described a method for assessing AEF capabilities, and we explained the workings of AEF DCAT, a tool specifically designed to execute the capabilities assessments. In this chapter, we illustrate how AEF DCAT can be used analytically and how such analyses facilitate capabilities-based planning. All the analyses described in this chapter are for an average AEF pair in Cycle 4 using the deployment factors for active-duty enablers and ARC, as discussed in the last section of Chapter Three.

In addition to showing how this kind of analysis can be used in a variety of applications, the illustrative calculations presented here highlight two particular strengths of this approach. First, because the RAND START program easily computes resource requirements of a specified deployment capability, an analyst can examine a wide range of AEF deployment capability cases. Second, the various filters on the AEF databases (discussed in the previous chapter) permit an analyst to capture AEF capabilities from a variety of perspectives.

Creating Fighter Bare Bases

This section considers the deployment capabilities for creating a bare base supporting one 24-PAA squadron of F-16CGs flying one sortie

per day per aircraft.[1] Using this metric of creating a single bare base, we can determine how much fuels-support marginal deployment capability resides within an average AEF pair in Cycle 4. Figure 4.1 shows one view of this capability generated by AEF DCAT. The capability is UTC-constrained and presented for steady-state coded UTCs.[2]

Supporting fuels operations for an F-16CG fighter squadron flying one sortie per day per aircraft out of a bare base requires seven manpower UTCs. From left to right in Figure 4.1, the first three are a seven-level manager (JFA7M), a seven-level supervisor (JFA7S), and a nine-level manager (JFA9M). The next UTC (JFABA) is a three-person fuels augmentation team; JFABB is a five-person fuels building block package; JFAFT is a three-person Fuels Mobility Support Equipment (FMSE)[3] set-up team; and JFASA is a three-person team to support cryogenic and fuels laboratory operations. Each of these UTCs is needed for creating a bare base, and each provides a marginal deployment capability, ranging from 3.5 bare bases for JFABB to 29 bare bases for JFABA.

The marginal fuels capability that can be deployed within the fuels functional area is determined by the limiting UTC, which in this case is JFABB, which produced a capability result of approximately 3.5 bare bases. This analysis assumes that a fuels airman can serve only in the UTC to which he is assigned. Because this restriction is not generally true, the UTC-constrained analysis gives a lower-bound estimate of the marginal fuels deployment capability for this metric.[4]

---

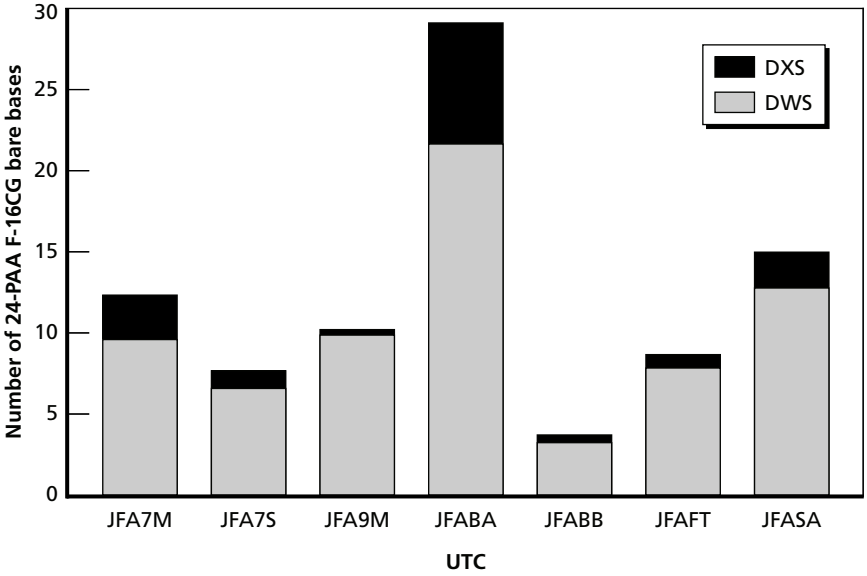
[1] We use the term "creating" a bare base to support a deployment capability to mean that all resources necessary to support that capability are present and operating, including the aircraft. We use this word to avoid confusion with the terms "to open" and "to establish," which have specific meanings in the context of Force Modules.

[2] Steady-state coded UTCs reflect the sum of DWS-coded and DXS-coded UTCs.

[3] FMSE is a collective term for fuel storage and distribution equipment. It includes items such as tanks, bladders, pumps, and refueling trucks, but does not include fuel itself.

[4] We emphasize again that this fuels capability is incomplete in the sense that these UTCs alone are insufficient to set up a bare-base fuels operation. The complete capability requires other supporting functional areas. Those areas include direct support, such as civil engineers,

Figure 4.1
UTC-Constrained Manpower Fuels-Support Deployment Capability, One Sortie per Day per Aircraft for Average AEF Pair



In several functional areas, many of the AFSCs are common among the UTCs and do not require an SEI or a functional account code (FAC).[5] Deficiencies in one of the UTCs shown in Figure 4.1 might be filled by airmen from a UTC that has a surplus (relative to this metric) and can provide the needed AFSCs. In fuels, for example, all of the AFSCs in Figure 4.1 are 2F0*1, where the placeholder "*" indicates the skill level. Only JFAFT and JFASA require unique SEIs.[6] Otherwise, airmen at the same skill level can substitute fairly

who might be required to dig berms for the fuel bladders, and indirect support, such as security forces to provide protection and kitchen services. For this reason, we emphasize that this is a marginal capability, given *authorized* manpower levels.

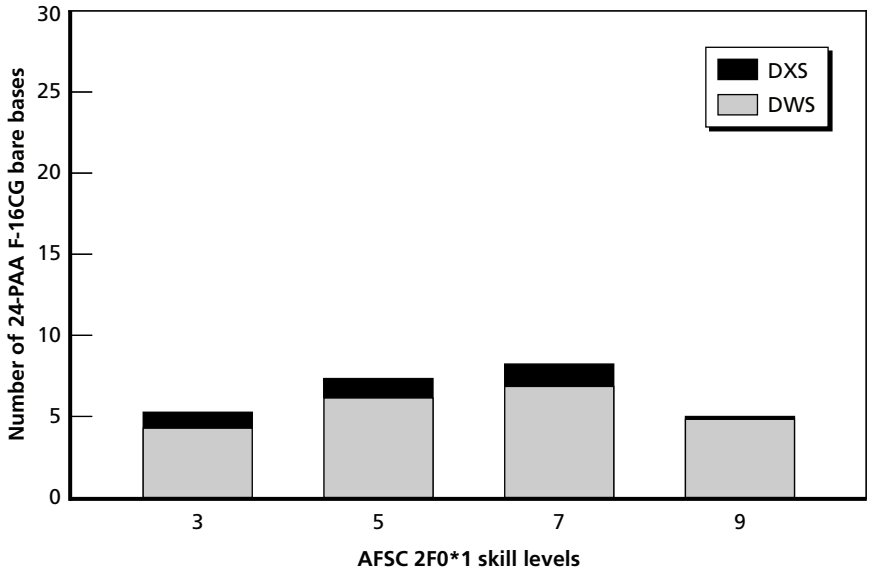
[5] An FAC is a code used to group the various manpower functions within an organization.

