INSTITUTE FOR DEFENSE ANALYSES

Force Structure Assessment Model

Jack N. Law, Project Leader
Astrid I. Berge
Jerome Bracken
Vivian Gao
Stanley A. Horowitz
Shaun K. McGee
George M. Prugh
Robert E. Schmidle
Nicholas A. Wagner

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INSTITUTE FOR DEFENSE ANALYSES
730 East Glebe Road
Alexandria, Virginia 22305

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For More Information

Jack N. Law, Project Leader
jlaw@ida.org, (703) 575-4683

David E. Hunter, Director, Cost Analysis and Research Division
dhunter@ida.org, (703) 575-4686

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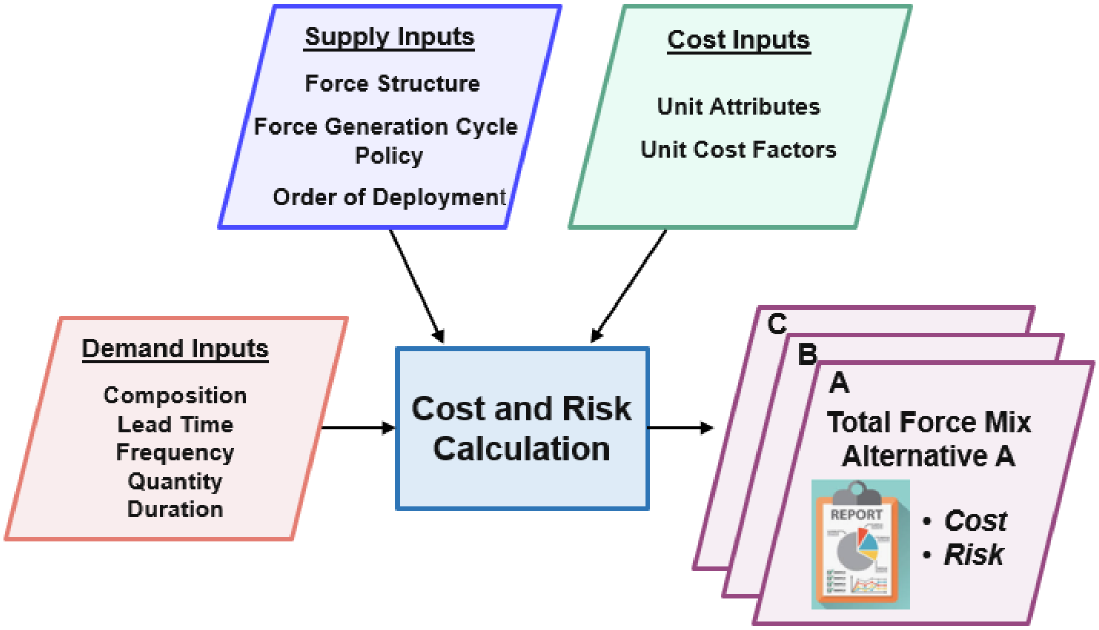
Executive Summary

To meet both expected and unexpected national security demands, the Department of Defense (DoD) relies on both its Active Component (AC) and Reserve Component (RC). The policies for structuring, maintaining, and deploying these two components affect the cost of the force, the stress on the force, and most importantly, the ability of the force to meet DoD's national security requirements. However, DoD does not currently have a multiservice tool that enables stakeholders to assess the impacts of programming and planning decisions on the cost of the force, the risk of not meeting demand, and the stress on the force.

To address these issues, OSD (P&R) asked the Institute for Defense Analyses (IDA) to develop a joint capability for programmers, decision-makers, and other stakeholders to comprehensively assess AC and RC costs. This paper describes the findings and results from Phase 1 of this multiphase project.

The Force Structure Assessment (FSA) Model

The product of Phase 1 of the project is a proof-of-concept computer application called the Force Structure Assessment (FSA) Model. The FSA Model is a discrete event simulation model that combines Service and DoD data and user inputs to produce descriptive reports. These reports detail a force mix alternative's overall cost and its ability to provide units to meet a user-specified demand. The primary objective of the FSA Model is to enable the user to see the impacts of changing policies, assumptions, and resources within a user-provided demand scenario. When fully developed, the FSA Model will provide a much-needed multiservice tool to address not only Active-Reserve mix questions, but also additional force management policies.

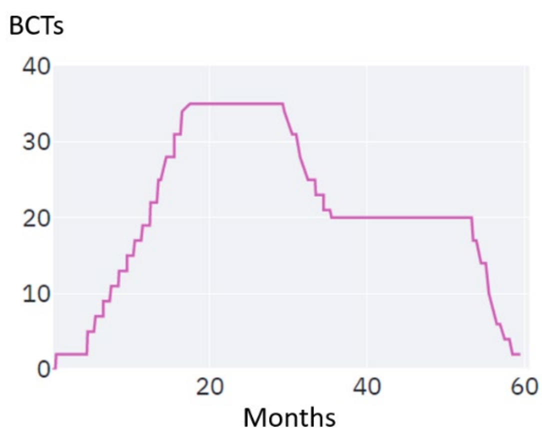


FSA Model Block Diagram

The Phase 1 model, as a proof-of-concept effort, is limited in scope and scale. The units employed in the Phase 1 model are Army Brigade Combat Teams (BCTs) only. Future phases of the model, as envisioned, will include additional units and Services.

Demand for Forces

In the Phase 1 model, the user provides a demand scenario that includes the number of BCTs required over a user-specified period. The number of demand profiles that can be stored is unlimited, so a user can test multiple policy alternatives against multiple demand scenarios. The following figure shows a notional demand profile for a long war type scenario.



Notional 60-Month Demand Profile

Supply of Forces

The FSA Model stores information about Service deployment policies, unit costs, force generation cycles, and other attributes. These data are provided by the user and establish the conditions under which forces can be supplied to meet demand. The model provides adjustable "levers" that enable the user to observe the impacts of potential force management decisions.

Costs

Costs are included on a unit-specific basis for both AC and RC units in different phases of the force generation cycle (e.g., *Reset*, *Training*, *Ready*, *Deployment*). Unit costs included in the model are derived from Service models and DoD data sources and include both direct and indirect costs. The following table highlights costs in four categories: Personnel, Equipment, Procurement, and Indirect.

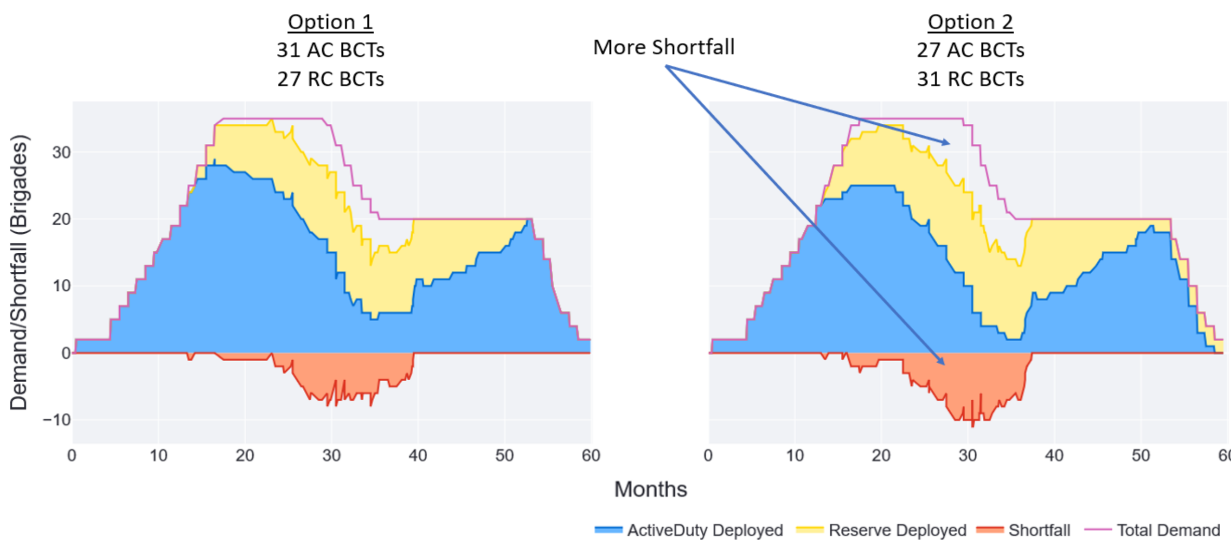
Cost Elements

Personnel	Basic Pay and Allowances / Drill Pay
	Retired Pay Accrual
	Housing Allowances
	Special Incentive / Hazardous Duty Pay
Equipment	Energy
	Depot Maintenance
	Depot Level Repairables
	Consumables and Repair Parts
Procurement	Amortization of Equipment Costs
	Replacement of Training Munitions and Expendable Stores
Indirect	Personnel Benefits
	Personnel Administration
	Education and Individual Training
	Installation Support
	Medical

The model is intended to be flexible with respect to what costs are included, and users can exclude categories that do not pertain to their current analysis. For example, users can exclude Procurement costs if they are looking at a short-term event and do not anticipate acquisition activities. Phase 2 will consider additional cost elements.

Example: Changing the AC-RC Mix

As an example, we consider the notional 60-month demand profile shown earlier and a force mix of 58 BCTs. The baseline mix is 31 AC and 27 RC Army BCTs and the user is interested in evaluating a change to an RC-heavy mix of 27 AC and 31 RC BCTs. The model output, showing the force's ability to meet the user-specified demand under each of these conditions, is displayed in the figure and table below.



Changing the AC-RC Mix

The blue area in the figure represents the deployment of AC BCTs, and the yellow area represents the deployment of RC BCTs. The gray area under the purple demand line indicates that BCTs are not available to fully meet demand; this same shortfall is depicted in orange below the x-axis. In addition to the graphical representation of how well the selected force meets demand, the FSA Model produces descriptive metrics that can be used for additional evaluation of alternatives.

Metrics for Two Force Structure Options

Metric	Option 1	Option 2	Delta
Avg. Annual Cost (wartime)	$36.0B	$34.5B	-$1.5B
Avg. Annual Cost (peacetime)	$23.9B	$21.9B	-$2.0B
Avg. Deployment Extension (months)	2.7	2.6	-0.1
Avg. AC BCTs Deployed	12.1	11.0	-1.1
Avg. RC BCTs Deployed	4.7	5.6	0.9
Total Shortfall (BCT-months)	88	115	27
% Demand Unmet	7.1	9.2	2.1
Maximum Shortfall (BCTs)	8	11	3
Average Shortfall (BCTs)	1.4	1.9	.5

From the metrics, the user can see that the total shortfall increases in Option 2 by about 30 percent, from 88 BCT-months to 115 BCT-months in this wartime scenario. The delta in *Avg. Annual Cost (wartime)* reflects, predominantly, the fact that Option 1 produces more deployments and satisfies more demand than Option 2. Deployments are, typically, the most expensive phase of a unit's cycle; thus, an option that has more shortfall can appear "cheaper" when it is really just less capable of meeting wartime demand. During peacetime, Option 2 would have an annual cost of approximately $22 billion, which is 10 percent less than the Option 1 peacetime cost of $24 billion. These metrics enable the user to evaluate the 30 percent increase in wartime shortfall against a 10 percent decrease in peacetime cost.

A broader spectrum of cost-related and risk-related metrics will be available to the user as the model and user interface is expanded in later phases.

Significance of the FSA Model

IDA is developing the FSA Model to provide DoD a much-needed multiservice tool to enable stakeholders to assess the impacts of programming and planning decisions on the cost of the force, the risk of not meeting demand, and the stress on the force.

Phase 1

Phase 1 of the project has demonstrated that major units from one Service can be usefully analyzed to reveal the impacts of changing demand assumptions, force management policies, Active-Reserve mix, and force sizing. The impacts on the cost of the force, the ability of the force to meet demand, and stress on the force can be quantified across multiple alternatives, allowing the user to determine the relative benefits of each alternative.

Subsequent Phases

Subsequent phases, as envisioned, will focus on developing joint capability. IDA will expand the FSA Model to include all Services and a broader scope of units. IDA developers will include additional cost details that support a "fully burdened" cost perspective. The IDA team will also work with stakeholders to determine the most useful cost metrics and graphical representations of cost elements. The focus of the IDA team is to provide a tool—available to users in all Services and DoD-wide—that provides valuable assessments of force mix and policy alternatives.

Contents

1. Introduction

A. Background

In the Department of Defense (DoD), Total Force Management (TFM) involves workforce mix and the resourcing, readiness, and use of the elements of the Total Force. The Total Force consists of all the sources of human capital used by DoD: Active Component (AC) military personnel, Reserve Component (RC) military personnel (including the National Guard), civilian employees of DoD, and contractor personnel performing functions similar to those of DoD's military and civilian employees.

As part of TFM, *force structure assessment* involves evaluating the force mix (the mix of AC and RC units and personnel); the phases, timing, and resourcing of the force generation cycle; and readiness and force utilization policies. In this paper, we address the assessment of force mixes that include AC and RC *military* personnel only; civilians and contractors are not addressed. Effective force structure assessment will, in turn, support effective TFM decisions.

Developing useful force structure assessments requires consistent, rigorous analyses that rest on two principles. First, force mix and other force management decisions are typically about units, not individual positions. Although the consistent costing of AC and RC personnel is key, an analysis must include unit-related cost factors beyond personnel, particularly operating and support costs.[1] The unit focus is critical because both relative personnel costs and relative operating costs differ substantially across types of units. One size does not fit all from a cost perspective. Second, in addition to cost, force mix alternatives should consider effectiveness, particularly the risk of not meeting requirements. RC forces are usually less expensive, in the long run, than AC forces, but they often take longer to mobilize and deploy. Their ability to meet the demands of selected missions is, therefore, a major consideration in determining their suitability.

One might expect guidance from OSD to the Services on total force mix analysis and decisions to reflect these principles. In fact, no such guidance exists. Appendix A to this paper reviews related documents. Also, there is no multiservice tool available to Service leadership, programmers, and those involved in program review that enables a consistent

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[1] Total Force analysis often focuses on differences in cost between AC and RC personnel. A prominent example is the paper by the Reserve Forces Policy Board (RFPB): *Requiring the Use of Fully Burdened and Life Cycle Personnel Costs for all Components in Total Force Analysis and for Budgetary Purposes. Update Report to the Secretary of Defense (RFPB Report, 19-01)*. This kind of approach is quite useful, but incomplete.

assessment of force mix and management policies. Instead, each Service has devised its own way of handling program reviews. For example, the Army has a process that, while elaborate, is generally not used to examine AC-RC mix alternatives. The Air Force has developed a model with reasonable scope, but it does not provide a detailed cost analysis. The Navy's model addresses only a small part of its force structure, and the Marine Corps has no relevant model.

B. Objectives

To address this lack of DoD-wide guidance, the Deputy Assistant Secretary of Defense for Military Personnel Policy asked the Institute for Defense Analyses (IDA) to develop a force assessment model. In response, the IDA team developed Phase 1 of the Force Structure Assessment (FSA) Model, which reflects the principles enumerated previously. This paper describes Phase 1 of model development and illustrates how it can support the needs of Service, OSD, and Joint Staff programmers and other stakeholders to weigh the costs and risks associated with total force mix alternatives. Full development of the tool will require several phases. The product of Phase 1 is a proof of concept, a working tool that enables an assessment of alternatives involving force mix and force management of Army Brigade Combat Teams (BCTs).

2. Structure of the Model

This chapter provides a high-level view of the components of IDA's FSA Model, summarized in Figure 1. This model is a discrete event simulation model, moving units of a specified type through various steps of preparation, mobilization, and deployment. The FSA Model is a modification of IDA's Stochastic Active-Reserve Assessment (SARA) Model.[2]

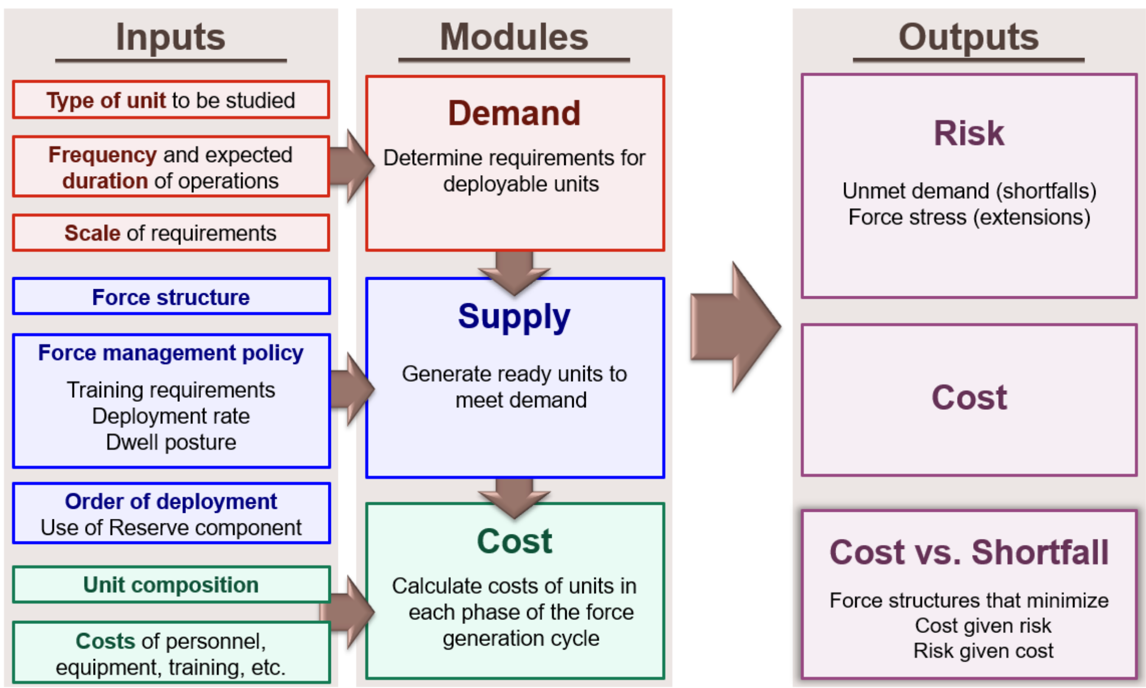

Figure 1. FSA Model Overview

2 The SARA model was documented as: Colin M. Doyle et al, "The Stochastic Active-Reserve Assessment (SARA) Model: Force Planning under Uncertainty," IDA Document NS D-5470, April 2015. This chapter draws heavily on that document. The most significant improvements in this model are: (1) full integration of the cost and supply models, which are critical to providing a user-accessible model; (2) a more flexible force generation cycle that is easier to edit in Excel and can be uploaded; (3) scenarios that are no longer fixed, are Excel-editable, and can be uploaded; (4) greatly simplified generation of the cost-risk frontier and sensitivity analysis for comparing effects of force generation cycle, cost, and force mix parameters on deployment shortfalls and costs.

