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

Analysis of Combat Support Basing Options

Mahyar A. Amouzegar

Robert S. Tripp

Ronald G. McGarvey

Edward W. Chan

C. Robert Roll, Jr.

Prepared for the United States Air Force

Approved for public release, distribution unlimited

RAND PROJECT AIR FORCE

The research reported here 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 : analysis of combat support basing options / Mahyar A. Amouzegar ... [et al.].
p. cm.
"MG-261."
Includes bibliographical references.
ISBN 0-8330-3675-0 (pbk.)
1. Air bases, American—Foreign countries. 2. United States. Air Force—Supplies and stores. 3. United States. Air Force—Foreign service. 4. Airlift, Military—United States. I. Amouzegar, Mahyar A.

UG633.S8535 2004
358.4'1621'0973—dc22

2004019357

Published 2004 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

Summary

Background

The Air Force is committed to the Air and Space Expeditionary Force (AEF) concept and the transformation needed to enable the Air Force to project power quickly to any region of the world. Forward positioning of heavy war reserve materiel (WRM) resources in a well-chosen forward support location (FSL) posture is central to that concept. The focus of this report is on the presentation and discussion of an analytic framework that can be used to evaluate alternative FSL basing and transportation options for use in assessing WRM storage options in an uncertain world.

The presentation of this framework is important because it addresses how to assess alternative options in terms of the relevant programming costs. This formulation minimizes FSL operating, construction, and transportation costs associated with meeting training and deterrent exercises needed to demonstrate the U.S. military's capability to repeatedly project power to important regions around the world, thereby deterring aggression, while maintaining the FSL storage capacity and throughput necessary to engage in conflicts should deterrence fail. This concept is based on the notion that the United States can no longer know, with a high degree of accuracy, what nation, combination of nations, or non-state actors will pose a threat to vital U.S. interests. Consequently, the U.S. Air Force must be ready to deploy capable forces quickly across a wide range of potential scenarios.

Selecting Forward Support Locations to Provide Deterrence and to Meet Contingency Requirements

The aim of this work is to investigate FSL postures that are capable of meeting the WRM throughput requirements needed to win major regional conflicts and small-scale contingency operations, which are discussed in the Department of Defense (DoD) Strategic Planning Guidance and Defense Planning Scenarios. Perhaps more important, this study also addresses FSL postures that can act to deter aggression and coercion.

The FSL options should be selected from a feasible set of options in such a way that the costs of supporting deterrent exercises are minimized, while assuring that the selected FSLs have the storage capacity and throughput needed to meet potential future contingencies, if deterrence should fail. Thus, resources are programmed to support peacetime training and deterrent exercises and to support contingency operations should they eventuate. We do not include the cost of actually conducting contingency operations in our model. The reason for not including that cost is that Congress provides supplemental funding for conducting wartime or contingency operations if and when they occur; those costs are not included in budgeting for combat support locations. This is consistent with programming guidance and historical perspectives.[1]

Analysis Approach

In order to evaluate and select alternative forward basing options, we have developed capability-based models that can assess the cost of

[1] In the past, the United States would program for defense resources that would prevent nuclear war and provide for conventional forces to be used to defeat the Soviet Union and protect Korea from invasion from the north, with potential intervention by China to support the North Koreans. The programming assumptions were that these resources would be used once to defeat the enemy. It was assumed in programming for resources that contingency operations, if they were to arise, could be dealt with using a portion of the resources that were programmed for major theater wars.

various portfolios of forward support locations (FSLs) for meeting a wide variety of global force projection scenarios. The Department of Defense has made capability-based planning one of the core tenets of defense policy. This policy is a shift from a "threat-based" model (specific plans for a specific adversary) that had dominated defense planning in the latter part of the last century to a model in which the focus is on the capability of a potential adversary.[2]

In this capability-based approach, we examine the costs of alternative support basing options for the same levels of performance against a variety of deployment scenarios. The analyses show how various FSL options would perform under various degrees of stress to combat support while taking into account infrastructure richness, basing characteristics, deployment distances, strategic warning, and reconstitution conditions. These scenarios would include potential military and non-military operations in the Near East, the Asia-Pacific region, Central Asia, South America, Europe, and Northern and sub-Saharan Africa. In examining potential scenarios, we make a departure from Cold War planning and the early post-Cold War preparation for two major regional conflicts, and we present the cost surfaces for differing levels of performance across a set of scenarios that can potentially take place over a multiple-year time horizon of succeeding engagements and reconstitutions in a variety of geographical areas with differing degrees of operational intensity.