[6] The five-person JFABB specifies three five-level fuels journeymen, one of whom should have a 387 SEI. All of the persons in UTC JFAFT have this SEI and are at an equivalent or higher skill level.

freely among the UTCs.[7] If we make the broad assumption that these substitutions can be made as needed, a slightly greater AEF capability results, as shown in Figure 4.2.

Note that this AFSC-constrained analysis has a limiting resource of 9-level fuels airmen (2F091), which produces an overall marginal fuels capability of approximately 5.0 bare bases. This 5.0 figure contrasts with the UTC-constrained estimate of 3.5 bare bases. The UTC-constrained estimate, then, gives a lower bound on the AEF capability, whereas the skill-level (or AFSC-constrained) analysis provides an upper bound. The actual (authorized) capability lies somewhere between these bounds and depends on the willingness to "fragment" UTCs.

Figure 4.2
AFSC-Constrained Manpower Fuels-Support Deployment Capability, One Sortie per Day per Aircraft for Average AEF Pair



[7] See AFM 10-401, 1998, for substitution rules. Figure 4.2 assumes substitutions among UTCs, but no substitutions among the skill levels.

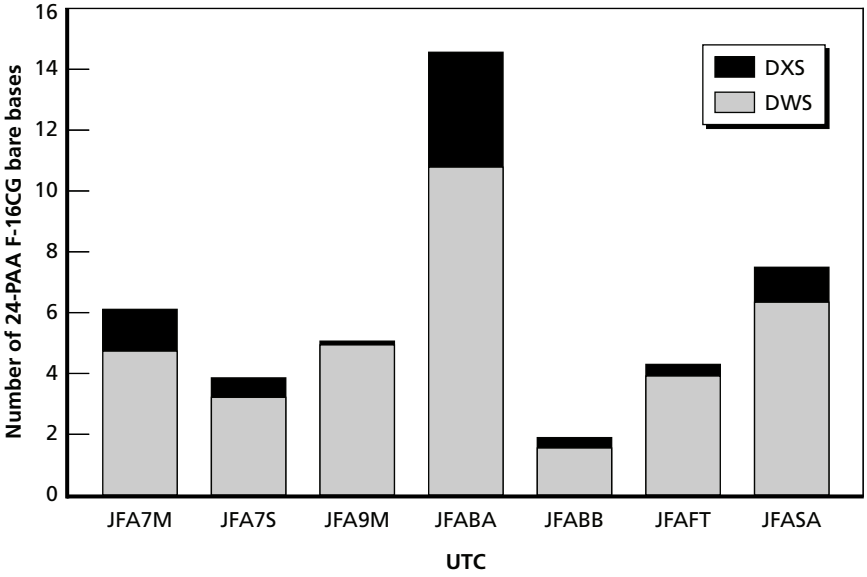
The difference between the UTC-constrained and the AFSC-constrained estimates is proportionally fairly large for the fuels area because of the substantial opportunities for personnel substitutions among the UTCs. For other functional areas in which the opportunities for such substitutions are few, such as medical support, the two estimates will not differ significantly. The ability to view capabilities from these two perspectives is valuable to a decisionmaker, as it provides insight into whether capability in a given area is restricted because of resource levels or because of how the UTCs are assigned within the AEF libraries.

To further illustrate the flexibility of this approach, we present a similar metric of marginal fuels-deployment capability, which differs from the previous metric only in that the F-16CGs fly at two sorties per day per aircraft.[8] Again, we present a UTC-constrained analysis for steady-state coded UTCs. The result is shown in Figure 4.3. Note that the capability has been approximately halved for most of the UTCs when compared with Figure 4.1, and the resulting overall marginal fuels capability is now only approximately two bare bases, again constrained by JFABB.

For both sortie rates (one per day and two per day), we observe that the constraining resource level is JFABB. Does this imply that the fuels UTCs are unbalanced? For this particular metric of creating a bare base to support F-16CG operations at a specific sortie rate, the manpower could be better distributed among the UTCs. But personnel in the fuels-support positions have many other obligations, including supporting tankers and sustaining home-station and training needs. Against metrics that capture other deployment metrics or home-station/training needs, the desired distribution of UTCs might be very different, suggesting yet another UTC apportionment. By carrying out analyses such as these for a range of metrics, which might include augmenting capabilities at deployed locations, or

[8] This level of analysis of deployment capability—distinguishing among various sortie rates—is an inherent feature of START, but it is not captured by Force Modules. Force Modules could easily be parameterized, however, to capture this additional level of analysis.

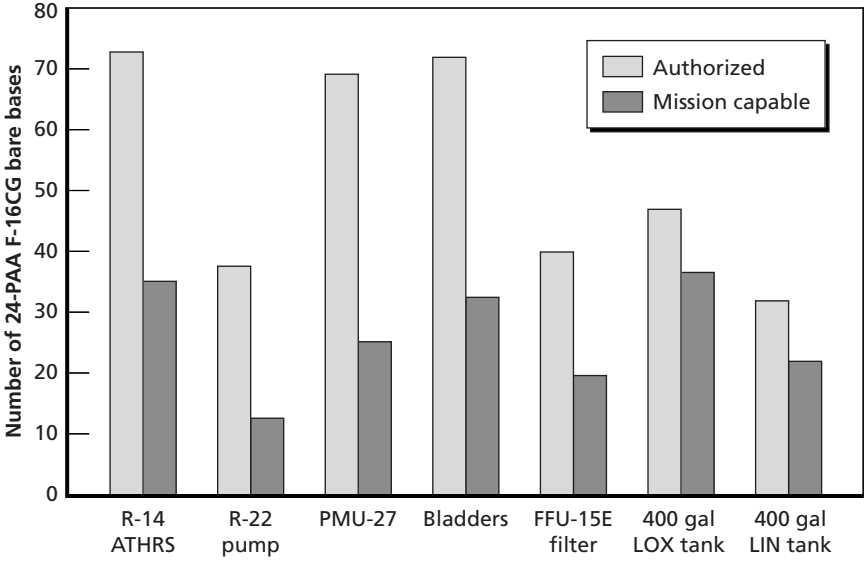
Figure 4.3
UTC-Constrained Manpower Fuels-Support Deployment Capability, Two Sorties per Day per Aircraft for an Average AEF Pair



opening, establishing, and sustaining bases to support tankers and bombers, and such, Air Force leaders can rapidly glean how well suited the UTCs are assigned in AEFs, given a range of plausible deployment requirements.