This paper describes only Phase 1 of the model. Because Phase 1 specified the development of a proof-of-concept tool, the tool includes only Army BCTs. However, the structure of the model can accommodate any kind of unit in any Service.

A. Inputs

The FSA Model is designed to analyze alternative sets of force structure options and force management policies. These alternatives are defined by inputs provided by the user. Default values are provided for some of the inputs, such as personnel cost factors, but all values can be altered by users to permit wide discretion in specifying alternatives of interest.

The user must provide the following information, which feeds the three modules of the model:

- The scenario that creates the demand that the force must attempt to satisfy;
- The force structure and force management policies being evaluated; and
- The structure, composition, and cost factors associated with the units of the force.

B. Modules

The FSA Model comprises three individual modules: a *Demand* module that generates requirements for forces, a *Supply* module that manages forces, and a *Cost* module that tracks the cost of these forces.

1. Demand Module

The demand for deployed forces of a given type of unit is specified by users on a time-phased (typically monthly) basis. Demand captures the scale of the operation being modeled and its duration. The number of units required, at any given time, is the "what" the supply module seeks to satisfy. It is worth noting that an unlimited number of demand scenarios can be stored in the model, and users can easily choose among scenarios. Thus, users can compare policy alternatives against a multitude of demand scenarios.

2. Supply Module

The Supply module generates deployed units based on a user-specified force structure and force management process. Force structure is the number of AC and RC units of each unit type. Force management involves the generation of deployable units based on a succession of training phases. Usually, training phases are associated with increasing resourcing (and readiness) levels as units return from one deployment and prepare for the next.

Force management includes Service policies regarding appropriate deployment-to-dwell (BOG:Dwell) ratios for AC and RC units and mobilization-to-dwell (Mob:Dwell) ratios for RC units. The FSA Model incorporates these policies and enables the user to vary the values to see the impact on cost and risk.

3. Cost Module

The FSA Model addresses both personnel and operating costs. Unit staffing and unit operating tempo can differ by force generation phase and are specified by the user. Generally, both personnel and operating costs in dwell phases are lower for RC units than for AC units. Deployed costs usually vary little by component.

Costs are a function of the phase a unit is in and the resourcing assumptions the user has made for units by phase and component. Costs are computed using both fixed and variable cost elements. Some cost elements are fixed for a phase regardless of its duration (e.g., cost to transport a unit's equipment during the deployment phase); others are fixed per month (e.g., military pay). Resourcing assumptions (e.g., staffing levels) can impact both fixed and variable costs.

C. Outputs

1. Risk

Risk can embody many dimensions. The FSA Model examines two specific measures of risk: *shortfall* and *stress on the force*.

For each month of the scenario, the FSA Model compares the number of deployed units with demand. Unmet demand, or *shortfall*, is the extent to which needed supply cannot be generated by a given force structure with a given force management policy. This is the primary measure of operational risk generated by the model.

The FSA Model also tracks *stress on the force*, a secondary measure of risk that represents the extent to which both AC and RC units are deployed beyond doctrinally defined maximums.

2. Cost

Costs are calculated based on the length of the phases in the force generation cycle and are aggregated up to the total cost for the specified demand scenario. AC and RC costs are calculated and displayed separately, as are personnel and operating costs.

3. Cost versus Shortfall

For every demand scenario and specified set of force management policies, the model can generate a cost versus shortfall analysis, as Figure 2 shows.

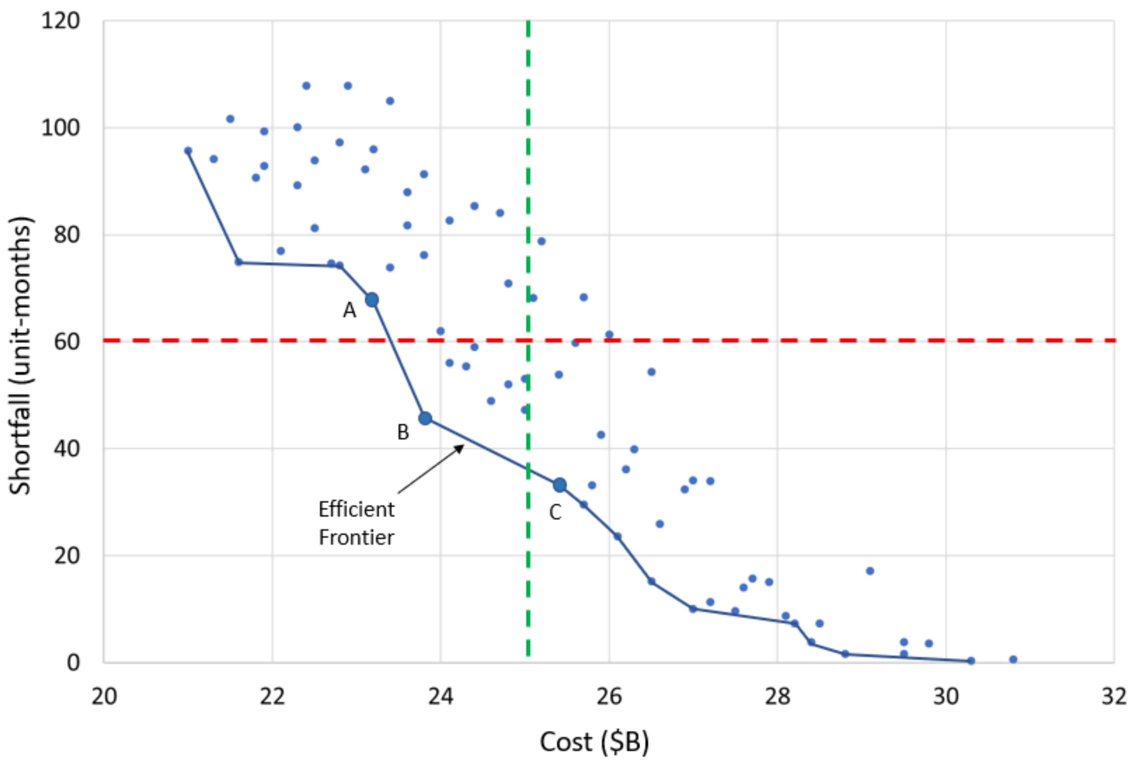

Figure 2. Cost versus Shortfall Analysis

Each blue dot represents a potential total force mix. At the efficient frontier, risk cannot be reduced without paying more, and cost cannot be reduced without incurring additional risk. Points A, B, and C can be thought of as alternative total force mixes under consideration. If a user adds a budget constraint of $25 billion (shown by the green vertical line), alternatives A and B both satisfy the constraint, with B being the lower risk of the two. Similarly, if a user adds a risk constraint of less than 60 unit-months of shortfall (shown by the red horizontal line), alternatives B and C both satisfy the risk constraint, with B being the lower cost of the two. Only alternative B meets both the cost and risk constraints.

It is important to remember that Figure 2 displays the results for only one demand scenario and set of policy choices. Mixes that are efficient for one scenario may be inefficient for others. Users should take this into account in their evaluations.

Figure 2 highlights a particular strength of the model: It enables users to identify the efficient frontier and avoid inefficient force mix alternatives. The users also see the trade space between risk and cost among alternatives.

3. Cost Modeling

This chapter describes the cost estimation framework used in the Phase 1 FSA Model and a method to add new data for any Service unit type. Force mix analyses should consider not only the cost of unit personnel, but the full cost of units, particularly all unit operating costs. The cost-estimating approach used in the initial version of the FSA Model meets this criterion and is derived from the model described in an IDA paper from 2015."[3] Most cost data used for example cases in this paper are updated versions of those used in the 2015 paper. The IDA team has provided unit and cost data for the Phase 1 FSA Model, but the model is designed to accept new data easily. This feature is essential to meet sponsor requirements, including flexibility, data transparency, and the ability to use the most appropriate data sources.

The following are key characteristics of the cost modeling methodology in the Phase 1 FSA Model:

- Cost and force generation inputs can be edited by the user and use structured and expandable configuration files.
- The model includes annualized recurring unit costs, including personnel, equipment, and support costs.
- Both peacetime and combined peacetime and wartime costs[4] are reported.
- Unit conversion, transition, stand-up, and deactivation costs are not included in the Phase 1 model, but may be included in future versions.

The Phase 1 FSA Model accepts user input via detailed configuration files. In future development, the model may link directly to Service and DoD databases. Although costs are addressed in this initial phase at a very high level, the model is flexible. Accordingly, the user can exclude, adjust, and expand cost categories. For example, the user can exclude the cost of equipment procurement that is not applicable to short-term force mix comparisons, especially for those including only existing units.

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3 Shaun K. McGee et al., *Active Reserve Force Cost Model*, IDA Document D-5057 (Alexandria, VA: Institute for Defense Analyses, January 2015).

4 *Peacetime* costs are associated with *programmed* unit training, sustainment, and operations. Unit deployment or mission costs generated for a given demand scenario are *wartime* costs. Combined peacetime and wartime costs include both *programmed* costs and the costs of meeting demand.

The data in the model is organized in three sets: *Demand*, *Cost*, and *Force Generation*. *Demand* adds to cost only when demand is met. The *Cost* and *Force Generation* data sets, however, are central to calculating the cost of an alternative. Both of these data sets are structured in configuration files that the user can select in the model and edit in Microsoft Excel. The *Cost* configuration file stores cost estimates by resource category for fully resourced units. The *Force Generation* configuration file describes each unit's force generation cycle and resourcing during all phases of the cycle. Together, the configuration files provide the periodic costs for each unit that, when summed across all units in a force mix, comprise the cost of the total force. Each data set consists of three components:

- Fixed phase costs
- Monthly fixed costs
- Monthly variable costs

$$\begin{bmatrix} Monthly \\ Force\ Mix \\ Cost \end{bmatrix} = \sum_{unit\,=\,1}^{n} \left\{ \left[\frac{\begin{pmatrix} Fixed \\ Phase\ Cost \end{pmatrix}_{unit}}{\begin{pmatrix} Phase \\ Duration \end{pmatrix}_{unit}} \right] + \begin{bmatrix} Monthly \\ Fixed \\ Cost \end{bmatrix}_{unit} + \begin{bmatrix} Monthly \\ Variable \\ Cost \end{bmatrix}_{unit} \right\}$$

Fixed phase costs, monthly fixed costs, and monthly variable costs act on or are a function of data from both the *Force Generation* and *Cost* configuration files. The *Force Generation* configuration file provides information on phase duration and resourcing. The *Cost* configuration file provides fully resourced costs that are a product of the quantity of a given resource and the cost of that resource:

$$\begin{bmatrix} Fixed \\ Phase\ Cost \end{bmatrix}_{unit} = \sum_{resource\,=\,1}^{n} \left\{ \begin{bmatrix} Fixed\ Cost\ of\ Resource \\ Over\ the\ Entire\ Phase \end{bmatrix}_{resource} \right\}$$

$$\begin{bmatrix} Monthly \\ Fixed\ Cost \end{bmatrix}_{unit} = \sum_{resource\,=\,1}^{n} \left\{ \begin{bmatrix} Monthly\ Fixed \\ Cost\ of\ Resource \end{bmatrix}_{resource} \right\}$$

$$\begin{bmatrix} Monthly \\ Variable\ Cost \end{bmatrix}_{unit} = \sum_{resource\,=\,1}^{n} \left\{ \begin{bmatrix} Resourcing \\ Rate \end{bmatrix}_{res.} * \begin{bmatrix} Monthly\ Variable \\ Cost\ of\ Resource \end{bmatrix}_{res.} \right\}$$

In this context, "resources" include elements of a unit's design, such as people and equipment. The objective for the FSA Model is to use unit resource and cost factor data to estimate the total unit cost for the selected scenario. Variable costs (e.g., fuel, spare parts) are adjusted according to resourcing rates. Fixed costs (e.g., deployment transportation costs) are not a function of resourcing rates.

A. Cost Data Structure

Cost data elements in the Phase 1 FSA Model are drawn primarily from current IDA models, specifically the force structure cost-estimating module in the Contingency Operations Support Tool (COST). DoD data sources are used as well. Table 1 highlights unit cost elements across four major resource categories: *Personnel*, *Operations*, *Procurement*, and *Indirect* support.

Table 1. Cost Element Highlights (DoD Costs Only)

Personnel	Basic Pay, Drill Pay, Salary, and Allowances (Basic and Drill)
	Retired Pay Accrual, Thrift Savings, and Retirement Contributions
	Housing and Subsistence Allowances / Subsistence in Kind
	Cost of Living and Related Allowances (COLA)
	Special, Incentive, and Hazardous Duty Pays
	Permanent Change of Station and Other Travel
	General and Specific Training
	General Benefits and Benefits Overhead
	Separation and Severance Pays
	Federal Insurance Contributions Act Payments
	Current Medical Care and Health Benefits
	Other Personnel Benefits and Costs
Operations	Energy
	Transportation
	Consumables and Repair Parts
	Depot-Level Repairables
	Depot Maintenance
	Contractor Logistics Support
	Equipment and Software Modifications and Maintenance
Procurement	Amortization of Equipment Purchases
	Replacement of Training Munitions and Expendable Stores
Indirect	Personnel Benefits
	Personnel Administration
	Education and Individual Training
	Installation Support
	Medical Care

For Phase 1, the cost framework is limited to DoD costs, and only DoD costs are included in the example case studies in this paper. *Personnel* and personnel-driven costs follow a typical framework as described in prior IDA papers.[5] The *Operations* category

[5] Shaun K. McGee et al., *Active-Reserve Force Cost Model*, IDA Document D-5057 (Alexandria, VA: Institute for Defense Analyses, January 2015); and Shaun K. McGee, Stanley A. Horowitz, and John J. Kane, *Analysis of Alternative Mixes of Full-time Support in the Reserve Components*, IDA Document D-8575 (Alexandria, VA: Institute for Defense Analyses, August 2017).

includes, primarily, equipment operations and maintenance. *Procurement* costs are derived from Service data on equipment replacement costs and consumption of ammunition. Equipment purchases capture the amortized cost of equipment over time.

In the Phase 1 model, *Indirect* costs are derived from information in the Future Years Defense Program (FYDP). Categories include personnel benefits, personnel administration, education and individual training, and installation support. Like other cost categories, *Indirect* costs can be selected and edited by users and may be excluded from unit cost comparisons, as necessary.

A list of primary sources of cost data appears in Table 2.

Table 2. Data Source Highlights (DoD Costs Only)

Personnel	All Services – OSD Comptroller and DoD Budget Justification Documents
Operations	Air Force – Air Force Total Ownership Cost (AFTOC), AFI 65-503
	Army – Army Cost and Economics (Force and Organization Cost Estimating System (FORCES) Cost Model)
	Navy – Naval Expeditionary Combat Command and Navy Visibility and Management of Operating and Support Costs (VAMOSC)
	Marine Corps – Total Force Structure Management System (TFSMS) and Navy VAMOSC
Procurement	Air Force – Air Force Equipment Management System (AFEMS)
	Army – Army Cost and Economics (FORCES Cost Model)
	Navy – Navy VAMOSC
	Marine Corps – Marine Corps Program Analysis and Evaluation (PA&E)
Indirect	All Services – FYDP

Note: Data sources are not comprehensive. Sources for follow-on phases will change as links to external and third-party data providers are established. All deployment-related costs are currently sourced from the IDA COST model.

The model includes mission deployment costs because many, but not all, marginal costs associated with a single deployment are similar for AC and RC units of a given type. Also, if AC and RC units have deployments of different durations over different deployment cycles, the total cost of deployments may differ when the AC-RC mix changes. In the Phase 1 model, deployment factors are primarily derived from IDA's COST model. The factors supporting this tool are sourced throughout DoD and from internal IDA studies and analyses.

B. Structure of the Force Generation Configuration File

To better understand the discussion that follows, review the basic cyclical force generation construct shown in Figure 3. Units move through Reset and Training phases to reach a ready status, during which they either deploy (or mobilize and deploy, for RC units) or return to reset status. The remainder of this section describes how elements of the Force Generation Cycle are used to produce cost estimates.

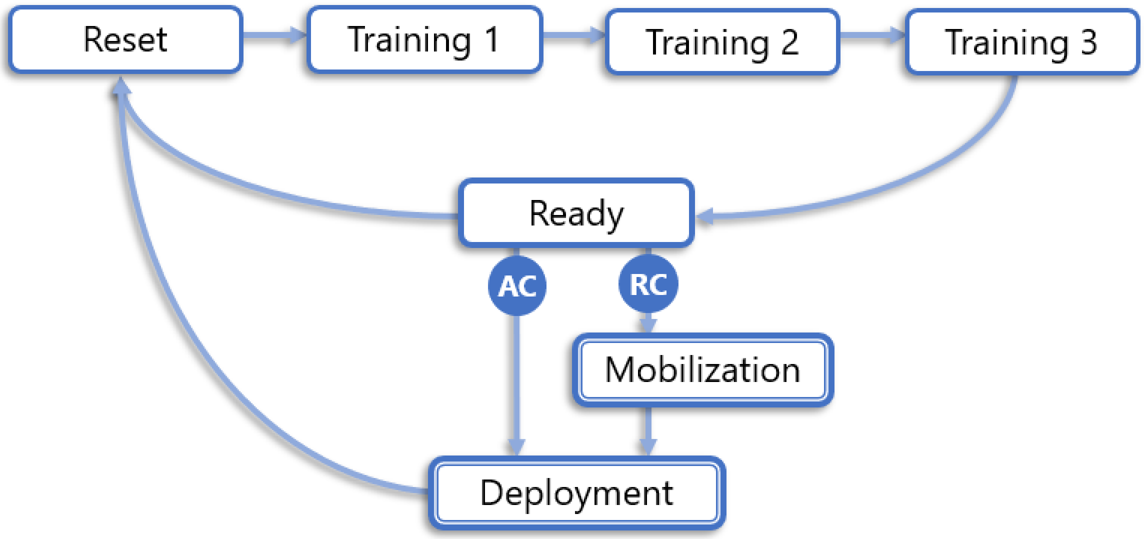

Figure 3. Force Generation Cycle

The *Force Generation* configuration file lists the set of units available and each unit's associated force generation approach. For each unit, the file sets the cycle of phases and each phase's duration and level of resourcing. Both resourcing levels and phase durations are key cost drivers and act directly on the cost factors in the *Cost* configuration file. Elements of the *Force Generation* configuration file are:

- Unit ID – unique code that links units in *Force Generation* configuration file to units in *Cost* configuration file;
- Unit Name – unique name for each unit across all configuration files
- Component – Active or Reserve;
- Phase – user-designated force generation phase (reset, training, ready, mobilization, and deployment);
- Resource Level –user-defined settings for Phase Duration and Resource Rate;
- Phase Duration – duration of the phase in months;
- Resource Category – user-designated resourcing area (e.g., *Personnel* or *Operations*[6]);

6 To limit the scope of resource categories in Phase 1, the *Operations* resource category includes all cost categories other than *Personnel*. Future phases will expand the resource categories to support greater estimate fidelity.