We coined the term *m-Period-n-Scenario* (MPNS) to describe a planning methodology that is in line with the expected deployment requirements, for which the Air Force must prepare to meet the high demand of multiple engagements of various sizes, with some (e.g., drug interdictions) occurring more than once in a short time horizon. This MPNS concept allows us to evaluate the requirements of several scenarios to determine the stresses that they place on WRM resources. These scenarios must be sequenced in order to determine their interdependency and their effect on the combat support re-

[2] Department of Defense, 2001.

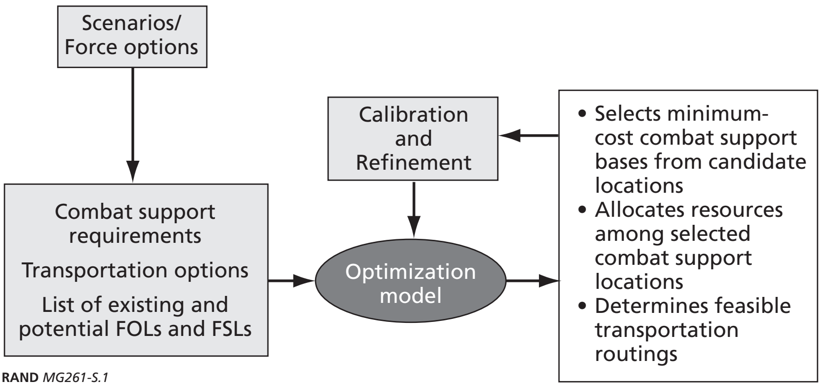
sources as well as to determine the maximum demands that a set of facilities must satisfy over the time period considered.

After the desired requirements in terms of combat support resources are determined, our optimization model selects a set of FSL locations that would minimize the peacetime costs of supporting deterrence against aggression while being able to support major regional conflicts should deterrence fail. This tool—the optimization model—essentially allows for the analysis of various "what-if" questions and assesses the solution set in terms of resource costs for differing levels of combat support capability.

There are several steps in our analytic approach (see Figure S.1):

1. A diverse set of scenarios that would stress the combat support system is selected. These scenarios would include small-scale humanitarian operations, continuous force presentation to deter aggression, and major regional conflicts. Each scenario would have a force mix of various weapon systems.
2. The scenarios and the force options drive the requirements for WRM, such as base operating support equipment, vehicles, and munitions.
3. These requirements, the potential FSLs and FOLs, and the options for transportation (e.g., allowing sealift or not) serve as the inputs to the optimization model.
4. The optimization model selects the FSL locations that minimize the FSL facility operating and transportation costs associated with planned operations, training missions, and deterrent exercises that take place over an extended time horizon and satisfy time-phased demands for WRM commodities at FOLs. The model also optimally allocates the programmed WRM resources and commodities to those FSLs. The model also computes the type and the number of transportation vehicles required to move the materiel to the FOLs. The result is the creation of a robust transportation and allocation network that connects a set of disjointed FSL and FOL nodes.

Figure S.1
Overview of the Analytic Process for the Optimization Model



RAND *MG261-S.1*

5. The final step in our approach is to refine and recalibrate the solution set by applying political, geographical, and vulnerability constraints. This allows for reevaluation and reassessment of the parameters and options.

The end result of this analysis is a portfolio containing alternative sets of FSL postures, including allocations of WRM to the FSLs, which can then be presented to decisionmakers. This portfolio will allow policymakers to assess the merits of various options from a global perspective.

Combat Support Factors

Some of the important factors and parameters that affect the selection of a forward support location and how we address them are discussed next.