We can take this analysis of fuels-support capability one step further. Up to this point, we have considered only manpower constraints on deployment capability. We will now compare the marginal fuels deployment capability in an average AEF pair with the marginal fuels deployment capability that can be generated with the existing FMSE. Very little of the required equipment—such as pumps, bladders, and trucks—is listed in the AEF libraries. This omission prevents us from using AEF DCAT to calculate marginal fuels deployment capability directly, but we can obtain this information by manually comparing known resource levels with those required by the specified deployment capability. Figure 4.4 illustrates the results of such an

Figure 4.4
Equipment-Constrained Fuels-Support Deployment Capability, One Sortie per Day per Aircraft



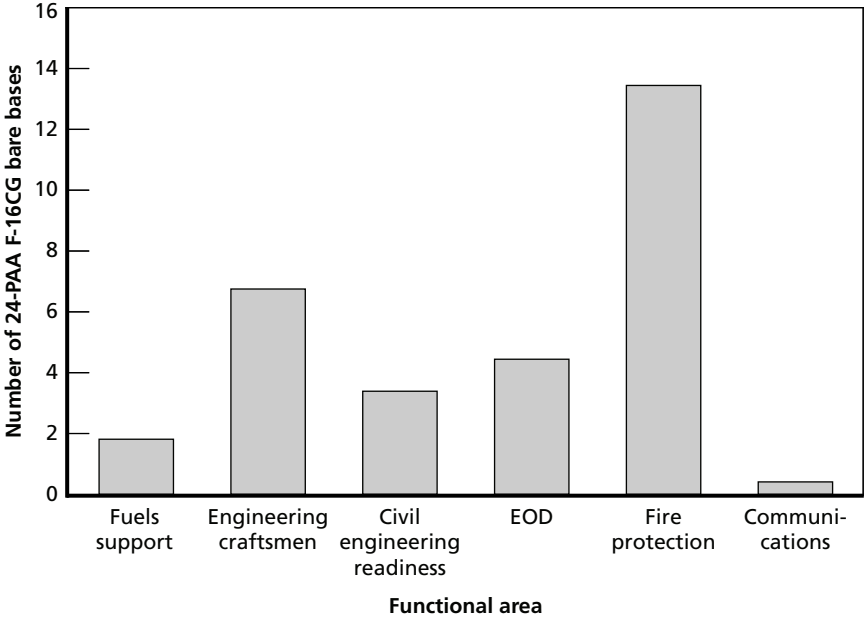
NOTE: ATHRS = Air-Transportable Hydrant Refueling System.

analysis, which is further specified by authorized levels of equipment and mission capable levels of equipment.[9] As expected, the overall capability is significantly higher than the marginal manpower capability. The constraining equipment resource for the "mission-capable" estimate is the R-22 pump, which produces a capability of just over 12 bare bases. Analyses such as these would be useful for assessing the relative balance between manpower and equipment resources.

As a final illustration using the creation of a 24-PAA F-16CG bare base as a deployment capability metric, we compare the capability across functional areas. Figure 4.5 combines the results from a

[9] Fuels equipment data were provided by SMSgt Robert McGonagle (AFLMA/LGS), personal communication, May 12, 2003. For the calculations, we assume the need for enough fuel bladders to provide a 500,000-gallon capacity.

Figure 4.5
Steady-State–Coded, UTC-Constrained Manpower Deployment Capability for Six Functional Areas for an Average AEF Pair



number of AEF DCAT analyses. For each functional area, we take the capability of that area to be constrained by the most-limiting manpower UTC resource. Only the steady-state coded UTCs are shown. For fuels, we use the case of two sorties per day per aircraft. Six functional areas are shown: fuels support, engineering craftsmen, civil engineering readiness, explosive ordnance disposal (EOD), fire protection, and communications.

As in the fuels-support case presented above, the results appear to imply an imbalance of capability among certain functional areas. Against this metric, this implication is, in fact, true. But all of these areas must also support other deployment capabilities, as well as home-station and training requirements. Rebalancing resources on the basis of this one metric would be premature. Yet, analyzing a range of metrics derived from a portfolio of deployment scenarios, in combination with home station and training requirements, would

provide a robust analytical evaluation of balancing manpower resources across functional areas. Such analysis cannot be done with Force Modules as currently defined; it requires the parameterization of the approach used in START.

Supporting Theater Operations

The spirit of capabilities-based planning creates the need to examine a range of deployment metrics. The selected metric in the above cases was the number of bare bases that could be created. This choice of a metric is arbitrary; other deployment capability metrics could be used. We used the same metric for each illustrative calculation simply for ease of comparison. In this section, we illustrate this aspect of the flexibility of our method by showing capability in terms of another metric: supporting theater operations.

Consider the deployment of the aircraft listed in Table 4.1. This force represents roughly half of the Air Force aircraft deployed to support OIF, less the special operations aircraft and UAVs. Taken alone, this list does not constitute a deployment capability, because no beddown information has been specified as yet.

Here, we explore how well an average AEF pair can support this example deployment as a function of how the aircraft listed in Table 4.1 are bedded down. Exactly how the forces are bedded down will affect the manpower resource demands on the various combat

Table 4.1
Aircraft for Notional Theater-Base Deployment Capability

Aircraft Type	Mission Design Series	Total Aircraft Deployed
Fighters	A-10, F-15C, F-15E, F-16C, F-117A	162
Bombers	B-1B, B-52H	24
C2ISR	E-3, E-8, RC-135, U-2	16
Tankers	KC-10, KC-135	84
Mobility	C-130	60

support areas, depending on how the variables of aircraft, base population, and number of beddown sites drive the UTC requirements. The factors that dominate in determining UTC requirements vary with the career field. For example, deployment requirements for personnel in aviation-related career fields, such as aircraft maintenance, are driven largely by the type and number of aircraft; they are nearly independent of base population or number of beddown locations. On the other hand, most combat support areas scale nearly linearly with the number of beddown sites and more weakly with the base population or number of aircraft deployed. An analysis by AEF DCAT shows this effect for fire protection, displayed in two different views in Figures 4.6 and 4.7.

Fire protection requirements depend on the size of the aircraft bedded down and the number of bases; for the purposes of this analysis, fire protection requirements are independent of base population. Larger aircraft require higher water-flow rates, requirements that are

Figure 4.6
UTC-Constrained, Steady-State Residual Fire Protection Deployment Capability for an Average AEF Pair as a Function of Basing Structure