- Resource Rate – percentage of resources funded during the phase; and
- Next Phase – phase that doctrinally follows the completion of the current phase.

Table 3 shows sample data for a Stryker BCT, structured according to a typical rotational force generation process. This notional cycle is influenced primarily by the Army's Sustainable Readiness Model (Army Regulation 525-29).[7] If an AC unit deploys while ready, it enters the deployment phase; if an RC unit deploys while ready, it mobilizes and then deploys. The FSA Model configuration files can support any number of force generation approaches, and thus provides a basis for evaluating a wide range of force management policies.

Table 3. Data Structure of the *Force Generation* Configuration File

Unit ID	Unit Name	Component	Phase	Resource Level	Phase Duration	Resource Category	Resource Rate	Next Phase
2	Stryker BCT	Active	Reset	Default	3	Personnel	0.80	Training
2	Stryker BCT	Active	Training	Default	6	Personnel	0.95	Preparation
2	Stryker BCT	Active	Preparation	Default	6	Personnel	0.95	Ready
2	Stryker BCT	Active	Ready	Default	12	Personnel	1.05	Reset
2	Stryker BCT	Active	Deployment	Default	12	Personnel	1.05	Reset
2	Stryker BCT	Active	Reset	Default	3	Operations	0.85	Training
2	Stryker BCT	Active	Training	Default	6	Operations	0.85	Preparation
2	Stryker BCT	Active	Preparation	Default	6	Operations	0.85	Ready
2	Stryker BCT	Active	Ready	Default	12	Operations	1.00	Reset
2	Stryker BCT	Active	Deployment	Default	12	Operations	1.00	Reset
2	Stryker BCT	Reserve	Reset	Default	36	Personnel	0.75	Training
2	Stryker BCT	Reserve	Training	Default	12	Personnel	0.85	Ready
2	Stryker BCT	Reserve	Ready	Default	12	Personnel	0.90	Reset
2	Stryker BCT	Reserve	Mobilization	Default	3	Personnel	1.00	Deployment
2	Stryker BCT	Reserve	Deployment	Default	9	Personnel	1.00	Reset
2	Stryker BCT	Reserve	Reset	Default	36	Operations	0.70	Training
2	Stryker BCT	Reserve	Training	Default	12	Operations	0.85	Ready
2	Stryker BCT	Reserve	Ready	Default	12	Operations	1.00	Reset
2	Stryker BCT	Reserve	Mobilization	Default	3	Operations	1.00	Deployment
2	Stryker BCT	Reserve	Deployment	Default	9	Operations	1.00	Reset

Note: Initial data structure to expand in future development. Data presented is notional and abridged for example purposes. Basic cycle information, like phase duration and resourcing level, is influenced by the Army Sustainable Readiness force generation model.

[7] Department of the Army, "Force Generation – Sustainable Readiness," Army Regulation 525-29 (Washington, DC: Headquarters of the Department of the Army, 2019), 34–37, https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN9412_AR525_29_FINAL.pdf.

The data in Table 3 is limited to a single unit type, but a fully developed *Force Generation* configuration file will include data for multiple unit types and force generation cycles.

Phase Duration and *Resource Rate* are the two key force generation factors that act on phase cost factors. Only variable monthly costs by phase are a function of *Resource Rate*. A *Resource Rate* of 1.0 for a given *Resource Category* indicates that all unit resources included in that category are fully resourced. A *Resource Rate* less than 1.0 implies lower overall structural readiness. Fixed phase costs are not affected by either the duration of a phase or its resourcing.

Resource Level is a field that contains the settings for *Phase Duration* and *Resource Rate* for all *Phases* and *Resource Categories*. This field enables a user to see the impacts of different combinations of settings. Additional approaches could describe higher or lower levels of resourcing or different phase profiles. For example, a user could define a *Resource Level* called “High” that has identical *Phase Duration* values and increased *Resource Rate* values compared to the “Default” settings. This approach would provide visibility into the sensitivity of overall cost and shortfall to *Resource Rate* increases.

C. The *Cost* Configuration File

For Phase 1, the *Cost* configuration file is structured to include the same set of units, force generation phases, and resource categories detailed in the *Force Generation* configuration file. To support user flexibility, the model was designed to use an editable configuration file rather than access natively stored data. Future development will allow users to link data in this tool to external data sources.

Elements of the *Cost* configuration structure are:

- Unit ID – unique code that links units in the *Force Generation* configuration file to units in the *Cost* configuration file;
- Unit Name – unique name for each unit across all configuration files;
- Component – Active or Reserve;
- Phase – user-designated force generation phase (e.g., reset, training, ready, mobilization, and deployment);
- Resource Category – user-designated resourcing area (e.g., *Personnel* or *Operations*);
- Fixed Phase Cost – fixed costs not a function of phase duration for each combination of *Phase* and *Resource Category* by unit and component;
- Fixed Monthly Cost – fixed costs that recur monthly for each combination of *Phase* and *Resource Category* by unit and component; and

- Variable Monthly Cost – costs that are a function of resourcing and recur monthly for each combination of *Phase* and *Resource Category* by unit and component.

Example *Cost* configuration data for the same notional Stryker BCT appears in Table 4. Costs are recorded for three functional types: fixed phase, fixed monthly, and variable monthly. Fixed phase cost examples include the transportation costs supporting a unit deployment and the cost of a training event prior to a ready phase. Fixed phase costs are not a function of resource rates or duration. Fixed monthly costs are a function of time but are not influenced by resourcing levels. They include costs like the amortization of equipment investments. Most costs are variable costs recorded by month. Examples of variable costs include personnel pay and allowances, training costs, and operations costs such as equipment maintenance costs and personnel support costs during a deployment.

Table 4. Data Structure of the *Cost* Configuration File

Unit ID	Unit Name	Component	Phase	Resource Category	Fixed Phase Cost	Fixed Monthly Cost	Variable Monthly Cost
2	Stryker BCT	Active	Reset	Personnel	0	0	38,000,000
2	Stryker BCT	Active	Training	Personnel	0	0	38,000,000
2	Stryker BCT	Active	Preparation	Personnel	0	0	38,000,000
2	Stryker BCT	Active	Ready	Personnel	0	0	38,000,000
2	Stryker BCT	Active	Deployment	Personnel	0	0	43,000,000
2	Stryker BCT	Active	Reset	Operations	0	6,000,000	18,000,000
2	Stryker BCT	Active	Training	Operations	0	6,000,000	18,000,000
2	Stryker BCT	Active	Preparation	Operations	0	6,000,000	18,000,000
2	Stryker BCT	Active	Ready	Operations	0	6,000,000	18,000,000
2	Stryker BCT	Active	Deployment	Operations	120,000,000	6,000,000	45,000,000
2	Stryker BCT	Reserve	Reset	Personnel	0	0	9,000,000
2	Stryker BCT	Reserve	Training	Personnel	0	0	9,000,000
2	Stryker BCT	Reserve	Ready	Personnel	0	0	9,000,000
2	Stryker BCT	Reserve	Mobilization	Personnel	0	0	39,000,000
2	Stryker BCT	Reserve	Deployment	Personnel	0	0	39,000,000
2	Stryker BCT	Reserve	Reset	Operations	0	6,000,000	7,000,000
2	Stryker BCT	Reserve	Training	Operations	0	6,000,000	7,000,000
2	Stryker BCT	Reserve	Ready	Operations	0	6,000,000	7,000,000
2	Stryker BCT	Reserve	Mobilization	Operations	0	6,000,000	18,000,000
2	Stryker BCT	Reserve	Deployment	Operations	130,000,000	6,000,000	45,000,000

Note: Initial data structure to be expanded in future development phases. Cost data presented is in FY 2021 dollars, is for example purposes, and is not the basis of cost results in example case studies elsewhere in the document.

The Phase 1 model is designed to address the cost of both normal peacetime operations and, when a unit is selected to satisfy demand, full unit costs including mobilization and deployment. The focus of force mix planning and programming, however, is on peacetime costs. Peacetime costs represent future program budget requirements. Although mobilization and deployment costs help analysts understand the full cost of a given force mix when used to satisfy demand, these costs do not represent actual programming commitments. Force mix suitability should be measured across a range of demand scenarios, including a peacetime scenario. The Phase 1 model can present information on multiple demand scenarios, but does not combine the resulting cost data. Future development of the model will enable users to combine expected costs across a range of potential future demands, including peacetime, to create an expected future total cost.

4. Aspects of Force Management

The FSA Model provides relevant force management insights that will help inform DoD planning and programming and can be used by decision-makers in the military Services, Joint Staff, OSD Personnel and Readiness, OSD Policy, and OSD Cost Assessment and Program Evaluation (CAPE). These insights are invaluable to senior decision-makers seeking to allocate personnel, programs, and money to support the National Defense Strategy.

In this chapter, we describe uses of the FSA Model and discuss the most important and relevant force management topics it addresses. We also describe the policy "levers" that can be pulled to evaluate force size, Active-Reserve mix, and other relevant policy options. Further, we highlight the value that the FSA Model brings to any discussion of those options.

A. Uses of the Model

When considering uses of The FSA Model, it is important to start with an understanding of the context in which the results of the model are interpreted. As with any analytic model, the quality and utility of the output is directly related to the data and assumptions that inform the inputs. Generally speaking, force planning constructs, with their inherent implications for force sizing and force capabilities, are driven by a combination of assumptions about available resources and the strategic demand for deployed forces. The extent to which resources are adequate to meet requirements is reflected in the output calculations of the model. For example, if using the model to gain insight into a potential AC-RC mix to support operational contingency plans, the input assumptions—such as the duration and scale of the conflict, the timeline to deploy forces, and the length of those deployments—are critical levers to be pulled. The FSA Model responds to those types of changes in input assumptions and provides a focused and tailored product for the user. These input assumptions are also among the levers that can be pulled to provide additional context and insight for senior leaders. The remainder of this chapter describes the policy levers in the FSA Model.

B. Policy Levers

1. Force Size

A lever of primary importance in managing the total force is force size. In Phase 1 of the model, force size is an input.[8] For example, whether trying to determine the optimum size for the entire Joint Force or for an individual Service, one might start with a notional force size and assess it against the demands included in the National Security Strategy (NSS) to determine the risk in execution of that strategy. Importantly, the execution of the strategy would be viewed within the context of the applicable constraints that determine whether the level of risk is acceptable. A number of variables introduce uncertainty into the challenging task of force management, and the FSA Model is designed to reduce those uncertainties.

Among the significant force management variables are assumptions about the general level of readiness required of the total force and about the required readiness of specific units. These assumptions are important factors in assessing the timeline for deployment. While the model is not designed to characterize overall risk per se, it does present data that informs a senior decision-maker's own calculus of risk. Specifically, the FSA Model can estimate the shortfall a selected force mix would have within a specified demand for deployment. Additionally, the model calculates some *stress on the force* metrics that are another facet of risk. The great advantage of the FSA Model is that it provides both a quick look and a more deliberate examination into the implications of force size and demand imperatives. The model will enable decision-makers to differentiate options from baseline levels of Joint Force capacity and will highlight the effects of changes in demand or policy on force capacity.

2. Active-Reserve Mix

Another important lever is the Active-Reserve force mix. In this case, as with the other levers, it is necessary to examine and question the underlying assumptions regarding deployment length, readiness levels, training requirements, and dwell time between deployments. It is also important to understand what we want the model to highlight. Is it the readiness to deploy or the training level before deployment? Or, is it a unique capability of an individual unit found only in the active component or only in the Reserves? These assumptions will shape the output of the model. In order to fully use the capabilities of this tool, these assumptions must be variable and their veracity open to questioning. Another consideration in using the model is the length of deployments. Assuming that there will be a "standard" rotation of forces favors a heavier weighting of active forces, which have fewer deployment constraints. Conversely, if we assume that, in a fight with a peer like

[8] As the model is developed, force size alternatives will become outputs of the model.

China, there will be less rotation of U.S. forces, then the larger force size made affordable by a more Reserves-intensive force mix may be attractive.

The missions that the AC and RC forces are expected to accomplish can also be examined in the model. The impact of those missions would be evident in the time-to-train requirements before a deployment and, consequently, would drive the "usability" of RC forces in some scenarios. A thoughtful discussion of Active-Reserve mix begins with the National Defense Strategy (NDS) and what it expects the Joint Force to execute and in what context (such as timeline for reaction to aggression and capabilities required of the total force).

3. Force Generation Cycle

Central to discussions of deployment policies for both AC and RC forces is the force generation cycle. Simply, the force generation cycle is the set of phases through which units move as they train, deploy, reset, and train again. Figure 4 presents a typical force generation cycle. The "Early Alert" phase signifies a potential policy of allowing units to deploy before all training is complete. The "Extended Deployment" phase indicates a potential policy decision to allow units to remain deployed for longer than normal. The FSA Model includes levers that the user must adjust to set the duration of each phase of the cycle and the resourcing associated with each phase. The user may also set the phases during which units may be deployed for Early Alert and can introduce Extended Deployment.

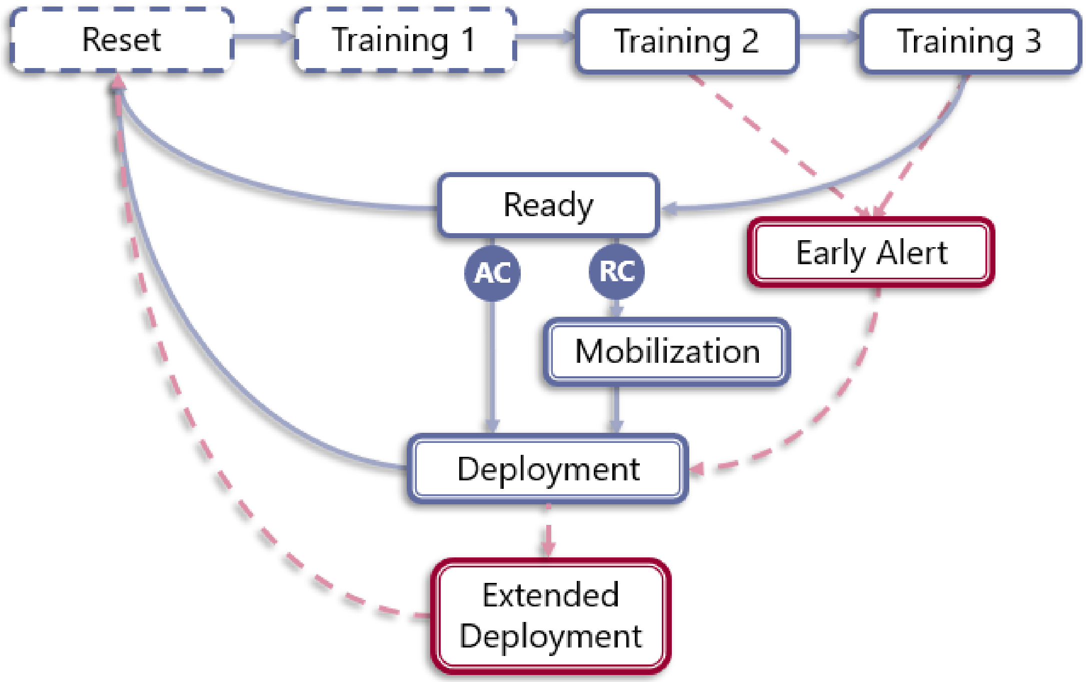

Figure 4. Force Generation Cycle

4. Readiness Resourcing

Another lever the user can pull is the resourcing of AC and RC units by phase. In this case, phase resourcing refers to the phases of an operation and the requirements for particular unit types in each phase. Resourcing decisions reflect desired readiness levels in each phase. For example, early in an operation, active duty forces may be in higher demand because they are at higher levels of readiness and are available for immediate deployment. Reserve forces that must be mobilized and trained would not typically be available early in the operation. The model can be used to break out forces by unit type and show decision-makers whether the appropriate capabilities are in the AC or RC. In other words, early deploying forces should have the organic capabilities that are required immediately. Those capabilities might logically be resident in the active forces but not in the Reserves, which are subject to longer call-up and mobilization timelines. However, a policy of using Reserve forces operationally, and resourcing them accordingly, will allow some to be ready on short notice. Airlift is an example of a capability with a large presence in the Reserves that can be resourced to remain at high readiness.

5. Deployment Length

When exploring force size and force mix options, another consideration is the length of deployments, something that has historically been determined by the Service force providers. However, extending a deployment to reduce perceived near-term risk has many implications beyond just the numbers required to fill an articulated need. Deployment length affects personnel issues from recruitment to retention, all of which contribute to the ability of the Services to provide for ultimate size of the force without resorting to conscription. The FSA Model provides information on how *stress on the force* metrics change under various policy settings.

6. BOG:Dwell and Mob:Dwell

An important pair of levers related to deployment length are BOG:Dwell and Mob:Dwell. BOG:Dwell is the policy that determines how long an active component unit must remain in a non-deployed ("Dwell") status following a "Boots on the Ground" (BOG) deployment. On the Reserves side, Mob:Dwell describes how long a reserve component unit must remain in a non-mobilized ("Dwell") status following a mobilization (Mob). Typically, units from the Reserves will have shorter deployment phases than their AC counterparts in order to accommodate mobilization activities, including pre-deployment training. In this case, the length of the training phase is also an important lever. The model describes how changes in the time to train, the time in dwell, and in the time devoted to pre- and post-mobilization for Reserves will impact the availability of the total force for a potential AC-RC mix. The amount of dwell time is a policy decision that has far-reaching effects on, among other factors, the availability of the total force and the stress on that force. The FSA Model can quickly compute the implications of reducing or extending the time a unit spends in dwell and how that duration affects its training phases for the next deployment.

C. Summary

Deployment and rotation of forces, and the application of other FSA policies, should always be informed by the NSS and NDS and not just by a desire for more boots on the ground (BOG) as an end state in itself. Additionally, BOG, dwell time, and mobilization time are driven by policy decisions and should be informed by a continuous reappraisal of the desired end state. The FSA Model is a tool that can show how variation in these policies will affect the required size of the total force and its ability to meet demand. The model does this by illuminating the connection between total force size and policy decisions, thus giving senior decision-makers a tool to evaluate the risk to the total force and to the missions required in national security documents.