- **Airlift and airfield throughput capacity.** One of the major factors in selecting a forward support location is its transport capability and capacity. The parking space, the runway length and width, the fueling capability, and loading and offloading equipment are all important factors in selecting an airfield to support an expeditionary operation. The maximum on ground (MOG) capability, for example, directly contributes to the diminishing return of deployment time as a function of available airlift. In other words, increasing the number air transporters by itself may not improve the deployment timelines (see page 22).

- **Forward operating location distance**. Distance from FSLs to FOLs can impede expeditionary operations. As the number of airlift aircraft increases, the difference in deployment time caused by distance becomes less pronounced. Adding more airlifters to the system will reduce the deployment time, albeit at a diminishing rate until the deployment time levels off due to MOG constraints (see page 23).
- **Base vulnerability.** In selecting regions and locations for forward support locations, we must consider the vulnerability of the candidate locations to attacks from adversaries in future conflicts. Forward support locations could be primary targets for adversaries with long-range fixed-wing aircraft, cruise missiles, or theater ballistic missiles (TBMs), as well as for special operations forces or terrorists (see page 25).
- **Base access.** This is an important issue that deserves careful consideration and one that must be addressed before each conflict or operation. Rather than taking the approach of eliminating some sites a priori due to political access problems, we let the model select the most desirable sites based on cost minimization. We then can "force" specific sites out of the solution set if they present access issues, and thereby provide the economic cost of restricting the solution to politically acceptable sites (see page 26).
- **Modes of transportation.** There are several advantages to using sealift or ground transportation in place of, or in addition to, airlift. Allowing for alterative modes of transportation might bring in some FSLs to the solution set that might have otherwise been deemed infeasible or too costly. Ships have a higher hauling capacity than any aircraft and can easily carry outsized or su-

per-heavy equipment. In addition, ships do not require overflight rights from any foreign government. Two attractive options are the Fast Sealift Ships (FSS), which have a speed of nearly 30 knots (versus 16 knots for conventional container ships) and a range of about 12,000 nautical miles, and the High-Speed Sealifts (HSS), which can achieve speeds of more than 60 knots lightship (400 metric tons). Trucks are, of course, cheaper and readily available in most locations through local contractors. Trucks do not require specialized airfield and, although they are much slower than aircraft, under certain circumstances they could contribute greatly to the delivery of materiel, especially when they are used in conjunction with airlift (see page 30).

Preliminary Results

To illustrate the MPNS planning concept and to demonstrate the potential of the optimization model, we present the results of an analysis dealing with collocating combat support materiel for the Army and the Air Force. Although this analysis highlights the value of the Eastern European basing as well the advantage of mixed modes of transportation, the results are preliminary and are for illustrative purposes only. In this analysis, we use the optimization model to select the locations of a set of FSLs that would be capable of meeting the storage and throughput requirements of a wide variety of scenarios at a minimum cost. The objective function minimizes the cost of the total number of exercises necessary to deter aggression while developing a capability to meet a potential regional conflict.

We assume that a small AEF package of fighters, bombers, refuelers, and Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) assets is being deployed in various annual exercise and deterrence missions over the next ten years. The Army also participates in some of these exercises with a portion (a battalion size) of its Stryker Brigade Combat Team (SBCT). Table S.1 illustrates the various deployments and locations examined.

Table S.1
Deployment Location and Package

FOL	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Baghdad	A/S	A/S	A/S	A/S	A/S	A/S	A/S	A/S	A/S	A/S
Bagram	A/S	A/S	A/S	A/S	A/S	A/S	A/S	A/S	A/S	A/S
Cairo	A/S	A/S		A/S		A/S	A/S		A/S	
Incirlik	A/S	A/S		A/S		A/S	A/S		A/S	
Bishkek-Manas	A		A		A	A		A		A
Amman	A		A		A	A		A		A

NOTE: A=AEF; S = Stryker.