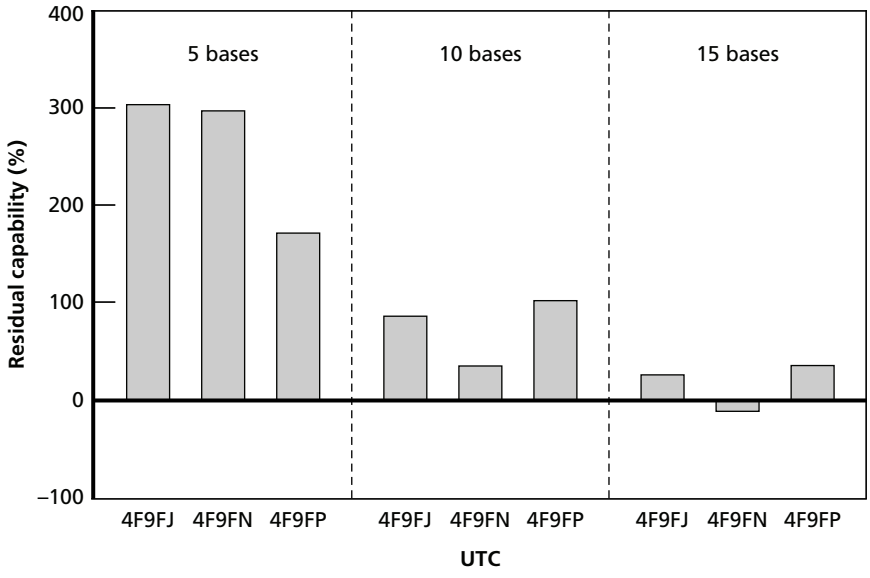
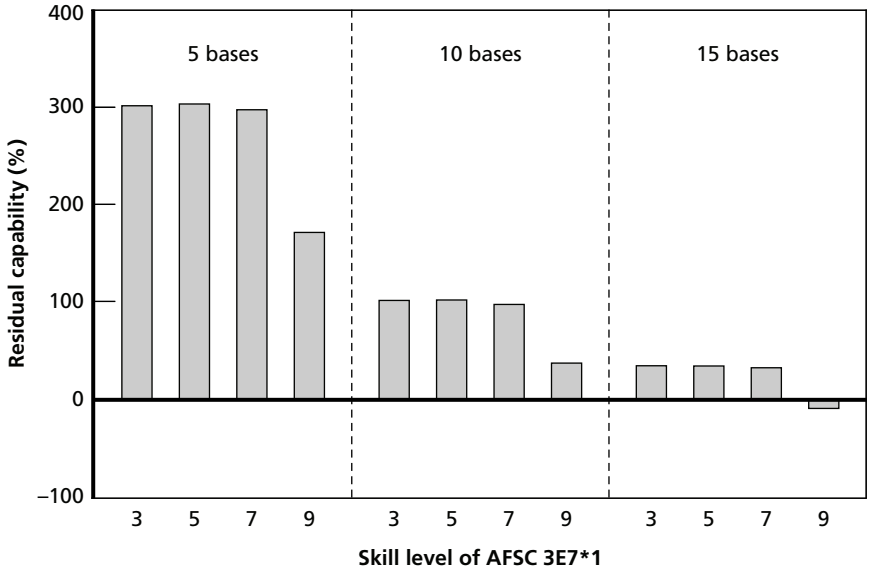


Figure 4.7
AFSC-Constrained, Steady-State Residual Fire Protection Deployment Capability for an Average AEF Pair as a Function of Basing Structure



met by adding additional equipment, which in turn, requires more manpower. All bases, regardless of their size, require a minimal fire protection capability.[10]

Figure 4.6 displays capability in a different manner than that of the previous figures; the data presented in Figure 4.6 were generated from multiple runs of the AEF DCAT program. Capability as shown in Figure 4.6 is measured in terms of the percentage of *residual capability* remaining in an AEF pair after the specified capability is deployed. For example, if an AEF pair contains x capability, and y capability is needed for a specified deployment, then the residual capability percentage is 100(x-y)/y. Hence, if an AEF pair contains the exact amount of a deployment requirement, x = y, and the resid-

[10] The requirements data from START, used in these calculations, estimate the manpower required to support specific vehicle sets designed to meet the minimal National Fire Protection Association standards. In practice, bases normally carry a larger capability than this minimum. See Snyder and Mills, 2004, p. 23, for more details.

ual capability is zero. If an AEF pair contains twice the capability of a deployment requirement, x = 2y, and the residual capability is 100 percent.

Three cases are shown in the figure. In the first, reading from left to right, the aircraft listed in Table 4.1 are positioned among five bases. The limiting capability is UTC 4F9FP, which indicates that if the beddown structure consisted of five bases, 172 percent of this capability remains in an average AEF pair without violating AEF policies. Said another way, 1.7 more theaters consisting of five identical bases could be created. The middle cluster shows the residual capability if the forces are bedded down in ten locations. This result cannot be linearly extrapolated from the five-base case because the fire protection requirements do not depend solely on the number of bases, but also on the size of the aircraft at those bases. In the ten-base case, the UTC 4F9FN is the limiting resource, and it limits the Air Force to a 34 percent residual capability, or a capability to create an additional third of an identical ten-base theater. Finally, the cluster on the right in Figure 4.6 shows the case of spreading the forces among 15 bases. In this case, UTC 4F9FN is insufficient to meet the demand, and the beddown cannot be supported. Figure 4.7 illustrates the same analysis, but constrained by AFSC. In the 15-base case shown in Figure 4.7, a shortage of 9-level fire protectors (3E791) thwarts the ability of 4F9FN to meet the requirements.

Two applications of this type of analysis are evident. First, as in the above examples, planners and Air Force leadership can quickly explore resource deficiencies relative to specified deployment capabilities. Second, contingency planners could use this approach to explore whether their proposed plans strain already tight resources and what Air Force capabilities would remain if their plans were executed. Automated, rules-based tools such as START and AEF DCAT permit this kind of powerful analysis. If these tools were to be fully developed, implemented, and integrated with the suite of analysis tools represented in Figure 2.3, operational planners could explore a range of logistical implications associated with their candidate plans without having to assemble a team of logisticians and without the addi-

tional risks to operations security from involving a larger orbit of planners.

Conclusions from Sample Calculations

The above examples show several potential applications of AEF DCAT in policy analysis. Here, we provide brief descriptions of the four most likely ways that the assessment method described in this chapter can be used to inform policy decisions, and explain how this approach can be useful for both planning and execution of plans.

Provides a Vocabulary for Articulating AEF Capabilities

The approach described here provides a flexible, expansive, and easily comprehensible vocabulary for articulating AEF capabilities. Quantifying and communicating Air Force capabilities within the AEF framework is a necessary step in the transition to capabilities-based planning. Capability expressed in terms of wings or squadrons of aircraft does not capture whether sufficient expeditionary combat support resources have been authorized to support operations. The more expansive view that includes support resources more accurately indicates what capabilities can be generated within a set of AEF policies.

Helps Identify Factors That Limit Deployment Capabilities

In addition to providing a means of articulating AEF capabilities, this approach to analyzing the relationship between policies and resources can help to identify factors that limit deployment capabilities for current resource levels. Examining a wide spectrum of perspectives on each deployment capability provides insight into whether capability in a given area is restricted because of resource levels, availability of UTCs, readiness status, or how UTCs are assigned to AEFs. Further, for a given deployment capability, this approach can reveal which UTCs and AFSCs are the limiting resources.