5. Using the Model

This section explains, with illustrations, how to operate the FSA Model. The FSA model includes three user-supplied configuration files (*Demand*, *Force Generation*, and *Cost*) and an interface that users navigate to set up and run simulations and display outputs. We recommend hosting the FSA model in an environment suitable for Python software development. For a detailed description of required programs and how to install the FSA model, please consult Appendix B.

A. Specifying Demand Scenarios

The first thing a user must do is specify the demand by uploading a *Demand* configuration file. This file tells the model how many units are required over time. A sample demand profile is shown in Figure 5. This 60-month profile shows (1) a steady increase in demand up to a maximum of 37 BCTs during notional combat operations, (2) a decrease to 20 BCTs during notional peacekeeping operations, and (3) a full redeployment of forces. Figure 6 shows an example of the spreadsheet-based *Demand* configuration file.

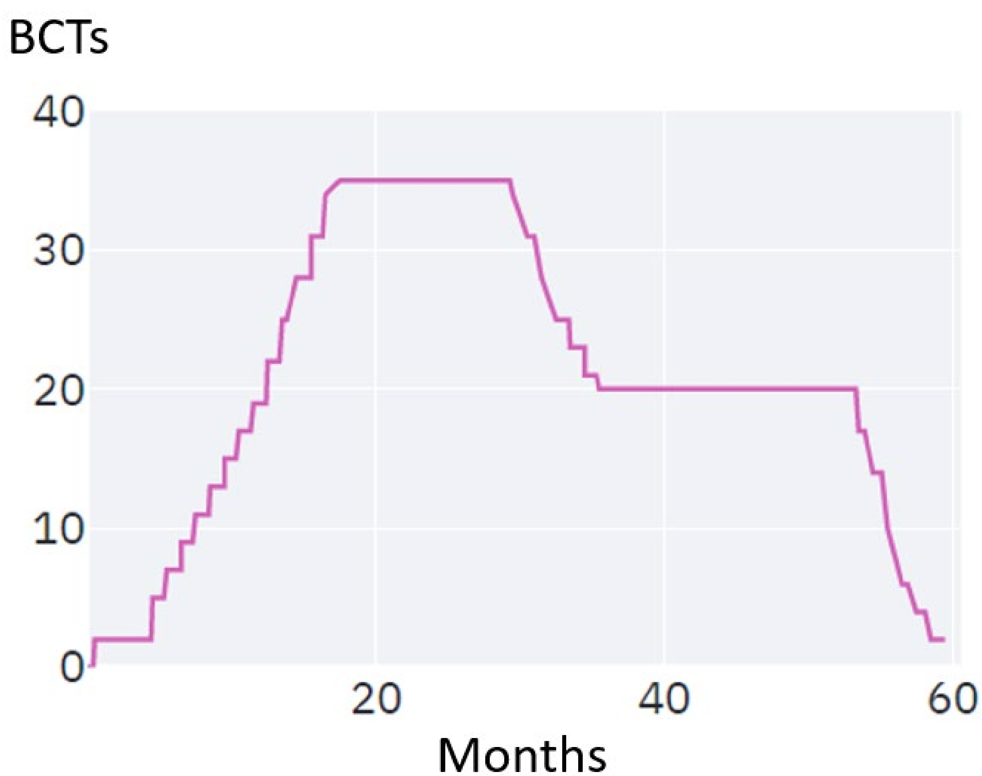

Figure 5. Notional 60-Month Demand Profile

Each *Demand* configuration file has three columns: *phase*, *demands*, and *duration*:

A. phase: numeric value representing the phase of the force generation cycle;

B. demands: the number of units demanded during a phase; and

C. duration: the number of months the demand level is sustained.

	A	B	C
1	phase	demands	duration
2	1	2	4
3	2	5	1
4	3	7	1
5	4	9	1
6	5	11	1
7	6	13	1
8	7	15	1

Figure 6. Demand Configuration File

B. Force Generation and Cost Configuration

The force generation cycle and resourcing policy are defined by two configuration files, *Force Generation* and *Cost.*

1. *Force Generation* Configuration File

The *Force Generation* configuration file specifies the force generation cycle followed by units and their level of resourcing at each phase. An example of the fields in this file is shown in Figure 7. In this file, the user specifies which phases exist in the force generation cycle, how quickly units move through the phases, and the types and level of resourcing required at each phase. Detailed definitions of the configuration fields are given in Appendix B.

	A	B	C	D	E	F	G	H	I
1	UnitID	UnitName	Component	Phase	ResourceLevel	PhaseDuration	ResourceCategory	ResourceRate	NextPhase
2	1	Armored BCT	Active	Reset	Default	3	Operations	0.85	Training_1
3	1	Armored BCT	Active	Training_1	Default	6	Operations	0.85	Training_2
4	1	Armored BCT	Active	Training_2	Default	3	Operations	0.85	Ready
5									

Figure 7. Example *Force Generation* Configuration File

Some force generation parameters are targeted for future addition to the configuration files but currently reside inside the model as changeable assumptions in the source code. These assumptions include the following

- Extended deployments are enabled for all units. If no other units are available to meet an expected demand, units deployed have their deployment duration extended by up to half the deployment phase duration specified in the force generation configuration file.
- All available AC units are deployed before any available RC units are mobilized.
- AC and RC units of the same type are considered equally able to meet demand.

2. *Cost* Configuration File

The *Cost* configuration file contains the unit resourcing data. Its format shares many elements with the *Force Generation* configuration file since costs are broken down by phase of the force generation cycle. Figure 8 is an example of data in a C*ost* configuration file. The full set of column definitions is provided in Appendix B.

	A	B	C	D	E	F	G	H
1	UnitID	UnitName	Component	Phase	ResourceCategory	FixedPhaseCost	FixedMonthlyCost	VariableMonthlyCost
2	1	Armored BCT	Active	Reset	Operations			41819742
3	1	Armored BCT	Active	Training_1	Operations			41819742
4	1	Armored BCT	Active	Training_2	Operations			41819742

Figure 8. Example *Cost* Configuration File

C. Evaluating Force Mix Alternatives

Upon opening the FSA Model dashboard, the user sees a choice of four pages. In Figure 9, the user has selected the *Cost and Force Generation Cycle Settings* page, which is also the default page the user sees after initially loading the dashboard.

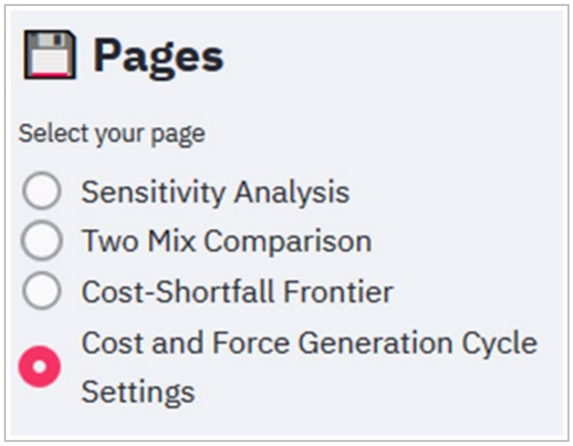

Figure 9. Selecting the Settings Page

Next, the user selects the desired configuration file(s). The drop-down menus allow the user to upload their own configuration files in addition to selecting files already in the model. In Figure 10, the user has chosen the *Sustainable Readiness Model* force generation cycle configuration file.

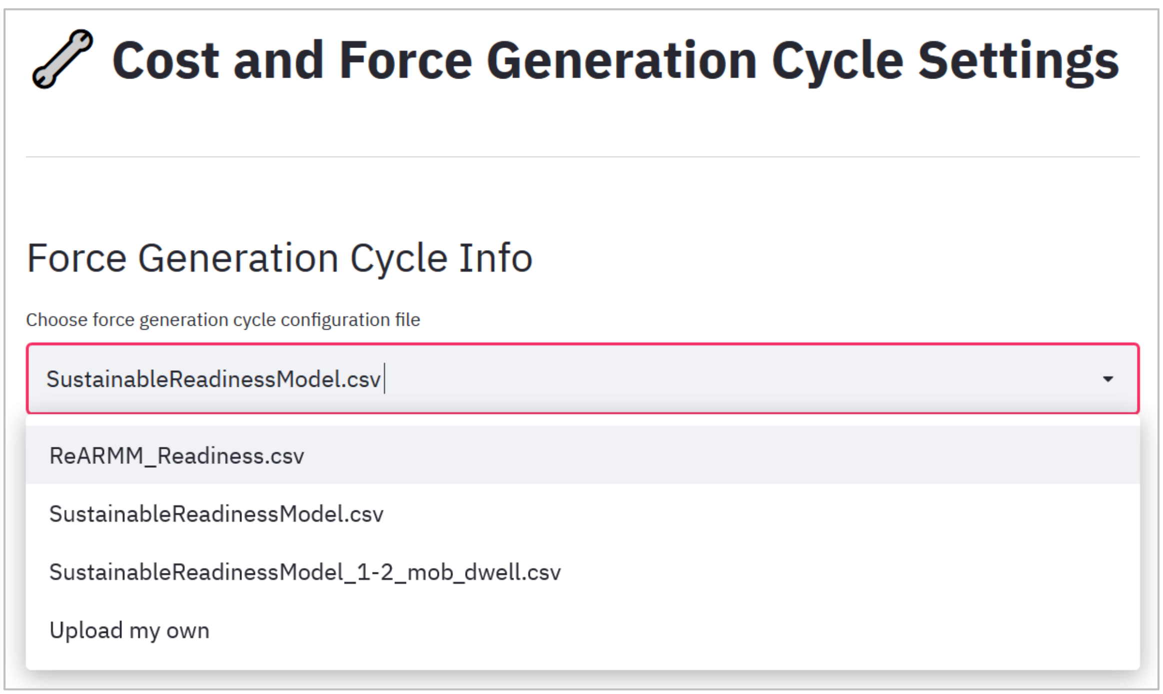

Figure 10. Selecting the Force Generation Cycle Configuration File

After selecting a force generation cycle configuration, the user can view a representation of the cycle, as shown in Figure 11. The cycle runs counter-clockwise in this diagram. Starting on the right, at *Reset*, a unit will pass through two training phases to the *Ready* phase. From the *Ready* phase, the unit moves either to *Deployment* or, if there is no demand (as in peacetime or if demand is filled by other units), returns to the *Reset* phase. The resource rates for each phase are also provided. Appendix B describes how resource rates are used.

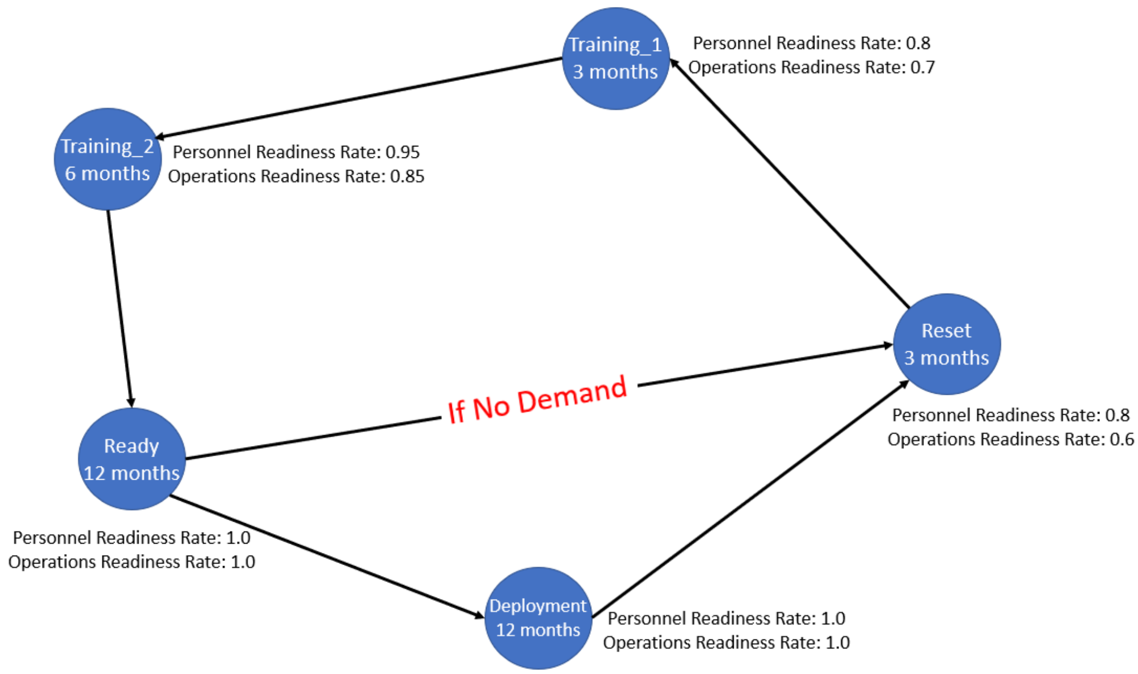

Figure 11. Example Force Generation Cycle

The *Cost-Shortfall Frontier* page (Figure 12) provides a high-level overview of the optimization space. On this page, a user selects a demand scenario (*deliberate_buildup.csv*), a unit type (*Average Brigade Combat Team*), and a total force size (*58 total BCTs*) to simulate the performance of all possible combinations of AC and RC units in the selected demand scenario.

Figure 12. Settings on the Cost-Shortfall Frontier Page

The annualized cost in billions of dollars and total shortfall in unit-months are then plotted for each combination (see Figure 13). A user can hover their pointer over any point to reveal the combination of AC and RC units leading to that cost and shortfall. To guide the eye, a line is drawn between points that represent the efficient frontier.[9] Less efficient points are made partially transparent to indicate there may be mixes with lower shortfall for a similar cost or the same shortfall at a lower cost. In Figure 13, the user has hovered over a point representing 31 AC and 27 RC BCTs. For this scenario, the model indicates that other mixes are more efficient. The user would do well to investigate the points labeled A and B in the figure.

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9 For any point that lies on the efficient frontier, less shortfall cannot occur without higher cost, and lower cost cannot result without increasing shortfall.

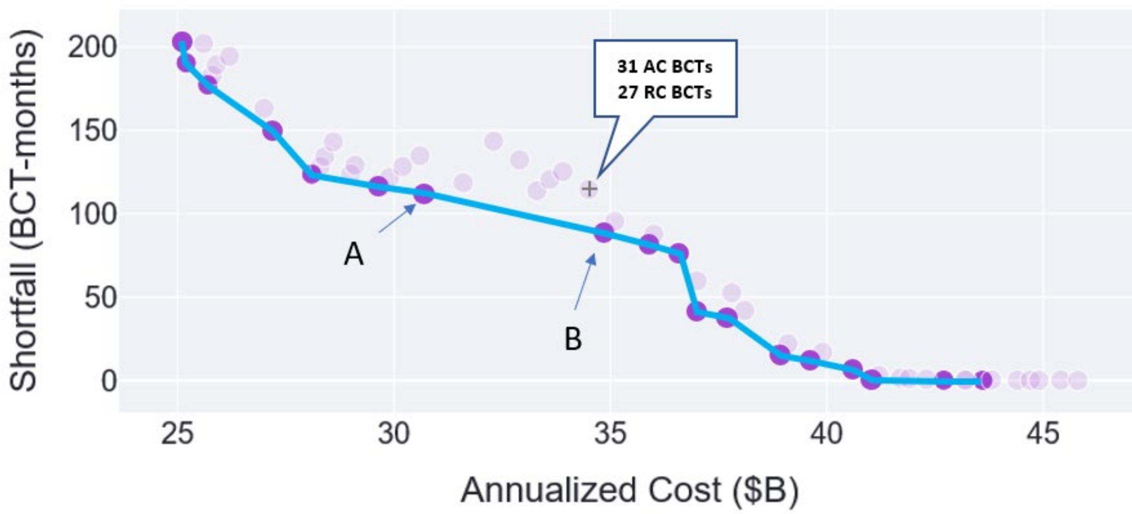

Figure 13. Example Cost-Shortfall Frontier Plot

In addition to the cost-shortfall plot, the model provides metrics for each combination (see Figure 14). These metrics can be sorted in the browser and can be exported as an Excel-compatible file. The full set of metrics in the Phase 1 model appears in Appendix B. As development of the model continues, stakeholders will assist in expanding and enhancing the set of metrics.

	Annualized Cost ($B)	Demand Unmet (BCT*mont…	#AC Units	#RC Units	Average Months Extende…	Average AC Deployed
0	25.2	190.5	1	57	4.1	0.5
1	25.1	203.4	2	56	4.2	0.8
2	25.7	177.3	3	55	4.0	1.7
3	25.8	183.0	4	54	4.1	1.9
4	25.6	202.1	5	53	4.6	2.0
5	25.9	189.4	6	52	4.2	2.9
6	26.2	194.5	7	51	4.4	3.3
7	27.2	149.7	8	50	4.4	4.1
8	27.0	163.2	9	49	4.5	4.4
9	28.1	123.8	10	48	3.9	4.8
10						

Download table as csv

Figure 14. Metrics on the Cost-Shortfall Frontier Page

Once a force mix is identified for further investigation, the user can explore mix alternatives on the *Two Mix Comparison* page. From this page, users can compare the deployment shortfall and cost profiles over time for two particular force mixes. Users select the demand scenario for each mix, the unit type being modelled, and the number of AC and RC units. There are three outputs of the *Two Mix Comparison* page: (1) a plot comparing the total unit demands and deployments over time, (2) a plot comparing the cumulative costs over time, and (3) a table of summary metrics.

The deployment plot (Figure 15) provides details on how the two force mixes deploy units over time (in months) in response to the demand scenario. While a cost-shortfall frontier plot may show that a particular mix has a reasonable cost and satisfies demand well overall, the deployments plot can show whether the same mix cannot meet demand rapidly in a wartime scenario compared to other alternatives.

In Figure 15, the purple line shows the level of units demanded, while blue and yellow shades indicate deployments by AC and RC units, respectively.[10] An orange shade indicating the shortfall between total supply and demand is given below the zero line. (The shortfall is also displayed as empty space between the yellow and purple lines.) In this case, Option 2 has more shortfall than Option 1.