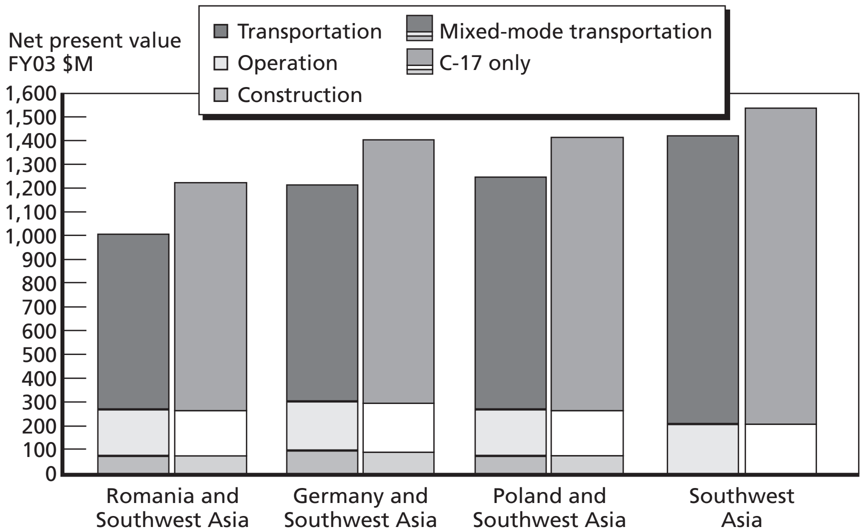
The potential FSLs that would support these deterrence exercises are Al Udeid (Qatar), Royal Air Force (RAF) Fairford (UK), Ramstein Air Base (AB) (Germany), Warsaw (Poland), and Constanta (Romania). The model was solved to determine the minimum cost set of FSLs that would meet all demand, achieving full operating capability within 12 days.

Figure S.2 presents the minimum cost attained for a mixed-mode transportation (air, sea, and land) given the 12-day full operation capability requirement (i.e., transporting all the combat support equipment and personnel). We also computed the air-only (C-17 only) transportation cost to show the cost of using a premium asset in case of a situation in which land or sea transportation is restricted. The minimum-cost solution has FSLs located in Southwest Asia (SWA) and in Romania, at a cost of $1 billion, a savings of slightly more than $200 million over the C-17-only solution (see page 60).

Although the Romania-SWA pairing is an optimal solution, there may be political or military factors that might prevent using Romania as an FSL site. By "forcing off" Constanta from the solution option, the model can show the economic cost of precluding the placement of an FSL in Romania. The second least-expensive option was to open FSLs in SWA and Germany (Poland and SWA provide a nearly identical solution). The savings realized through the use of multiple modes of transportation are greatly dependent upon the geography of the FSL posture in question. It is interesting to note that the Romania-SWA pairing offers about the same cost for air-only transportation (a premium choice) as the mixed—mode transportation for the Germany-SWA or Poland-SWA pairing (see page 60).

In addition to its economic savings, the Romania-SWA FSL posture also affords substantial savings in the use of strategic airlift to support these peacetime training missions. The use of trucks saved 250 C-17 sorties per year, while HSS saved an additional 150 C-17 sorties per year, a significant savings for a high-priority resource (see page 60).

Figure S.2
Cost of a Mixed-Transportation Strategy Versus an Air-Only Strategy



RAND *MG261-S.2*

Conclusions and Future Research

A global basing strategy can affect the ability to quickly deploy materiel in support of expeditionary forces. Prepositioning WRM at forward support locations reduces the distance between the points of storage, the FSLs, and the potential points of use—the FOLs. Deployment distances affect deployment times, but they are not the only factors. The number of airlifters and the quality of airfield infrastructure (e.g., MOG) interact with the flying distance to determine deployment time. As the number of airlifters increases, the effect of distance on deployment time becomes less pronounced, and the restriction on airfield capacity becomes more pronounced. However, one of the major tradeoffs is between the throughput capacity of the airfields and the number of airlifters. Finally, serious consideration must be given to a mixed-mode transport strategy.

FSL postures that are proposed without accounting for transport constraints may prove inferior once these transport considerations are included in the analysis. Our analytic approach offers a rational approach for selecting an appropriate FSL posture that is capable of meeting a wide range of potential scenarios.

Presently, we are collecting data and performing analysis of global basing options to recommend a set of alternative forward support locations that could support various types of deployment scenarios.