Provides an Analytic Basis for Balancing Resources

If authorized resource levels in disparate areas, such as civil engineering and fuels support, are set independently, they may not be balanced; i.e., they may not provide similar deployment capabilities with respect to one another. By analyzing deployment capabilities using a range of metrics derived from a portfolio of deployment scenarios, planners could combine results from this approach with independently derived home-station and training requirements to provide a robust analytical evaluation that balances manpower resources. This balancing could also be done among UTCs or AFSCs within a single functional area, as well as among the various functional areas.

Provides an Analytical Foundation for Exploring Alternative AEF Policies

AEF policies provide the Air Force and combatant commanders with a supply of deployable forces. The policies do not express resource demands calibrated to meet planning objectives. If AEF policies do not meet Air Force objectives, the policies can be revised or the force can be resized or reshaped. The approach described in this chapter provides a basis to guide such an analysis. In this way, the ramifications of alternative AEF policies can be surveyed against a portfolio of deployment scenarios and home-station and training requirements.

Permits Analyses to Guide Both Planning and Execution of Plans

All the examples of applications would be useful during both planning and execution. During crisis-action planning, the above insights would provide planners and Air Force leadership with the ability to

- quickly explore resource deficiencies relative to specified deployment capabilities
- determine the extent to which various courses of action strain already tight resources
- quantify what capabilities remain if candidate plans are executed.

For the Air Force to size and shape its force according to a portfolio of capabilities, as prescribed in the Quadrennial Defense Review,[11] it needs comprehensive ways to assess the capabilities that a set of resources can provide relative to planning objectives. The methodology described above and the illustrative calculations show how such an analysis can be done within the AEF framework. Yet, the ability to perform such calculations and the usefulness of the results derived from those calculations depend on the fidelity of the available supporting data.

The creation and maintenance of the AEF libraries have made possible these analyses in the area of manpower. Assigning nearly all Air Force personnel to UTCs and allocating them to AEFs while maintaining these data in a single database enables a rapid, comprehensive view of Air Force manpower capabilities. This practice also enables an evaluation of alternative AEF policies, and an assessment of how well a given force structure and AEF polices can satisfy the requirements of any one of a large set of possible planning scenarios. The readiness status of these UTCs is also maintained in the central, widely accessible, and frequently updated ART database, which, by having such characteristics, expands the questions that capabilities analysis can address.

In contrast to the manpower data in the AEF libraries, the data for Air Force equipment are not centrally maintained, are not assigned to UTCs, and are not frequently assessed for readiness. These limitations restrict the visibility of these resources to planners and thereby impede the analysis of capabilities beyond individual areas (e.g., vehicles, fuels support, and so forth). While each functional area may, according to its own criteria, size and shape its resources according to planning objectives, top-level assessments of the balance of capabilities across areas is restricted. An analysis of equipment resources done with the same accuracy and ease as a manpower analysis would be expedited by maintaining data on equipment in a similar manner that manpower data are maintained in the AEF libraries.

---

[11] Rumsfeld, 2001, p. 17.

Introducing all deployable-equipment resources into UTCs, reporting on readiness status, and maintaining these data in a central, widely accessible database such as the AEF libraries would collectively be an enormous task. Yet, the benefits of sizing and shaping a force more precisely to meet planning objectives might offset the initial costs of such a task. Equipment whose numbers could be reduced with an acceptable level of risk (as measured by planning objectives) might be identified, and savings could be used to meet needs in other areas. Ultimately, the Air Force would be better situated to assess its resources and to size and shape those resources according to a portfolio of capabilities, as is now becoming possible in the area of manpower.

CHAPTER FIVE

Conclusions and Recommendations

A central tenet of the current defense strategy is to transform deployment planning from a threat-based posture to a capabilities-based posture. This "transformation" abandons deliberate planning based on a limited number of scenarios in favor of building forces to provide a "portfolio of capabilities."[1] The new approach dramatically increases the number of deployment capabilities that will need to be assessed during the planning and analysis of force sizing. The large number of deployment capabilities subject to analysis magnifies the need for powerful tools that can analyze those capabilities and compare the requirements needed to generate these capabilities with the authorized or available manpower and equipment determined by AEF policies. In addition, this transformation highlights the need for an analytical foundation for exploring alternative AEF policies.

In light of these observations and the work reported here on the prototype, Web-based AEF Deployment Capabilities Assessment Tool and the START program developed by RAND, we recommend that the Air Force implement and maintain a parameterized approach, such as AEF DCAT, for assessing deployment requirements.

A summary of our conclusions from this study and our recommendations for the Air Force are as follows:

- **Develop and implement a rules-based, parameterized tool to quantify deployment requirements.** A parameterized tool to as-

[1] Rumsfeld, 2001.

semble UTC lists from specified deployment capabilities, first advocated by Galway et al.[2] and developed and demonstrated by Snyder and Mills,[3] would permit the analysis of deployment capabilities within minutes; this process currently can take weeks to months to complete and requires a range of specialists to be assembled. A tool such as the one proposed here would not only form the kernel of an AEF capabilities-assessment system, but also would be useful to quickly build TPFDD lists during crisis-action planning. Force Modules (see Chapter Two) represent a significant step in this direction; parameterization of Force Modules is the next logical step in their maturation.

- **Consider assigning all unit equipment and nonconsumable war reserve materiel to UTCs.** A central tenet of capabilities-based planning is that equipment be expressed as "capabilities" rather than raw quantities of materiel. Currently, a considerable amount of materiel is inventoried in disparate databases by stock number. Assessing the capabilities that can be generated by these items requires the expertise of a number of specialists and the linking of a number of databases. Identifying this materiel within UTCs would indicate their capabilities at the UTC level and make them more visible to the AFWUS. These changes would considerably advance the transformation to capabilities-based planning.
- **Consider placing all equipment UTCs into the AEF libraries or a similar centralized database.** Since the inception of the AEF policies in the late 1990s, an increasing number of personnel have been assimilated into AEFs. These personnel include even ordinarily nondeployable personnel, such as officers assigned to the Air Staff. They are typically coded as associate UTCs to reflect their deployability status. This addition of personnel into AEFs provides a wide visibility of manpower and thereby strengthens the utility of AEF policies, as well as fur-

[2] Galway et al., 2002.

[3] Snyder and Mills, 2004.

thering the Air Force's mission as an expeditionary force. Equipment has not been similarly introduced into the AEF libraries and is not sourced by the AEF Center. Placing equipment UTCs into the AEF libraries—or into a similar database devoted to equipment—would further advance the goals of AEF policies and greatly facilitate rapid AEF-equipment capabilities assessment such as is done for manpower capabilities.

- **Consider assigning to the equipment UTCs an availability (NSUTC) coding and readiness status.** In combination with placing all equipment into the AEFs, assigning an availability coding and readiness status to equipment would provide greater visibility of what materiel is available for deployment, facilitate a cross-functional assessment of deployment capabilities, and assist in efforts to balance these resources across functional areas to support the desired portfolio of deployment capabilities. The coding and readiness status for equipment would probably differ in content and reporting frequency from the status for manpower UTCs and may need to be reported on a different time schedule.
- **Develop a suite of deployment-related analytical tools with a systems engineering approach.** An array of analytical tools would be useful in analyzing a portfolio of capabilities. This set of tools would include those based on START and AEF DCAT, as well as tools for time-phasing UTCs, nominating the source (i.e., the unit) that will provide a UTC, and evaluating the feasibility of movement described by the TPFDD. All these tools should be developed with systems engineering oversight so that they function smoothly in concert.