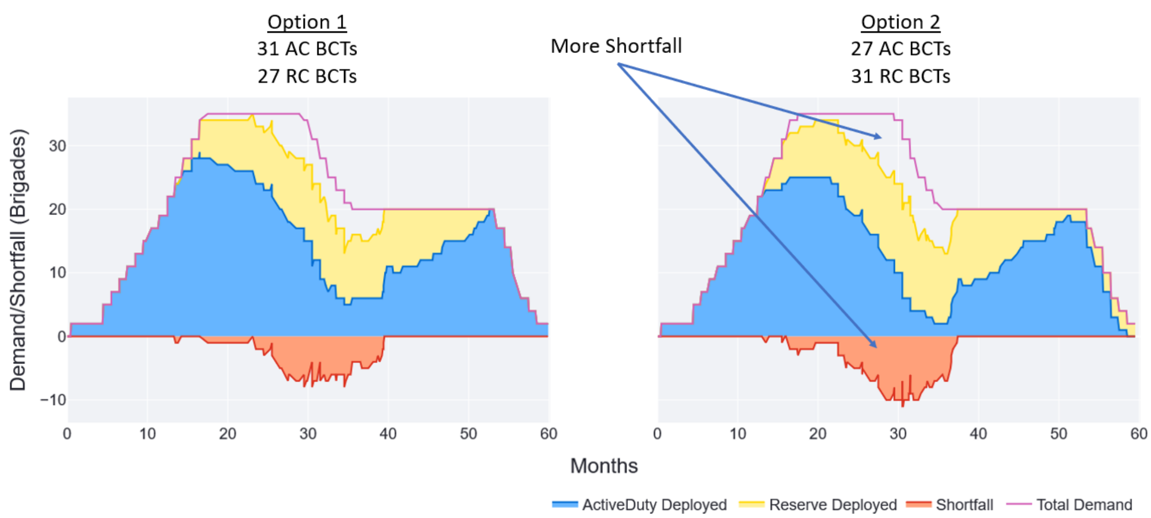

Figure 15. Two Mix View of Deployment/Shortfall Plot

The cumulative cost plot (Figure 16) shows the accumulation of expenditures over time. Blue shows Active costs and orange shows Reserve costs. The darker shades represent personnel costs and the lighter shades are operations costs.

[10] In the Phase 1 model, units begin in a proportional distribution across phases of the force generation cycle (longer phases will have more units in them).

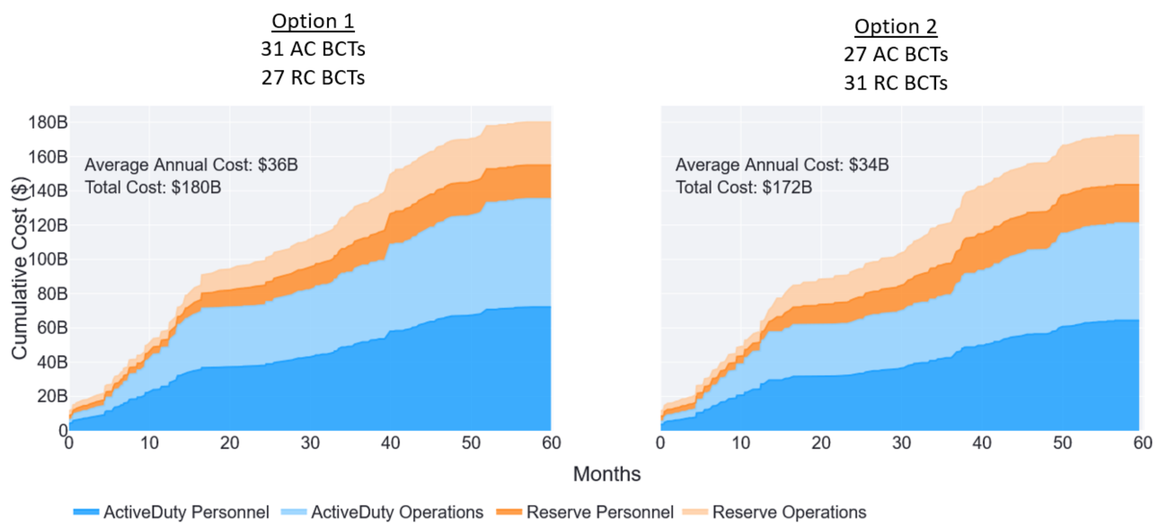

Figure 16. Two Mix Cumulative Cost Plot

Metrics provide information that is not easy to read from the plots. The comparison metrics currently calculated and displayed by the FSA Model are shown in Figure 17. Some are measures of stress on the force, such as *Average Months Extended per Deployment*. Others, such as *% Demand Unmet*, assess the capacity of the force to meet demand. Hazard sign symbols indicate the first option scores better, while green checkmarks indicate the second option scores better.[11] The full definitions of the metrics are provided in Appendix B.

[11] Different audiences can interpret the quality of the result differently. For example, the reduction in deployment of AC units could be a *desirable* result of an effort to shift deployments to the RC. All information should be considered in full context. As development continues, prospective users will give input on useful symbology.

Metric	Option 1	Difference (Option 2 - Option 1)		Option 2
Avg. Annual Cost	$36.0B	-$1.5B	✓	$34.5B
Avg. Months Extended per Deployment	2.7	-0.1	✓	2.6
Avg. AC BCTs Deployed	12.1	-1.1	⚠	11.0
Avg. RC BCTs Deployed	4.7	0.9	✓	5.6
Max BCTs Deployed	35.0	-1.0	⚠	34.0
Demand Unmet (BCT-months)	87.7	26.9	⚠	114.6
% Demand Unmet	7.1%	2.1%	⚠	9.2%
Max Shortfall (BCTs)	8	3	⚠	11
Average Shortfall (BCTs)	1.4	0.5	⚠	1.9

Figure 17. Two Mix Comparison Metrics

D. Evaluating Force Mix Alternatives under Multiple Scenarios and/or Force Generation Cycles

To compare the sensitivity of results under more than two scenarios or more than one force generation policy, users begin with the *Sensitivity Analysis* page, shown in Figure 18. Users input any number of combinations of force generation cycle, cost, and scenario configuration files along with choices of unit type and numbers of AC and RC.

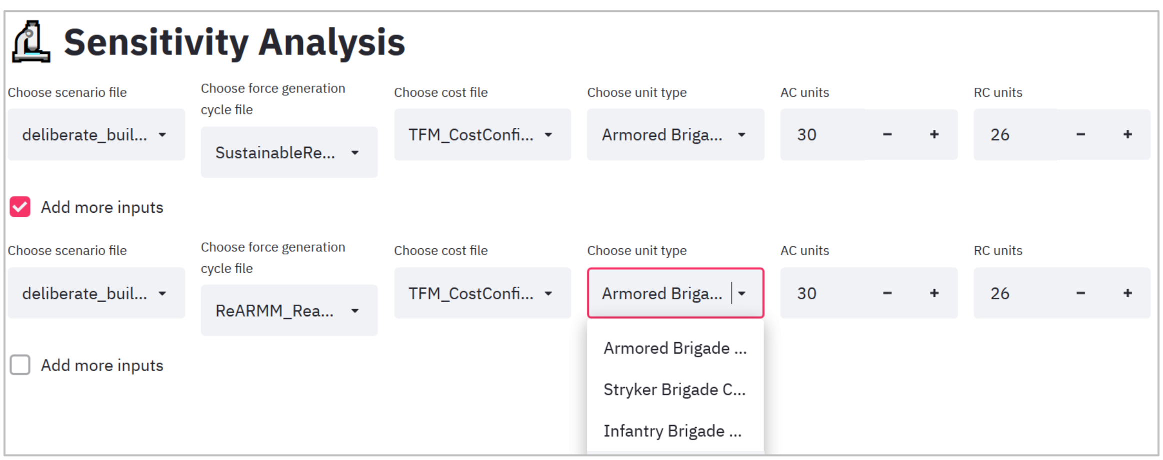

Figure 18. Choosing Parameters on the Sensitivity Analysis Page

Below the input dropdowns, the model displays a cost-shortfall frontier plot similar to the one on the *Cost-Shortfall Frontier* page. For each combination, *Deployment/Shortfall* and *Cumulative Cost* plots are provided; these are similar to plots on the *Two Mix Comparison* page.

Unique to the *Sensitivity Analysis* page is a plot showing the number of a component's units in each phase. This plot allows users to visualize the model's handling of units moving through the force generation cycle. This plot is called the *Phase Occupancy Chart*, and an example is presented in Figure 19. The vertical axis shows the number of units in each phase of the cycle, while the horizontal axis is time in months. In the example of AC units provided in Figure 19, the user sees an initial decrease in ready units (blue line) as they are pulled into deployment (orange line). The figure also shows the subsequent movement of units in and out of the various phases.

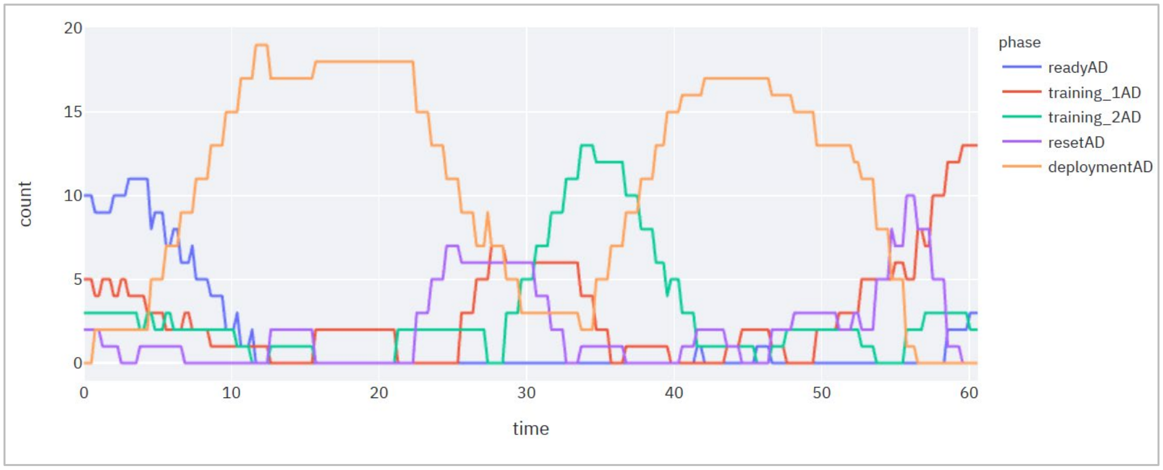

Figure 19. Phase Occupancy Chart

This section introduced the capabilities of the model and some examples of how it can be used. We have shown how the model displays the cost and shortfall information for different force mixes and have introduced metrics that can be used to evaluate and compare mixes. The next chapter provides detailed case studies of how specific policy questions can be studied with the model.

6. Example Use Cases

In this section, we describe how a user can change parameters for the force generation cycle, such as extended deployment policy, AC-RC mixes, and Mob:Dwell ratios, to meet a scenario's deployment demands. We also observe the impacts of those variations on output metrics including cost, shortfall, and unit operating tempo (OPTEMPO). Illustrations are provided throughout. The force generation cycle parameters are based on the Sustainable Readiness Model (SRM) doctrinal standards for AC and RC units.[12]

Throughout this section, we use the terms "peacetime" and "wartime." These terms represent convenient, notional ways to give the sense of time when the force is generally not heavily deployed ("peacetime") and periods when the force is heavily deployed and employed ("wartime").

A. Base Case

Figure 20 shows the Base Case for a force of 31 AC and 27 RC BCTs. This notional wartime scenario is one of graduated buildup. The demand profile is represented by the top purple line in the figure. Demand goes from 0 to 34 deployed BCTs by month 17 of a 60-month scenario. It remains constant at 34 BCTs until month 32, and then is reduced to 20 BCTs through month 52, when it descends to 0 in month 60.

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[12] Department of the Army, "Force Generation – Sustainable Readiness," Army Regulation 525-29 (Washington, DC: Headquarters of the Department of the Army, 2019), 34–37, https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN9412_AR525_29_FINAL.pdf.

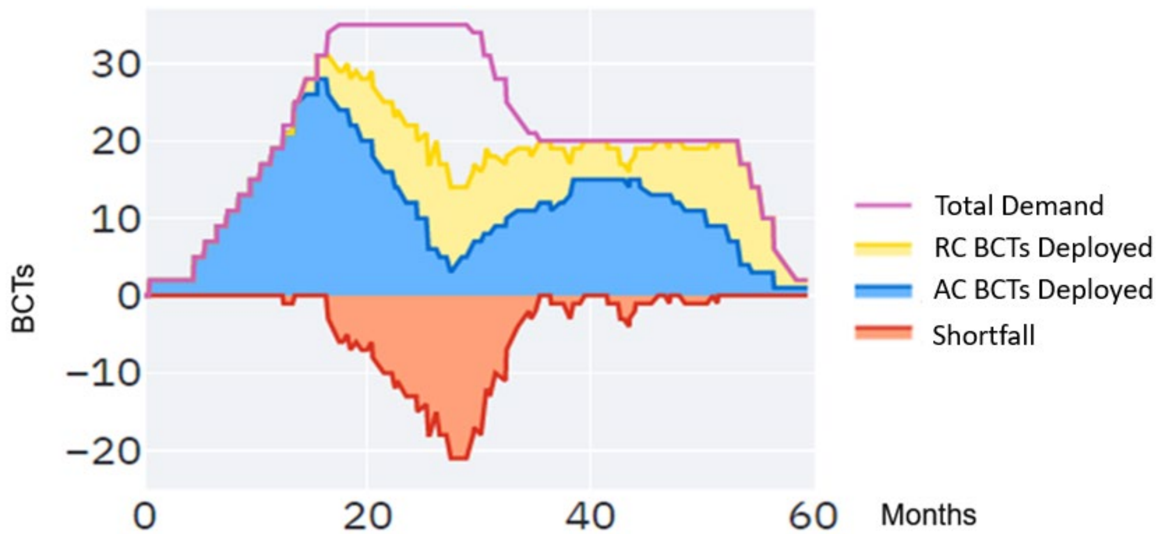

Figure 20. Base Case (31 AC and 27 RC BCTs)

The top line of Figure 20 is the total demand. The first line above the horizontal axis records the deployments of AC BCTs (blue shaded area). The second line above the horizontal axis records the deployments of RC BCTs (yellow shaded area). The space above that line, and below the demand line, shows the shortfall (gray unshaded area). This space is repeated below the horizontal axis for ease of display (orange shaded area).

Current settings in the Phase 1 model direct the deployment of AC BCTs if they are available. When there are no AC BCTs available, the model deploys ready RC BCTs. This is an example of a force management policy that is set in the code of the Phase 1 model but may become part of the user interface during future development. In this scenario, AC BCTs deploy for 12 months, while RC BCTs deploy for 9 months after 3 months of post-mobilization training. This is an example of a force management policy that is uploaded by the user in the *Force Generation* configuration file (see Figure 7).

Figure 20 shows a shortfall beginning in month 17 and lasting until month 37, and several small shortfalls after that. There is a cumulative shortfall of 234 BCT-months.

Table 5 breaks down the costs of the Base Case planning scenario. The total cost is $173.8 billion over the 60-month event.

Table 5. Cost of the Base Case Scenario

Cost Element	Cost ($B)
RC Operations	24.4
RC Personnel	18.6
AC Operations	60.2
AC Personnel	70.6
Total	**173.8**

B. Extended Deployments

Figure 21 shows the effect of allowing AC and RC deployments to be extended by up to 6 months. The left side of the figure is a copy of Figure 20.

Figure 21. Effect of Allowing Extended Deployments

The right side of the figure shows that there is a significantly smaller area of shortfall when extended deployments are allowed. Determining the specific quantity of shortfall will be introduced later in this chapter. In this case, the total shortfall has decreased from 234 to 88 BCT-months.

Table 6 gives the costs of the planning scenario with extended deployments. The total cost is increased from $173.8 billion in the Base Case to $180.3 billion (compare to Table 5).

Table 6. Cost of Allowing Extended Deployments

Cost Element	Cost ($B)
RC Operations	25.1
RC Personnel	19.6
AC Operations	63.2
AC Personnel	72.2
Total	**180.3**

C. Changing the AC-RC Mix

Figure 22 shows the effect of changing from an "AC-Heavy" mix of 31 AC BCTs and 27 RC BCTs to an "RC-Heavy" mix of 27 AC BCTs and 31 RC BCTs. The extended deployments added in the previous section remain in the scenario. (The left side of Figure 22 repeats the right side of Figure 21).

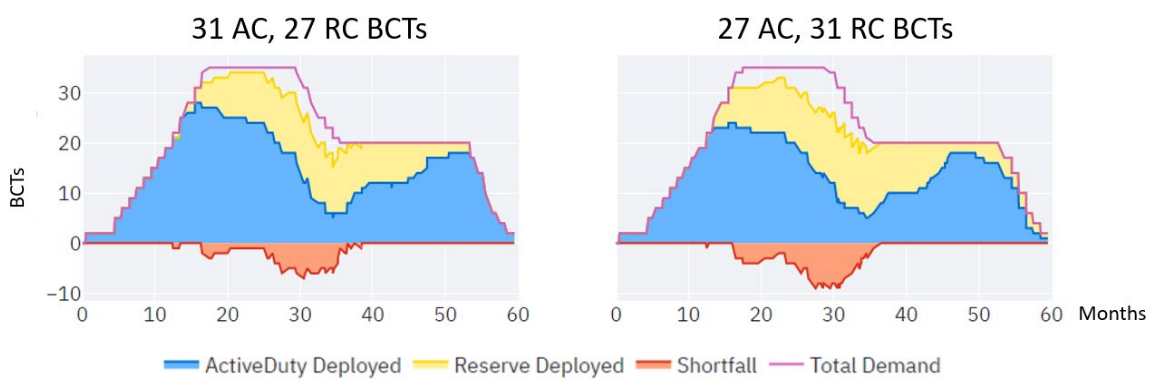

Figure 22. Effect of Changing the AC-RC Mix

While the figure does not show a dramatic visual change, the total shortfall does increase about 30 percent with the AC-RC mix change. Metrics available in the model provide the specific shortfall quantity. In this case, the total shortfall has increased from 88 BCT-months on the left to 115 BCT-months on the right.

Table 7 gives the costs of the planning scenario with a changed AC-RC mix (including extended deployments). The total cost decreases from $180.3 billion to $172.5 billion (compare to Table 6). However, the primary reason for the cost decrease is not that this mix is less expensive; it is that the additional shortfall means there are fewer deployments.

Table 7. Cost of an RC-Heavy Mix

Cost Element	Cost ($B)
RC Operations	28.9
RC Personnel	22.4
AC Operations	56.8
AC Personnel	64.4
Total	**172.5**

In order to get a better sense of the financial impacts of changing the AC-RC mix, we look at the peacetime costs of the alternative mixes.

Peacetime Costs

Changing the AC-RC mix can have significant impacts on the peacetime cost of the force. Because peacetime costs are central to planning and programming decisions, it is important to evaluate the peacetime cost of force mixes under consideration. The FSA Model allows users to run “zero demand” scenarios to obtain peacetime costs, which are shown in Table 8 for a 60-month time period, along with the wartime costs shown in Table 6 and Table 7. We can see that, in peacetime, the RC-Heavy mix results in greater cost savings—$10 billion versus the $7.8 billion difference between the two wartime cases.

Table 8. Comparing Costs of AC-RC Mixes

Cost Component	AC-Heavy 31 AC/27 RC Cost	RC-Heavy 27 AC/31 RC Cost	Delta
RC Operations (Peacetime)	10.6	12.1	1.5
RC Personnel (Peacetime)	9.2	10.4	1.2
AC Operations (Peacetime)	33.8	29.5	-4.3
AC Personnel (Peacetime)	66.1	57.7	-8.4
Total (Peacetime)	**119.7**	**109.7**	**-10.0**
Total (Wartime)	**180.3**	**172.5**	**-7.8**

Note: Costs in $B; wartime costs from Table 6 and Table 7.

Another way to compare the two mixes is to note the differences between wartime shortfall and peacetime annual costs:

- The AC-Heavy mix (31 AC/27 RC) produces 88 BCT-months of wartime shortfall and costs about $24 billion per year during peacetime ($119.7 billion ÷ 5 years).
- The RC-Heavy mix (27 AC/31 RC) produces 115 BCT-months of wartime shortfall and costs about $22 billion per year during peacetime ($109.7 billion ÷ 5 years).

Using that information, the decision-maker can, for example, weigh the risks of a 30 percent increase in potential shortfall during wartime against a peacetime annual cost that is 10 percent lower.

D. Changing the RC Mob:Dwell Policy

Figure 23 shows the effect of changing the RC Mob:Dwell policy from 1:4 to 1:2.[13] The force mix is the original Base Case force of 31 AC and 27 RC BCTs. The extended deployments added previously remain in the scenario. Changing the RC Mob:Dwell policy essentially eliminates the 88 BCT-month shortfall.

Figure 23. Effect of Changing the RC Mob:Dwell Policy

Table 9 shows the cost changes resulting from the new policy. The total cost increases from $180.3 billion to $200.0 billion (compare to Table 6). This cost increase is due to the increased number of deployments resulting from higher availability, not because the policy change has a direct cost.

Table 9. Cost of Changing the RC Mob:Dwell Policy

Cost Element	Cost ($B)
RC Operations	32.5
RC Personnel	29.1
AC Operations	65.4
AC Personnel	73.0
Total	**200.0**

[13] *RC Mob:Dwell* is the policy that determines how long a Reserve unit must remain in a non-mobilized status (Dwell) after a mobilization (Mob). A Mob:Dwell policy of 1:4 means that a unit returning from a 1-year mobilization must not be mobilized again for 4 years.

E. Changing Both the AC-RC Mix and RC Mob:Dwell Policy

Figure 24 shows the effect of changing the AC-RC mix from 31-27 to 27-31 and changing the RC Mob:Dwell policy from 1:4 to 1:2. Extended deployments continue to be included.

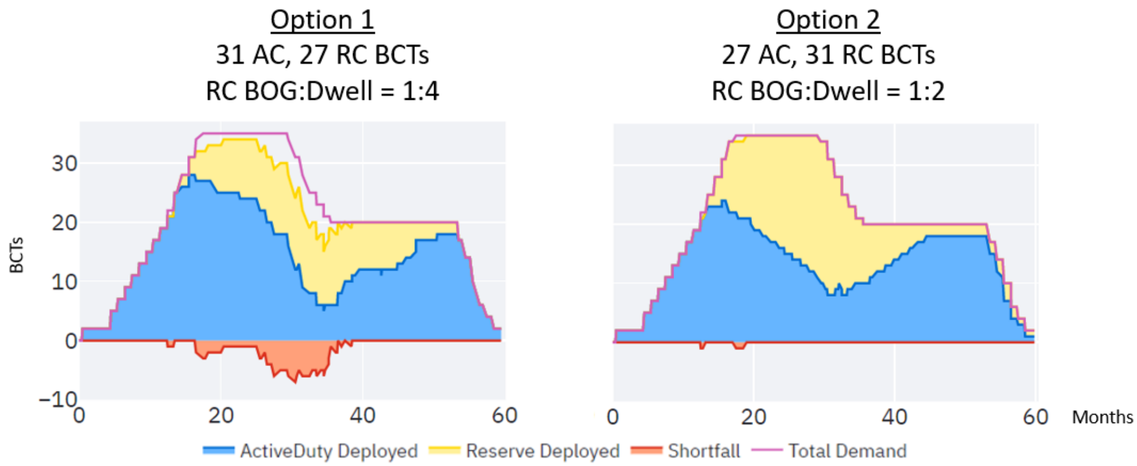

Figure 24. Effect of Changing Both the AC-RC Mix and RC Mob:Dwell Policy

The shortfall is again essentially eliminated. This example shows that, using these notional data, the AC-RC mix can be modified to include fewer AC units and still result in no shortfall if the RC Mob:Dwell policy is changed during wartime to create additional RC deployment availability.

Table 10 gives the cost of the planning scenario after changing the AC-RC mix and RC Mob:Dwell policy, given extended deployments. The total cost increases from $180.3 billion to $194.0 billion (compare to Table 6).

Table 10. Cost of Changing Both the AC-RC Mix and RC Mob:Dwell Policy

Cost Element	Cost ($B)
RC Operations	38.4
RC Personnel	34.0
AC Operations	57.8
AC Personnel	63.8
Total	**194.0**

Peacetime Costs

Again, the question of peacetime costs is relevant:

- The AC-heavy mix will cost, as before, about $24 billion per year to maintain and operate during peacetime. With an RC Mob:Dwell policy of 1:2 during wartime, there is close to zero shortfall.
- The RC-heavy mix will cost, as before, about $22 billion per year to maintain and operate during peacetime. With an RC Mob:Dwell policy of 1:2 during wartime, there is close to zero shortfall.

In the previous example of peacetime comparisons, the change to an RC-heavy mix resulted in a lower peacetime cost, but with more wartime shortfall. In the current example, however, there is no shortfall "penalty" to pay in the wartime scenario if the RC-heavy mix is selected. However, stress on the RC force must be considered as units will deploy more frequently during wartime.

F. Metrics

The FSA Model can produce a wide variety of metrics. Some metrics may have expected results, while others may have counter-intuitive results and suggest further analysis. When decision rules in the model change, the user will see the impact of the changes both in the graphs and in the list of metrics.

Sample metrics are provided in Table 11 for the Base Case and for the Base Case with extended deployments allowed (compare to Table 5 and Table 6).

Table 11. Selected Metrics

Metric	Type	Base Case	Base Case with Extended Deployments	Delta
Total Shortfall (BCT-months)	Shortfall	234	88	-146
Total Cost	Cost	$173.8B	$180.3B	$6.5B
Percent Demand Unmet	Shortfall	18.9	7.1	-11.8
Maximum Shortfall (number of BCTs)	Shortfall	27	8	-19
Average Shortfall (number of BCTs)	Shortfall	3.8	1.4	-2.4
Average AC BCTs Deployed	Output	11.4	12.1	0.7
Average RC BCTs Deployed	Output	4.0	4.7	0.7
Average Deployment Extension (months)	Stress	0	2.7	2.7

The metrics reveal some interesting information that may be difficult to read in the graph. For instance, the maximum shortfall experienced during the war declines from 27 to 8. Additional useful metrics can be included in future phases of model development (e.g., average deployment length and average dwell). The current set of metrics has utility, but future coordination with stakeholders will produce a broader and enhanced list.

7. Potential Model Enhancements

The plan for future phases of the FSA Model is to develop a joint capability model. The Phase 1 model, as a proof of concept, addresses only Army BCTs. A full joint capability model will incorporate AC and RC units from the Army, Air Force, Marine Corps, and Navy. The future version of the model will also address deployment issues, such as constraints on transportation capacity. The model will enable the user to deploy combat, combat support, and combat service support units in an integrated manner.

This chapter discusses options to develop and enhance the model in follow-on phases of the project. Some are straightforward, while some will be more difficult. All are useful.

A. Expand the Scope of Units in the FSA Model

The Phase 1 model is limited to Army BCTs in order to develop and demonstrate a proof of concept. In future phases, all Services will be included, as described next.

1. Include More Army Units

The current FSA Model addresses notional AC and RC BCTs. In the next phase of development, the IDA team will collect and include additional readiness cycle and cost data, as well as employment scenarios, for an expanded list of Army units. The next set of units to be considered will be individual maneuver units, followed by combat support units and enabling units.

2. Include Air Force Units

The U.S. Air Force (USAF) readiness and assignment cycles for AC and RC units are very different from those of the Army. USAF RC units are deployed for relatively short durations and more often than Army RC units. The model accommodates these differences. The IDA team will obtain data on readiness cycles, costs, and planning scenarios for the full range of USAF AC and RC units.

3. Include Marine Corps and Navy Units

The model will be extended to accommodate readiness cycles, costs, and planning scenarios for Marine Corps and Navy units. Unique features of Navy financial operations will need to be captured in the model. For example, flying hour costs for Marine Corps aircraft are paid out of Navy, not Marine Corps, appropriated funds. The model is designed to incorporate Service-specific funding and deployment characteristics.

B. Enhance Cost Modeling

Future development of the FSA Model will include the following improvements to unit resource and cost elements that expand model flexibility and capacity.

1. Incorporate Inflation Factors

Costs are treated as constant currency across the full duration of the demand scenario; the model does not currently support differential real cost growth rates. Support for user-selected real cost growth rates will be added.

2. Expand Cost Categories

Current configuration files support cost elements that are constrained to a few categories, like personnel and operations. This constraint limits fidelity with respect not only to the structure of cost estimates, but also for cost relationships and cost factors like cost growth rates. Disaggregating cost elements like training, procurement, or infrastructure from operations is not a simple exercise. Therefore, a priority in the next phase of the tool is to add support for an unlimited number of cost elements, defined by users, that can be specified in the configuration files.

3. Automatically Import Unit Data

Future phases of the tool will consider approaches to link known unit and cost data sets from external sources identified in prior phases directly to the FSA Model. The objective is to allow users to directly import unit and cost data from other systems, rather than creating configuration files.

4. Automate Elements of the Force Generation Cycle

Future phases will incorporate business rules that relate unit resourcing levels, phase cycle time, cost, and desired readiness in configuration files. Then, the model will be able to, for example, use historical data to calculate how long it will take a unit to move between phases of the force generation cycle.

C. Address Force Generation Constraints

In order to enhance the realism of the model, it will consider constraints such as limitations on training ground capacity and mobilization throughput.

D. Address Warning and Mobilization Preparation

The model currently includes data on the steady state condition of the AC and RC units. It does not include an option for the planner to change the readiness cycles based on warning and resultant decisions. If there were warning, and resultant mobilization preparation, deployments could be sped up and shortfalls reduced, given adequate resources. The model will be enhanced to include alternative readiness cycles and their costs and results.

E. Enhance the User Interface

This section describes future enhancements to the FSA Model user interface.

1. Allow Decision Rules to Be Modified by the User

The Phase 1 model has several hard-coded decision rules. It will be modified to allow the user to change the assignment logic and decision rules for multiple levers that influence output. This enhancement will improve results and will assist in identifying more cost-effective strategies.

2. Enhance Output Products

The development team will work closely with stakeholders to create output products that contain the data that is most relevant to stakeholders' work. This development will enhance existing graphs, lists of metrics, and tables of cost information and include new products that capture and present the most useful information.

F. Include Uncertainty in the Model

The model will be developed so that selected inputs, particularly in the readiness cycle data, are stochastic. The resulting model will produce a distribution of outcomes over multiple runs. Knowing the amount of overall uncertainty is valuable, particularly if it is fairly large.

G. Continue Advana Integration Efforts

Advana is the DoD-wide platform to store, manage, and share DoD data and applications on both classified and unclassified networks. In Phase 1, the IDA team researched integration of the FSA Model with Advana. Many integration challenges were uncovered, but the team will continue to develop an integration plan to both use Advana data and, if deemed desirable, host the FSA Model on the Advana platform in order to maximize user access.

H. Summary

Phase 1 concentrated on developing a proof of concept. All of the potential enhancements described previously are feasible, and they will result in a robust system for contributing to decisions about active and reserve forces. The model is unique in its scope and capabilities. As development continues and the enhancements listed in this chapter are implemented, the FSA Model will realize its potential as a powerful joint decision support tool for planners, programmers, and other Total Force Management stakeholders.

8. Conclusion and Recommendations

A. Successful Demonstration of the Model

The principal purpose of this paper was to describe the IDA team's FSA model. Phase 1 of the model produced a proof of concept, a demonstration that illustrated how the model can support the needs of Services, OSD, and Joint Staff programmers and other stakeholders to weigh the costs and risks associated with total force mix alternatives.

This concept has been successfully demonstrated. Using Army BCTs as a test case, the model can evaluate alternative total force mixes and management policies in terms of both their cost and their ability to meet user-specified deployment requirements.

The FSA Model is quite flexible. For both AC and RC units, users can evaluate resourcing and deployment policies of their choosing. We have shown that the policies selected can substantially alter the relative efficacy of potential mixes of AC and RC units. For any demand scenario of interest and set of force management policies, the model provides the efficient force mix frontier. This frontier defines the mixes of Active and Reserve units that meet, as much as possible, a required deployment capability at any given cost.

Most importantly, the FSA Model, when fully developed, will give programmers, analysts, and decision-makers a joint, data-based method to examine the cost and risk impacts of a wide range of potential force structure, force mix, and force management policy options.

B. Recommendations for DoD Guidance

Appendix A provides a comprehensive review of DoD guidance regarding AC-RC costing and Total Force mix analysis. In addition to describing the benefits and shortcomings of the existing guidance, the review provides the following recommendations:

- OSD should issue guidance on (1) conducting consistent cost comparisons between AC and RC personnel and (2) including the RC in comparisons that include AC, civilian, and contractor personnel. Such guidance would enable true Total Force cost analyses.
- OSD should issue guidance on performing unit-based analysis of AC-RC force mix alternatives. The guidance should specify the cost elements to be considered and the elements to be considered in quantifying the operational effectiveness of

the alternatives. Such guidance would enable better assessments of the cost of the Force and its ability to meet operational requirements.

Appendix A.
Review of Guidance Regarding Active-Reserve Costing Comparisons and Total Force Mix Analysis

Introduction

Active and Reserve force mix decisions have substantial implications for resources and for the U.S. military's ability to meet the requirements of emerging conflicts. If force mix decisions are not based on sound, consistent principles, DoD is likely to spend too much to achieve its capabilities, fail to provide the capabilities required, or both.

This appendix reviews guidance provided by OSD to the DoD components. The guidance is intended to instruct the components on how to develop cost estimates for AC and RC personnel and units, and how to use such estimates to inform force management decisions.

OSD issues Instructions to the components to guide their total force costing and decision-making processes. In this appendix, we consider three such instructions:

- DoD Instruction (DoDI) 7041.04, Estimating and Comparing the Full Costs of Civilian and Active Duty Military Manpower and Contract Support
- DoDI 1100.22, *Policy and Procedures for Determining Workforce Mix*
- DoD Directive (DoDD) 1200.17, *Managing the Reserve Components as an Operational Force*

In this review, we also consider four other sources of information that pertain to the total force decision-making space. The first two are computer models for estimating personnel costs, the third is a report that relates to improved personnel costing, and the fourth is a report that provides broad guidance on workforce mix:

- The Full Cost of Manpower model (FCoM). FCoM is a web-based tool developed for OSD's Cost Assessment and Program Evaluation office (CAPE). FCoM facilitates calculation of personnel costs by Service, rank, and specialty.
- The Air Force's Individual Cost Assessment Model (ICAM). ICAM is designed to sharpen comparisons of AC and RC costs, following many of the precepts of DoDI 7041.04.

- The 2019 report from the Reserve Forces Policy Board (RFPB) to the Secretary of Defense, *Requiring the Use of Fully Burdened and Life Cycle Personnel Costs for all Components in Total Force Analysis and for Budgetary Purposes*. This report widens the scope of cost elements included in personnel costing.
- The *2017 Workforce Rationalization Plan* (report). This report provides a broad "strategic roadmap and consolidation of existing policies and procedures for how DoD will work to optimize its Total Force to achieve the direction from the President and Secretary of Defense to maximize lethality, recover readiness, grow the force, and increase capability and capacity."[1]

In the following sections, the seven sources described previously will be evaluated against four subjective criteria: *accuracy*, *completeness*, *specificity*, and *relevance*.

- *Accuracy* addresses whether the instruction, model, or report accurately portrays what it is designed to portray.
- *Completeness* addresses whether any major elements or considerations are omitted.
- *Specificity* addresses whether the level of detail is adequate to guide critical analysis.
- *Relevance* addresses whether the methodologies are capable of guiding AC-RC cost comparisons and AC-RC unit mix analyses.

In the next section, we review the instructions, models, and reports.

Review of DoD Instructions, Models, and Reports

The first three items that we review are the two DoD instructions and one DoD directive.

DoDI 7041.04, Estimating and Comparing the Full Costs of Civilian and Active Duty Military Manpower and Contract Support

Accuracy

The intent of DoDI 7041.04 is to address civilian and active duty personnel costs as well as contract support costs in decision-making and to guide cost analyses of alternative ways of buying labor services. Generally, the instruction does an excellent job within those bounds. While it provides an adequate process for comparing AC and government civilian

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[1] *DoD Workforce Rationalization Plan*, Introduction, para. 3.

personnel costs, it does not address RC manpower or provide a concise method for determining contractor support. Its positive attributes include the following:

- Its definition of *full costs* includes all costs to the Federal Government, the appropriate basis for expenditures of government funds. The instruction also supports calculating and displaying the costs to DoD.
- It includes direct labor costs and non-labor costs that vary with (in the language of the instruction, are "attributable" to) the amount of labor.
- It breaks labor costs down into costs that are
  - Variable in the short-run;
  - Fixed in the short-run, but vary when there are large, enduring changes in the number of people; and
  - Deferred.
- It provides a detailed cost element structure that covers all the categories of relevant costs and includes data sources.

At least two kinds of costs appear to be included inappropriately in the cost element structure: (1) the Treasury Contribution to Retirement for military personnel and (2) the Unfunded Civilian Retirement (Civil Service Retirement System (CSRS) only) for civilian employees. These payments do not vary with the number of currently serving individuals and therefore are not a marginal cost of staffing decisions. They should not enter into personnel cost comparisons. Specifically, the retirement costs of currently serving military and civilian personnel are funded through accrual payments that go into trust funds. This accrual funding was initiated in 1985 for military personnel and 1987 for civilians, when the existing CSRS was replaced by the Federal Employees Retirement System (FERS) for new employees. Retirement benefits accrued before those dates are covered by general fund payments and are unaffected by the current workforce mix.