Implementing these recommendations should facilitate the Air Force's continuing transformation from a threat-based to a capabilities-based planning posture, provide senior leadership and combatant commanders with greater visibility of deployment capabilities, and further advance the mission of the Aerospace Expeditionary Forces.

APPENDIX A

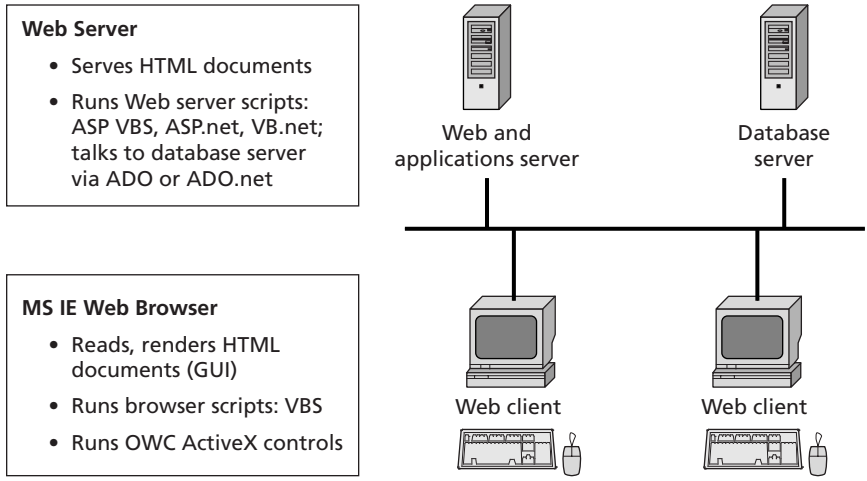
Computer Hardware and Software Requirements for START and AEF DCAT

START runs on a PC and requires Microsoft Excel 2000 (Version 9.0) or a later version. The software is written in Excel's Visual Basic for Applications. Results from START calculations, both tabular and graphic, can be copied to other spreadsheets or reports.

The World Wide Web environment makes AEF DCAT suitable for wide use in a distributed fashion, as illustrated in Figure A.1. The wide availability of Web browsers makes this technology very attractive, because no additional software is needed for the client's basic use. To view the various graphs resulting from ad hoc database queries, the user's (client's) computer requires Microsoft Internet Explorer (MS IE) Version 5.5 or higher and the Microsoft Office Web Components (OWC). The OWC are available with any one of the Microsoft Office 2000 (Version 9) or newer products for PC-type computers.

On the server side, AEF DCAT requires the Microsoft Internet Information Server (IIS) version 5.0 and related software products. Data reside in relational Microsoft Access databases (Microsoft Jet Engine version 4.0 or later), which are accessed by using Structured Query Language (SQL) via Microsoft ActiveX Data Object (ADO) version 2.7. Clearly, the databases can be ported to other, more-industrial-strength database servers, such as an Oracle or Microsoft SQL Server.

Figure A.1
AEF DCAT in the Web Environment



The Web server program scripting is written in two versions—in Microsoft Visual Basic Script (VBS) for Microsoft Active Server Pages (ASP) and in Microsoft Visual Basic under ASP.net (running under the Microsoft.Net Framework 1.1). Users' Web requests are serviced by the Web server, which in turn sends information encoded with HTML and VBS programs back to the user's browser for the proper display of data tables and graphs (see Appendix B for more information).

With the exception of Microsoft Office, these products are either already available in the Microsoft Windows 2000 operating system or can be downloaded from the Microsoft Web site; newer versions of software can also be downloaded from the Microsoft Web site free of charge.

AEF DCAT can be made accessible to a selected set of planners within a local area network (LAN) or can be made accessible Air Force–wide. Access can be restricted through password protection.

APPENDIX B

Architecture of AEF DCAT

Interactivity of the AEF DCAT Web Programs

Web programs such as AEF DCAT allow interaction between a user and a Web server via the mutual exchange of information. The Web server (under DCAT's control) prompts the user for input specifications and asks the user what steps or queries are needed next. The user's selections from the choices presented on the initial Web page become instructions to the Web server, which then executes the instructions and returns the results to the user via additional Web pages, perhaps giving the user additional prompts for information. This interaction from beginning to end is called a "DCAT session." Figure B.1 shows a typical DCAT Web session, as seen by the DCAT program that controls the interaction.

Tour of the DCAT Graphical User Interface

Figure B.2 shows the first screen displayed by AEF DCAT after the user launches the program.

Web queries trigger computations that use data in AEF DCAT's database, which include a number of Air Force files (either in their original form or combined by RAND) (see Table 3.3 for a list of those files). All user queries must specify the AEF cycle number from the AEF libraries and the functional area to be used by the query (see Table 3.2 for a list of functional areas).