Completeness

The costing taxonomy in DoDI 7041.04 does not currently include the RC. However, the taxonomy appears to be quite adaptable, and the RC could be included. With a workforce of over 800,000 personnel, the RC should factor prominently in force mix decisions and related guidance. Without the RC, the instruction is incomplete.

Specificity

DoDI 7041.04 defines quite specifically individual cost factors in cases where relevant data are available; however, in some cases, the definitions may be misleading. These cases include training costs and costs related to veterans' benefits. The details of these cases will be addressed in the discussion of FCoM, the costing tool based on this DoDI.

Relevance

If modified and expanded to cover the RC, DoDI 7041.04 would provide stronger guidance to AC-RC personnel cost comparisons. Without the RC, its utility is reduced. Even so, it is still a valuable reference for those interested in becoming familiar with the cost elements that would be used in AC-RC personnel cost comparisons.

To be relevant to AC-RC force mix decisions, DoDI 7041.04 could be supplemented by guidance addressing other relevant aspects of such decisions. For example, in some cases, the relevant tradespace between AC and RC is at the unit level rather than at the personnel level. However, units have significant additional costs not directly linked to people. Acquisition costs and operations and maintenance (O&M) costs not associated with civilian or contract personnel are the most important of these. Both personnel-level and unit-level costing guidance should address how to treat the ability of AC and RC personnel and units to be available when needed.

DoDI 1100.22, Policy and Procedures for Determining Workforce Mix

Accuracy

Two stated purposes in DoDI 1100.22 are that it:

- "[e]stablishes policy, assigns responsibilities, and prescribes procedures for determining the appropriate mix of manpower (military and DoD civilian) and private sector support"[2]; and
- "[p]rovides manpower mix criteria and guidance for risk assessments to be used to identify and justify activities that are inherently governmental (IG); commercial (exempt from private sector performance); and commercial (subject to private sector performance)."[3]

The instruction supports these goals logically. Its guiding principle is that "the workforce of the Department of Defense shall be established to successfully execute Defense missions at a low to moderate level of risk."[4] Implicitly, the least costly feasible

[2] DoDI 1100.22, 1.

[3] DoDI 1100.22, 1.

[4] DoDI 1100.22, 2.

workforce design option should be chosen subject to the condition that “risk mitigation shall take precedence over cost savings.”[5]

This instruction provides a sequential set of rules: “[f]unctions that are IG cannot be legally contracted.”[6] A set of manpower mix criteria provides definitions and examples of IG functions. The rules also provide a framework for determining when commercial activities (non-IG) should be performed by government personnel.

For IG positions, this instruction states that manpower will be staffed by civilians, with some guidelines that specify the exceptions when military personnel should be employed. Though there are issues with exactly how to implement these rules, they support the purposes of the instruction well.

Completeness

DoDI 1100.22 defines manpower mix as including military personnel, DoD civilians, and private sector support. It does not provide guidance regarding the mix of AC and RC military manpower. Considering that the RC provides 37 percent of the department’s military manpower, this is a serious shortcoming in the instruction.[7]

Specificity

The rules guiding position classification are subject to arbitrary interpretation. For example, the requirement that military personnel be assigned when military-unique knowledge and skills are required seems straightforward, but it can be used to exclude well-qualified veterans. Similarly, the determination of when military performance is required for “esprit de corps” is not well defined.

The role of cost in guiding manpower mix determinations is unclear. The instruction implies, but does not state explicitly, that the least-cost option that provides low-to-moderate risk should be chosen when it says “[r]isk mitigation shall take precedence over cost savings when necessary to maintain core capabilities and readiness.”[8] This may encourage the use of military personnel even when the additional cost exceeds the additional benefit.

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5 DoDI 1100.22, 2.

6 DoDI 1100.22, 2.

7 DoD, “Defense Budget Overview, United States Department of Defense Fiscal Year 2022 Budget Request,” (Washington, DC: OUSD(C)/CFO, May 2021), A-4, https://comptroller.defense.gov/Budget-Materials.

8 DoD, “Defense Budget Overview, United States Department of Defense Fiscal Year 2022 Budget Request.”

Relevance

DoDI 1100.22 addresses choices among military, government civilian, and contractor personnel. However, the guidance for when to use military personnel does not include guidance for choosing AC or RC. This omission indicates an important direction for development of future guidance regarding AC-RC cost comparisons and Total Force mix decisions.

DoDD 1200.17, *Managing the Reserve Components as an Operational Force*

Accuracy

The purpose of DoDD 1200.17 is to establish "the overarching set of principles and policies to promote and support the management of the Reserve Components (RCs) as an operational force."[9] Operational RCs are defined as those that "participate in a full range of missions according to their Services' force generation plans. Units and individuals participate in missions in an established cyclic or periodic manner that provides predictability for the combatant commands, the Services, Service members, their families, and employers."[10] This operational function contrasts with the strategic role of RCs in which they provide strategic depth and "train or are available for missions in accordance with the national defense strategy."[11] This directive states that "[t]he RCs provide operational capabilities and strategic depth to meet U.S. defense requirements across the full spectrum of conflict."[12]

The directive does not over-prescribe rules for managing the RCs as an operational force, noting that their use should be based "on the attributes of the particular component and individual competencies"[13]; however, it does provide general management guidance:

- "Utilization rules are implemented to govern frequency and duration of activations. Since expectation management is critical to the success of the management of the RCs as an operational force, these rules enhance predictability and judicious and prudent use of the RCs."[14]
- "Voluntary duty… is encouraged."[15]

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9 DoDD 1200.17, 1.

10 DoDD 1200.17, 8.

11 DoDD 1200.17, 8.

12 DoDD 1200.17, 8.

13 DoDD 1200.17, 1.

14 DoDD 1200.17, 2.

15 DoDD 1200.17, 2.

- "The RCs are resourced to meet readiness requirements… [and] RC resourcing plans shall ensure visibility to track resources from formulation, appropriation, and allocation through execution."[16]

This level of direction is consistent with Title 10 of the United States Code, which states that, subject to the authority, direction, and control of the Secretary of Defense, the mission of the Military Departments is to organize, train, and equip the forces to be assigned to the combatant commands.[17] The directive provides guidance at the level it was meant to provide; in that sense it is accurate.

Completeness

This directive does not provide detailed rules for managing an operational force in the RCs. Such management requires decisions on desired readiness levels, associated funding levels, the amount of time between planned deployments, the length of pre-deployment training periods, and the duration of deployments. These decisions are left to the discretion of the Services, depending on Service and unit attributes.

By focusing narrowly on the use of the RCs as an operational force, DoDD 1200.17 provides no guidance on how to determine the mix of active and reserve elements in the force structure.

Specificity

As noted, DoDD 1200.17 does not seek to be specific. The details of managing an operational force in the RCs are left to the Services.

Relevance

Although this directive does not affect costing and does not directly guide AC-RC force mix decisions, it does have some relevance to the determination of the appropriate mix of active and reserve forces. The mix of AC and RC units for all types of units should depend partly on how the RC units are expected to be used. This includes their use as an operational force. By specifying that RC units should be used operationally, DoDD 1200.17 implies that the parameters of possible operational use should be an element in AC-RC force mix analyses. The question to be addressed in such analyses becomes: What AC-RC force mix is most cost-effective for a particular kind of unit given the possible demands for it in both operational and strategic roles?

We now shift the review from DoD instructions and directives to costing tools and documents that build on the instructions and directives or discuss issues raised by them.

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[16] DoDD 1200.17, 2.

[17] United States Code, Title 10, § 7013b, 8013b, and 9013b, 2020.

Full Cost of Manpower (FCoM) Tool

OSD CAPE created FCoM to provide a consistent approach for all DoD employees to estimate the fully burdened costs of manpower. It separately shows estimated costs borne by the DoD component, the DoD as a whole, and the Federal Government as a whole for both government civilian employees and AC personnel.

Designed to reduce effort needed to estimate costs associated with DoD manpower, the FCoM tool relies on user input to determine specific attributes associated with military, civilian, and contractor personnel, including occupation/specialty, rank/grade, length of service, location, and so on. The tool automatically estimates the total annual cost for each type of manpower submitted by the user."[18]

Accuracy

FCoM largely follows the cost structure presented in DoDI 7041.04.[19] For some cost elements, especially those that can be tracked at the desired level of detail (e.g., basic pay), it presents reasonable, well-documented cost estimates. For other cost elements, however, its estimates do not accurately reflect the marginal cost of employing a person with the user-specified characteristics. Examples of costs that are not well estimated include training costs and costs associated with the Department of Veterans Affairs (VA):

- Training Costs: Generally, FCoM provides costs by rank and occupational specialty. In the case of training costs, however, it gives the same estimate for everyone in a Service.[20] In fact, training costs vary greatly by rank and occupation. Training pilots is much more expensive than training personnel administrators. This treatment is understandable, however, because detailed training cost data is not readily available.
- VA costs: In the case of veterans' benefits, again all military personnel are assigned the same estimate. This treatment ignores changes in the VA's liability associated with variations in length of service.

Also, the FCoM VA cost estimate is not derived appropriately, even for an average. It is calculated by dividing the entire VA budget by the number of veterans;[21] that is, the average annual cost of a veteran in a given budget year, but it does not reflect the marginal cost to VA of an additional military employee. The marginal cost instead depends on the likelihood that a military individual will achieve veteran status, the number of years they

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18 For more information about the FCoM tool, visit https://fcom.cape.osd.mil/user/Default.aspx. You will require special access, such as a CAC, to visit the site.

19 FCoM does not include Treasury payments for retirement, mentioned earlier in this appendix. This exclusion is correct. These payments do not vary with the number of serving personnel.

20 OSD CAPE, FCoM Military Rates, 23.

21 OSD CAPE, 34.

expect to receive VA benefits, and the amount of benefits they are expected to receive. The estimated lifetime VA benefits expected to be received by current service members (appropriately discounted) would then need to be divided by their expected number of years of service to generate the marginal annual cost of a uniformed employee. This actuarial estimate is likely to yield a much higher estimated cost than FCoM provides because most veterans receive benefits for more years than they were in the military. Developing better VA cost estimates would be a major research project, but it is one that should be undertaken so that DoD can accurate estimate the fully burdened cost of military personnel.

In summary, FCoM allows users to omit questionable cost categories and to substitute their own estimates. We think it would be helpful for the tool to identify when estimates are based on poor assumptions.

Completeness

Following in the footsteps of DoDI 7041.04, by omitting the RCs, FCoM does not support costing for 37 percent of military personnel. Also, since it is constructed as a billet-by-billet analysis, it is not well suited for a larger, more complex costing effort, though it does have the ability to construct units as an aggregation of billets. Unit personnel profiles are not preprogrammed into the tool.

Specificity

FCoM provides great specificity. It allows the costs associated with individual military personnel to be calculated for a specific Service, rank, specialty, and number of years of service. However, special and incentive pays are not disaggregated by specialty. Both direct and indirect costs are addressed, as are deferred costs. Costs associated with DoD and other parts of the Federal Government are identified separately. However, FCoM does not distinguish between personnel with and without dependents, even though some benefits, like the basic allowance for housing and childcare benefits, vary with dependent status. FCoM also allows users to build the personnel structure for units; however, the tool does not use preprogrammed unit personnel profiles.

The desired level of specificity is reached only for those direct cost elements that are tracked in a disaggregated fashion. As with training, many indirect cost categories provide the same annual cost estimate for all personnel in a Service. These include health-care costs, commissary costs, recruiting costs, and childcare costs. They are calculated in a similar fashion: total expenditures divided by end-strength. The same annual recruiting cost is assigned to an E-8 with 25 years of service as to a new E-1. This figure likely does not accurately reflect the marginal recruiting cost of increasing the end-strength of a Service by one E-8.

For retirement costs, FCoM uses the accepted budgeting methodology, multiplying basic pay by 0.31, a factor provided by the DoD Actuary. A recent RAND paper shows that different factors should be used for officers and enlisted personnel in each Service.[22]

Relevance

FCoM would be quite relevant to AC-RC personnel cost comparisons if it covered reserve personnel. Its structure could accommodate indirect cost elements that differ between the two groups, like training, recruiting, health benefits, and veterans' benefits.

Considerable analysis would have to be done to develop the estimates, however. Like DoDI 7041.04, FCoM does not grapple with unit costs not directly linked to personnel, such as O&M costs. These are critical to AC-RC force mix decisions, which are made at the unit level. FCoM also does not consider the operational availability of AC and RC units, another key element in determining the best Total Force mix.

Reserve Forces Policy Board (RFPB) 2019 Report

In 2013, the RFPB first provided a critique of the principles of DTM 09-007,[23] the previous version of DoDI 7041.07.[24] In 2019, it updated its presentation, after DoDI 7041.07 had been released.[25] It concludes "that the DoD lacks appropriate policy requiring a complete and consistent costing methodology to identify the true fully burdened and life cycle costs of military manpower," and recommends that the department:

1. Establish DoD policy/guidance for computing fully burdened Military Personnel Costs for the Total Force, including the Reserve Component;
2. Calculate and report cost element figures annually using budgeted and actual costs; and
3. Develop a model to calculate and compare Active and Reserve Component fully burdened life cycle costs.[26]

It goes on to state that "[t]he primary purpose of these recommendations is to ensure senior DoD leaders receive accurate analytical products that are based on current, complete, and consistent data."[27] CAPE agreed with the first recommendation, stating, "[t]he Board's recommendations properly identify the need for a consistent set of policy and guidelines on costing military personnel. We need reasonable consistency and

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22 Asch, "Setting Military Compensation," x.

23 Reserve Forces Policy Board (RFPB), "Eliminating Major Gaps in DoD Data," 2013, 10.

24 DoDI 7041.04, 1.

25 RFPB, "Requiring the Use of Fully Burdened and Life Cycle Personnel Costs," 2019.

26 RFPB, 2019, 5.

27 RFPB, 2019, 5.

completeness in our estimates of costs as we think about adjustments in our force composition."[28]

Accuracy

The first recommendation of the RFPB report is to expand CAPE personnel costing guidance to include the RC. This would be a major improvement, since, as noted earlier in this document, neither DoDI 7041.04 nor FCoM cover the RC.

The RFPB also desires that the range of cost elements be extended in both AC and RC personnel costs. The aim is to achieve fully burdened cost estimates that capture all costs that vary with personnel in AC-RC cost comparisons. CAPE's methodology already captures many indirect personnel costs, such as discount groceries and child development costs. The RFPB recommends including additional cost elements, specifically military construction; base operations support; procurement; and research, development, test, and evaluation (RDT&E) costs, noting that they are lower in the RC than in the AC.

Conceptually, this approach is reasonable to the degree that costs really can be attributed to AC or RC personnel. The RFPB proposes using budget data to accomplish the attribution. This is reasonable for military construction and base operations support. The RC requires less of an infrastructure footprint and, while construction expenditures vary from year to year, budget data, especially smoothed out over several years, may yield a reasonable approximation of AC-RC differences.

Procurement and RDTE are a different issue. Systems are developed and bought for forces, not for people. AC and RC units have largely similar equipment. It is true that procurement and RDT&E are generally not funded through RC appropriations; equipment is developed and bought for the Service as a whole. It is misleading to assign the cost of tanks (for example) in National Guard Brigade Combat Teams to active personnel. Perhaps more importantly, procurement-related costs are not personnel costs; they do not vary consistently with the number of people in a unit. Procurement is a unit cost and should be considered as such in AC-RC force mix deliberations. The same is true of O&M costs, which the RFPB wisely does not include in fully burdened personnel costs. RDT&E does not even vary with the number of units and should be treated as a sunk fixed cost.

Completeness

The RFPB report argues for costing that covers everything associated with personnel and it is quite complete. As noted above, in some cases, like procurement and RDT&E, it

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[28] Memorandum to the Secretary of Defense from Christine Fox, Director, CAPE, "Comments on the Final Reserve Forces Policy Board Report on Costs of Military Personnel," March 2013. This reference can be found in Appendix D of RFPB, "Requiring the Use," 109.

is *too* complete, attempting to assign costs to personnel when they are actually driven by other elements.

Specificity

The RFPB approach has the same lack of specificity as FCoM for many types of indirect costs, since it relies on budget data to determine aggregate measures of cost per person for the AC and RC for many cost elements. Unfortunately, however, the RFPB approach lacks FCoM's specificity in regards to direct costs and therefore would make it impossible to see direct cost differences by rank or unit type. To the extent that the RFPB would require annual data on budgeted and actual costs, it implies a move away from FCoM's specificity in the estimation of personnel costs at the unit level.

Relevance

The RFPB report remedies a major shortcoming of DoDI 7041.04 and FCoM by trumpeting the importance of consistent costing of AC and RC personnel. AC-RC personnel cost comparisons are also well-served by including all cost elements that vary with the number and nature of personnel (e.g., rank and occupational specialty).

Further, the report acknowledges that AC-RC force mix decisions rest on more than personnel costs; however, it does not strive to capture total unit costs. While it notes that O&M costs "should be considered in costing studies and included when appropriate," it does not suggest an analytic structure for such inclusion.[29] It also does not consider or propose modeling approaches that integrate cost and the ability of forces to meet operational demands.

The RFPB report gives good advice on how to improve guidance on AC-RC force mix analysis, but it does not provide a complete template.

Individual Cost Assessment Model (ICAM)

ICAM is a decision-support simulation model that provides analytical insights into fully burdened lifecycle manpower costs of U.S. Air Force Airmen. ICAM is a discrete-event microsimulation model that provides a detailed cost accounting of manpower costs from the time an Airman is accessed into service to when that Airman or surviving beneficiaries die and stop receiving pay and benefits.[30]

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[29] RFPB, "Requiring the Use," 2019, 38.

[30] Kudo, Gillespie, and Combs, "Overview, Individual Cost Assessment Model (ICAM)," Air Force Reserve Command, May 2013, 6.

ICAM follows a large number of hypothetical individuals through their careers and calculates the costs associated with each career. This enables it to calculate average costs for personnel of various ranks and occupational specialties.

The model captures career events having cost implications including recruitment, training events, permanent change of station (PCS) moves, deployments, promotions, transitions between Reserve categories of employment, changes in component affiliations (e.g. Active Duty to Air Force Reserve or Air National Guard), separations, and retirements. ICAM accounts for basic pay, housing and subsistence, medical and retirement costs (accrual or actual), training costs, PCS costs, and other compensation, entitlements and benefits.[31]

ICAM builds on the recommendations of the RFPB report (described in the previous section). ICAM captures the cost elements that the RFPB suggests be included as "fully burdened" and does so based on all costs incurred over complete life cycles rather than at a single point in time.[32]

Accuracy

ICAM is an impressive effort and it does a very good job of capturing transitions of individuals between various stages of their careers, including accession, promotion, movement between components, separation, and retirement eligibility.

However, ICAM's treatment of initial training costs is questionable. An individual who joins the active Air Force receives this training shortly after accession. If the person subsequently leaves active duty and joins the RC, there is no marginal training cost associated with this change in status. ICAM, however, attributes at least some of these training costs to the RC.[33] This approach overstates the marginal training cost of getting a prior service accession into the RC and implicitly understates the significant investment in experienced Airmen that can be recouped/preserved through continued service in the Air Force Reserve and Air National Guard,[34] despite their explicit acknowledgement of this recouped investment.

Since no other civilian employee costs are considered by ICAM, the inclusion of Air Reserve Technician (ART) civilian pay is appropriate when the AC alternative to an ART is a full-time military person performing the same duties.

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[31] Kudo, Gillespie, and Combs, 6.

[32] Kudo, Gillespie, and Combs, 7.

[33] Email exchange with Dr. David Gillespie, Deputy Director Analysis, Lessons Learned, and CPI, HQ U.S. Air Force Reserve, February 19, 2021. Please contact the authors of this appendix for a copy of the email correspondence.

[34] Kudo, Gillespie, and Combs, 10.

ICAM uses the estimate of VA costs for AC personnel provided by DoDI 7041.04. As discussed in the context of FCoM, this is not a good estimate.

Completeness

ICAM includes factors for all elements of military personnel costs and other DoD and government costs covered in DoDI 7041.04. ICAM does not include base operations, military construction, procurement, or RDTE costs.

No VA cost factor is provided for the RC. Likewise, costs associated with some benefits that are received by mobilized RC members, such as commissary privileges, are also not included. Kudo, Gillespie, and Combs envisioned that these costs would be addressed in a revised version of ICAM after information is provided in a revision of DoDI 7041.04.[35]

Specificity

ICAM is very specific. Special and incentive pays are particularly well-treated—they are disaggregated by component, grade, and specialty. This specificity allows for more accurate estimation of personnel costs at the unit level than is provided by averaging these pays over all individuals, as with FCoM.

Relevance

In addition to being very specific, ICAM is extremely relevant as a tool for comparing the fully burdened personnel costs of various kinds of AC and RC units. However, it requires that users build unit personnel structures themselves.

ICAM is not, however, a unit cost model. It omits consideration of operating costs. While ICAM can be used to estimate how costs vary with policy regarding the frequency of deployment of both AC and RC units, it does not provide an integrated treatment of the cost-effectiveness of alternative AC-RC mixes.

Workforce Rationalization Plan

In April 2017, OMB directed all government agencies to craft plans to reduce the size of the federal civilian workforce.[36] The Secretary of Defense determined that such a reduction would not be consistent with the goal of improving DoD readiness. In lieu of a civilian workforce reduction plan, the Deputy Secretary submitted an Overarching

35 Kudo, Gillespie, and Combs, 66.

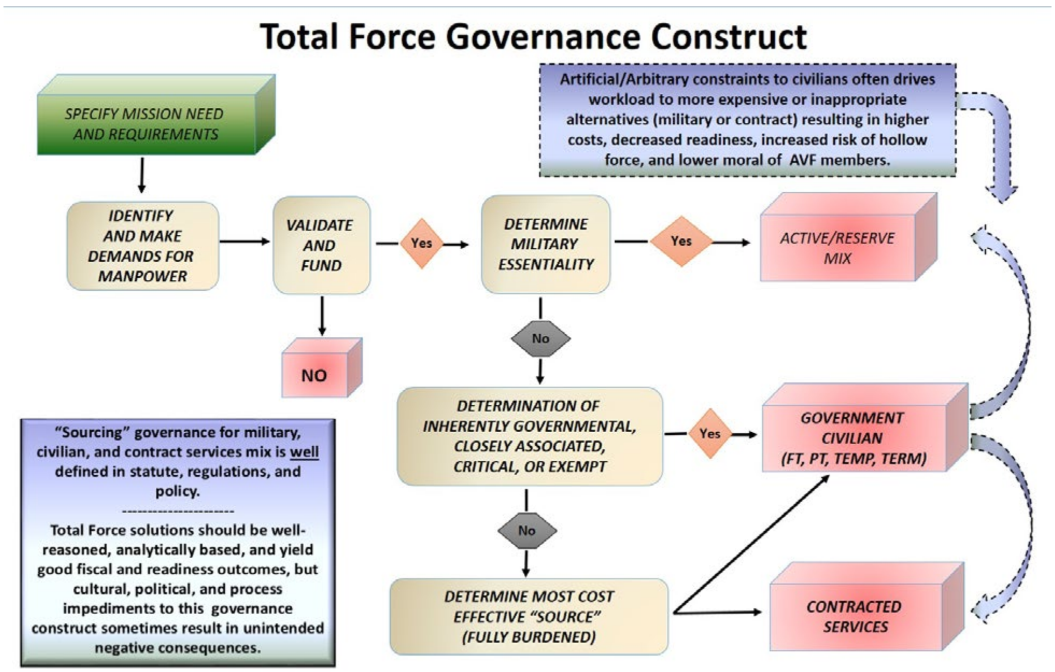
36 Executive Office of the President, Office of Management and Budget (OMB), Memorandum M-17-22, "Comprehensive Plan."

Workforce Rationalization Strategy in June 2017. It was followed in September 2017 by the more in-depth Workforce Rationalization Plan (WRP).

The WRP is based on the understanding that, rather than focusing on civilian personnel reductions, the department:

> must improve the overall management of our Total Force of active and reserve military, government civilians, and contracted services. That means we must have the right manpower and human capital resources in the right places, at the right time, at the right levels, and with the right skills to provide for the nation's defense, while simultaneously being good stewards of taxpayer dollars.[37]

Figure A-1 reproduces the paradigm envisioned for structuring the Total Force.



Source: Workforce Rationalization Plan, 7.

Figure A-1. Total Force Governance Construct

There is not much detail presented on the determination of the AC-RC mix of uniformed personnel. The WRP emphasizes, however, that, "[a]n optimally sized and balanced Total Force is one in which the mix of labor sources supports the Department's strategic priorities and the needs of our military forces in an effective and cost-efficient manner."[38] The bottom line is the ability to accomplish missions while economizing on

[37] DoD WRP, 2.

[38] WRP, 8.

resources and balancing risk and sufficiency. This includes considering changes in the AC-RC mix.[39] The WRP emphasizes that "[i]n order to maintain readiness and minimize resource impacts, analytically based manpower requirements are essential."[40]

The WRP says that "[a]dditional internal implementation guidance for DoD leaders and decision makers will be forthcoming."[41] However, almost 4 years later, such guidance has not been issued.

Accuracy

The WRP calls for the application of fully burdened costing principles. It cites DoDI 7041.04 as providing costing guidance. However, that instruction does not address the cost of RC personnel.

Completeness and Specificity

The WRP is very general. It calls for analysis and completeness, but gives no details.

Relevance

The WRP is potentially very relevant to improved AC-RC force mix determination. It points to the way ahead with its call for an analytically based approach that integrates meeting operational requirements and costs. It does not, however, address the need to do AC-RC force mix planning at the unit level, focusing entirely on personnel—the workforce. Unfortunately, the general guidance it provides has not yet been fleshed out.

Conclusions and Recommendations

Conclusions

In this Appendix, we reviewed and assessed guidance provided by OSD to the Services and others on how to develop cost estimates for AC and RC personnel and units, and how to use such estimates to inform force management decisions. We also considered four other sources of information. Two are data systems for estimating personnel costs, one relates to improved personnel costing, and the fourth provides broad guidance on workforce mix.

Our major conclusions are as follows:

- OSD CAPE provides good guidance in DoDI 7041.07 on what cost elements should be considered in developing cost estimates of RC personnel and DoD

[39] WRP, 9.

[40] WRP, 6.

[41] WRP, 2.

civilian employees. CAPE's FCoM tool embodies the guidance and provides an easy way to estimate the cost of personnel with reasonable fidelity, though its estimates are flawed for some cost elements.

- There is no guidance from CAPE or any other element of OSD on developing cost estimates for RC personnel. The RFPB recommended filling this gap in 2013. CAPE concurred, but no subsequent action has been taken.
- OUSD(P&R) DoDI 1100.22 provides good guidance on determining the mix of the DoD workforce among military personnel, DoD civilians, and private sector support.
- There is no guidance from P&R or any other element of OSD regarding the mix of AC and RC military manpower. Considering that the Selected Reserve components provide 38 percent of the department's military manpower, this is a serious shortcoming in DoDI 1100.22.
- DoDD 1200.17 provides guidance on the use of the RC as an operational force, as opposed to a strategic reserve. The directive does not bear on costing and does not directly guide AC-RC force mix decisions.
- The RFPB's 2019 report updates its 2013 analysis of AC-RC personnel cost comparisons. It condemns the lack of guidance and costing tools for developing consistent intercomponent cost comparisons. The analysis suggests a specific approach to making such comparisons using fully burdened costs, and takes a rough cut at quantification. It largely embodies the principles of DoDI 7041.07. However, the RFPB suggests including cost elements such as procurement and RDT&E that have little to do with personnel. Also, it does not address unit cost comparisons and does not balance cost and effectiveness.
- The Air Force's ICAM is quite similar to FCoM (and DoDI 7041.07) in terms of its cost elements. It extends the structure to include the RC. It does a particularly good job of capturing special and incentive pays at a detailed level. Its allocation of initial skill training costs associated with prior-service RC personnel does not fully capture the savings associated with such accessions.
- The Workforce Rationalization Plan focuses largely on developing the best mix of military, government civilian, and contract personnel. It touches on AC-RC issues in a general way. It calls for an analytically based approach that integrates meeting operational requirements and costs. It does not, however, address the need to do AC-RC force mix planning at the unit level, focusing entirely on personnel.

Table A-1 summarizes these conclusions in terms of the four criteria we applied.

Table A-1. Summary of Assessment Documents

	Accuracy	Completeness	Specificity	Relevance
DoDI 7041.04				
DoDI 1100.22				
DoDD 1200.17				
FCOM				
RFPB Report				
ICAM				
Workforce Rationalization Plan				

While all the documents do at least a fairly good job of conveying what they are meant to convey, none is directly relevant to performing complete AC-RC force mix analyses. In some cases, RC forces are simply not addressed. In most cases, the ability to meet required demands for deployed forces are not considered. In all cases, the fact that AC-RC force mix decisions are made at the unit level and must incorporate operating and other costs is ignored.

Recommendations

- OSD should issue guidance on (1) conducting consistent cost comparisons between AC and RC personnel and (2) including the RC in comparisons that include AC, civilian, and contractor personnel. Such guidance would enable true Total Force cost analyses.
- OSD should issue guidance on performing unit-based analyses of AC-RC force mix alternatives. The guidance should specify the cost elements to be considered and the elements to be considered in quantifying the operational effectiveness of the alternatives. Such guidance would enable better assessments of the cost of the Force and its ability to meet operational requirements.

Appendix B.
Details on the Model Installation Process, Configuration Files, and Metrics

Installing the Model

Development of the FSA Model is managed using git version control. Please contact the authors for a copy of the git archive, which contains source code as well as all configuration files used throughout this report. Running the dashboard requires a working installation of Python with the Streamlit, Pandas, Simpy, and Plotly packages installed. We recommend using the Anaconda distribution of Python to create a new environment with just the required packages. The version requirements are given in the following table.

Table B-1. Software Version Requirements

Package	Version Requirement
Pandas	≥ 0.23.4
Simpy	3.0.11
Plotly	≥ 4.1.1
Streamlit	≥ 0.78.0

After you unzip the code to a chosen location, go to that location using the command prompt and execute the dashboard by entering the `streamlit run master_dashboard.py` command. If the streamlit command is not recognized, your system may be running a conflicting installation of Python.[1]

[1] Troubleshooting advice is available in this discussion post: https://discuss.streamlit.io/t/getting-an-error-streamlit-is-not-recognized-as-an-internal-or-external-command-operable-program-or-batch-file/361/21.

Configuration Files

This section describes the field definitions in the *Force Generation* and *Cost* configuration files.

Force Generation Configuration File

Table B-2. Field Definitions in the *Force Generation* Configuration File

Field Name	Definition
UnitID	Unique numeric index
UnitName	Name of the unit
Component	Active or Reserve component
Phase	Stage of the force generation cycle. All cycles must include *Ready, Deployment,* and *Reset*. Cycles for RC units must also include *Mobilization*.
ResourceLevel	Standardized instructions that set PhaseDuration and ResourceRate for all units and phases
PhaseDuration	Duration of the phase in months
ResourceCategory	Type of resourcing (e.g., Operations, Personnel, etc.)
ResourceRate	Proportion of full resourcing applied to that unit for that ResourceCategory for that Phase
NextPhase	Text describing the next phase in the cycle. For RC, the NextPhase for “Ready” is always “Mobilization;” for AC, “Deployment.” For RC, “Mobilization” is always followed by “Deployment.” For both components, “Deployment” is always followed by “Reset.” Other than those mandatory orders, the phases can follow each other in arbitrary order (e.g., NextPhase for “Training_1” can be “Training_2” or “Ready”).

Cost Configuration File

Table B-3. Field Definitions in the *Cost* Configuration File

Field Name	Definition
UnitID	Unique numeric index
UnitName	Name of the unit
Component	Active or Reserve component
Phase	Stage of the force generation cycle. All cycles must include *Ready, Deployment,* and *Reset*. Cycles for RC units must also include *Mobilization*.
ResourceCategory	Used to delineate different types of resourcing for the unit in a phase (e.g., Operations, Personnel)
FixedPhaseCost	Fixed cost associated with a phase regardless of its duration (e.g., the transportation costs associated with getting a unit to its deployment theater and back)
FixedMonthlyCost	Fixed cost associated with each month of a (e.g., facilities overhead)
VariableMonthlyCost	Monthly costs that can vary depending on resourcing choices (e.g., costs associated with a given level of manning of a unit). This cost is given as the monthly cost associated with resourcing used in the Ready phase. It is multiplied by the ResourceRate provided in the *Force Generation* configuration file when computing a unit's cost for a phase.

Metrics

Table B-1. Metrics Provided by a Two Mix Comparison Dashboard Page

Metric	Definition
Average Annual Cost	Average annual cost ($B)
Average Deployment Extension	Average number of months any deployed unit had its deployment extended
Average AC Deployed	Average number of active component units deployed at any time
Average RC Deployed	Average number of reserve component units deployed at any time
Max Units Deployed	Maximum number of total units deployed at any time
Demand Unmet	Number of unit-months where demand existed but an insufficient number of units was able to deploy
% Demand Unmet	Percent of unit-months where demand existed but an insufficient number of units was able to deploy
Maximum Shortfall	Largest difference between units demanded and units deployed at any time
Average Shortfall	Average difference between units demanded and units deployed

Illustrations

Figures

Tables

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Abbreviations

AC	Active Component
AD	Active Duty
AFEMS	Air Force Equipment Management System
AFTOC	Air Force Total Ownership Cost
ART	Air Reserve Technician
BCT	Brigade Combat Team
BOG	Boots On Ground
CAPE	Cost Assessment Program Evaluation
COLA	Cost of Living and related Allowances
COST	Contingency Operations Support Tool
CPI	Continuous Process Improvement
CSRS	Civil Service Retirement System
csv	Comma-separated values
DoD	Department of Defense
DoDD	DoD Directive
DoDI	DoD Instruction
Dwell	Non-deployed (AC)/Non-mobilized (RC) status
FCoM	Full Cost of Manpower
FERS	Federal Employees Retirement System
FORCES	Force and Organization Cost Estimating System
FSA	Force Structure Assessment
FY	Fiscal Year
FYDP	Future Years Defense Program
ICAM	Individual Cost Assessment
IDA	Institute for Defense Analyses
IG	Inherently Governmental
Mob	Mobilization
NCA	National Command Authorities
NDS	National Defense Strategy
NSS	National Security Strategy
O&M	Operations and Maintenance

OMB	Office of Management and Budget
OPTEMPO	Operating Tempo
OSD	Office of the Secretary of Defense
OSD-CAPE	Office of the Secretary of Defense, Cost Assessment Program Evaluation
OUSD Policy	Office of the Undersecretary of Defense, Policy
OUSD(C)	Under Secretary of Defense (Comptroller)
OUSD(P&R)	Office of the Undersecretary of Defense for Personnel and Readiness
PA&E	Program Analysis & Evaluation
PCS	Permanent Change of Station
RC	Reserve Component
RDT&E	Research, Development, Test, and Evaluation
RFPB	Reserve Forces Policy Board
SARA	Stochastic Active-Reserve Assessment
SRM	Sustainable Readiness Model
TFM	Total Force Management
TFSMS	Total Force Structure Management System
USAF	United States Air Force
VA	Veterans Affairs
VAMOSC	Visibility and Management of Operating and Support Costs
WRP	Workforce Rationalization Plan

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Law, Jack N.
Berge, Astrid I.
Bracken, Jerome
Gao, Vivian
Horowitz, Stanley A.
McGee, Shaun K.
Prugh, George M.
Schmidle, Robert E.
Wagner, Nicholas A.

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14. ABSTRACT
This paper describes Phase 1 of a multiphase project to develop a joint capability to comprehensively assess Reserve and Active component costs and the Force's capacity to meet proposed demand scenarios under alternative force sizing and force management policies. DoD lacks a multiservice tool to assess how force planning decisions affect the cost of the military force, the ability of the force to meet demand, and stress on the force. In addition, DoD instructions and tools that guide force planning do not include Active-Reserve force planning in a holistic manner. To address these issues, IDA is developing a computer application called the Force Structure Assessment (FSA) Model. This model will enable Service, OSD, and Joint Staff programmers and other stakeholders to weigh the long-term cost and risk of force management alternatives. This model is a much-needed tool that addresses not only force size and Active-Reserve mix, but also force management policies including (1) force generation, (2) deployment and mobilization constraints, (3) deployment extensions, and (4) pre-deployment training requirements. The FSA Model addresses these topics using representative, and often user-provided, data and methodologies and will be valuable for informing planning and programming decisions. Phase 1 of the project demonstrates a proof of concept version of the FSA Model.

15. SUBJECT TERMS
total force management; Active-Reserve mix; total force costing; stress on the force; Joint Force planning; Reserve Component costing

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