Figure B.1
Flowchart of AEF DCAT Actions in Response to User Queries

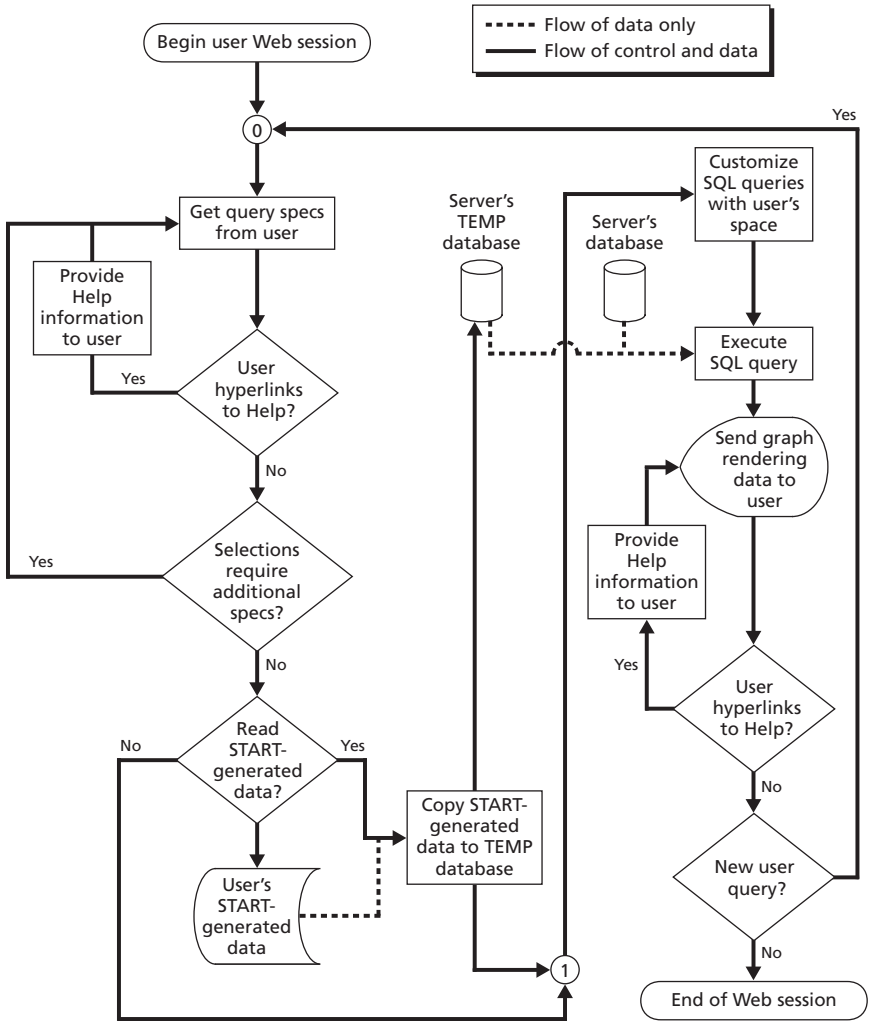
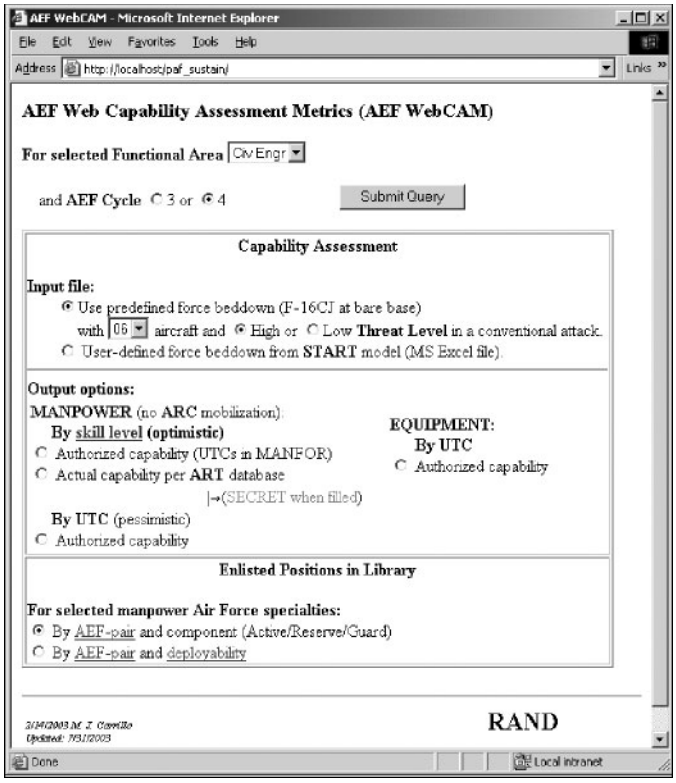


Figure B.2
Initial Screen of AEF DCAT Graphical User Interface



Currently, AEF DCAT offers four capability-assessment queries and two resource-level queries. As discussed in Chapter Three, DCAT capability-assessment Web queries also require a user to select an input file with UTC requirements: The user may chose to use a default AEF DCAT file for F-16CJs, as described in the examples in Chapters Three and Four, or an alternative user-specified file, which may be derived from START or from any properly formatted UTC list, such as Force Modules. Resource-level (manpower-level) queries do not require this additional input.

After specifying a query and clicking on the "Submit Query" button on the initial AEF DCAT screen, more Web pages may open (depending on the query) prompting the user for additional specifications. Figure B.3 shows a sample Web page that follows after a resource-level query is initiated.

Once again, users' selections on the second Web page (for example clicking on the "Select a specific AFSC" checkbox shown in Figure B.3) will trigger another Web page and prompt the user for additional specifications. Of particular interest is the Web page that prompts the user to provide a START-generated file as input, which is shown in Figure B.4.

Web Site Map

Figure B.5 shows the Web design of the AEF DCAT that uses Microsoft ASP script. All the files shown in the figure reside on the Web server. The ".asp" files contain the Visual BASIC Script (that is, the

Figure B.3
Example of a Second Screen in the AEF DCAT User Interface

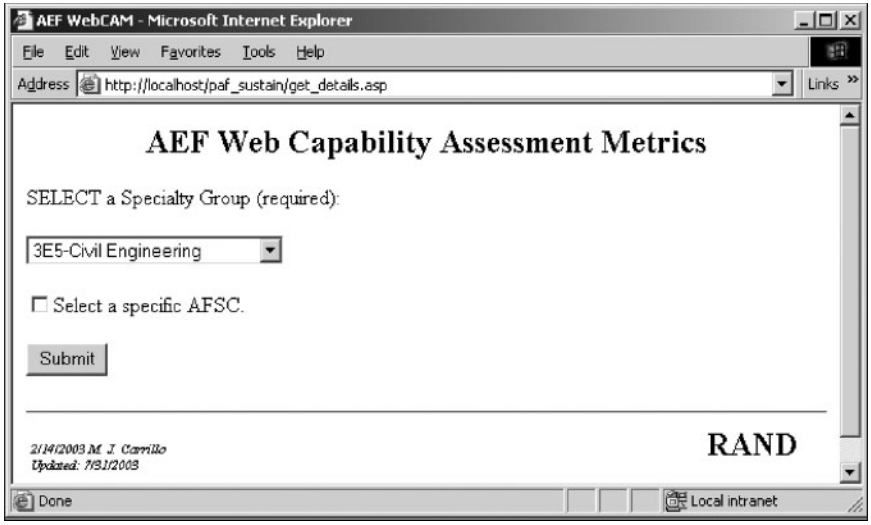
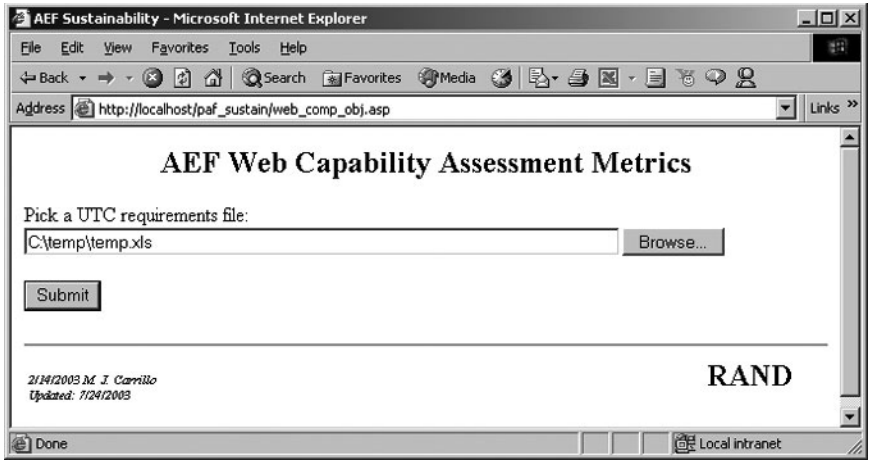


Figure B.4
Prompt for Importing User-Provided START File



program) that controls the branching off from one file to another, depending on the user's input. The ".html" and ".gif" files are "Help" files that are accessible via text hyperlinks.

Database Schema

Figure B.6 illustrates an example of the relationships (metadata) among some of the data tables in the AEF DCAT relational database. Specification of those relationships is required by the program instructions coded in the Structure Query Language (SQL) join operations that correspond to a particular user query. The relational structure of the database allows great flexibility in creating new queries, and the query language (SQL) allows wide customization (under program control) of queries.

Figure B.5
Design of AEF DCAT Web Server Scripts

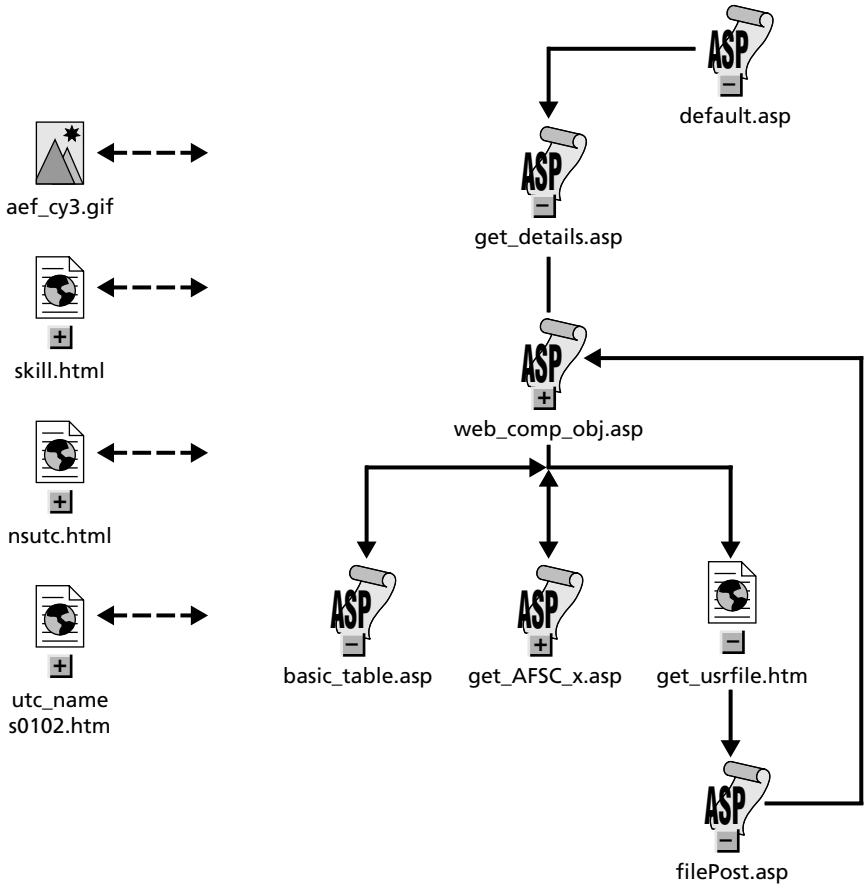
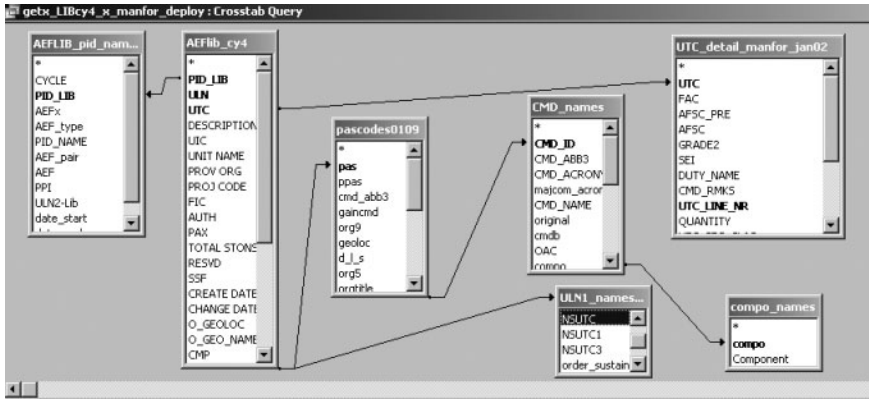


Figure B.6
Section of the AEF DCAT Relational Database Schema



Bibliography

AFI. *See* Air Force Instruction.

AFM. *See* Air Force Manual.

AFPAM. *See* Air Force Pamphlet.

"Agile Combat Support CONOPS," U.S. Air Force, memorandum, July 2005.

Air Force Instruction 10-201, *Status of Resources and Training System*, Washington D.C.: Department of the Air Force, January 8, 2002.

Air Force Instruction 10-244, *Reporting Status of Aerospace Expeditionary Forces*, Washington D.C.: Department of the Air Force, February 19, 2002.

Air Force Instruction 10-400, *Aerospace Expeditionary Force Planning*, Washington D.C.: Department of the Air Force, October 16, 2002.

Air Force Manual 10-401, *Operation Plan and Concept Plan Development and Implementation*, Vol. 1, Washington D.C.: Department of the Air Force, May 1, 1998.

Air Force Pamphlet 10-219, *Bare Base Conceptual Planning Guidance*, Vol. 5, Washington, D.C.: Department of the Air Force, June 1, 1996.

Cook, Lt Gen Donald G., Col Robert Allardice, and Col Raymond D. Michael Jr., "Strategic Implications of the Expeditionary Aerospace Force," *Aerospace Power Journal*, Winter 2000, pp. 6–14.

Correll, John T., "The EAF in Peace and War," *Air Force Magazine*, July 2002, pp. 24–31.

Davis, Paul K., *Analytic Architecture for Capabilities-Based Planning, Mission-System Analysis, and Transformation*, Santa Monica, Calif.: RAND Corporation, MR-1513-OSD, 2002.

Elliott, Master Sgt Scott, "Force Modules Give Commanders 'Playbook,'" *Air Force Print News*, January 24, 2003 (http://www.af.mil/news/Jan2003/12403907print.shtml; last accessed September 2005).

Galway, Lionel A., Mahyar A. Amouzegar, Richard J. Hillestad, and Don Snyder, *Reconfiguring Footprint to Speed Expeditionary Aerospace Forces Deployment*, Santa Monica, Calif.: RAND Corporation, MR-1625-AF, 2002.

Rumsfeld, Donald H., *Quadrennial Defense Review Report*, Washington D.C.: Office of the Secretary of Defense, September 2001.

Snyder, Don, and Patrick Mills, *Supporting Air and Space Expeditionary Forces: A Methodology for Determining Air Force Deployment Requirements,* Santa Monica, Calif.: RAND Corporation, MG-176-AF, 2004.