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A Methodology for Determining Air Force Deployment Requirements

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Preface

Transforming from threat-based planning to capabilities-based planning has highlighted the need for the Air Force to be able to quantify quickly the manpower and materiel necessary to support a desired capability. From a logistical point of view, the transition accentuates the utility of having a rapid, analytical method for determining the total support required to deploy specified forces to bases across the full range of support infrastructures, including austere bases.

This monograph presents such a methodology for determining manpower and equipment deployment requirements and summarizes a prototype research tool—called the Strategic Tool for the Analysis of Required Transportation (START)—which illustrates the methodology. (The appendix serves as a user's guide for this prototype tool.) The START program, an Excel-based spreadsheet model, determines the list of Unit Type Codes (UTCs) required to support a user-specified operation, along with the movement characteristics of the materiel for a wide range of support areas. It therefore is a demand generator of the manpower and materiel needed at a base to achieve initial operating capability, and a fully implemented tool based on this prototype should be useful for both deliberate and crisis-action planning.

This work was conducted by the Resource Management Program of RAND Project AIR FORCE and was jointly sponsored by the USAF Deputy Chief of Staff of Installations and Logistics (USAF/IL) and the USAF Directorate of Operational Plans and Joint Matters (USAF/XOX). It is one element of a larger study entitled

"Forward Support Locations (FSLs) and Other Wartime Support," which in turn is part of a series of studies entitled "Supporting Expeditionary Aerospace Forces." Other reports in this series are:

- MR-1056-AF, *Supporting Expeditionary Aerospace Forces: An Integrated Strategic Agile Combat Support Planning Framework* by Robert S. Tripp, Lionel A. Galway, Paul S. Killingsworth, Eric Peltz, Timothy L. Ramey, and John G. Drew
- MR-1075-AF, *Supporting Expeditionary Aerospace Forces: New Agile Combat Support Postures* by Lionel A. Galway, Robert S. Tripp, Timothy L. Ramey, and John G. Drew
- MR-1174-AF, *Supporting Expeditionary Aerospace Forces: An Analysis of F-15 Avionics Options* by Eric Peltz, H. L. Shulman, Robert S. Tripp, Timothy L. Ramey, Randy King, and John G. Drew
- MR-1179-AF, *Supporting Expeditionary Aerospace Forces: A Concept for Evolving the Agile Combat Support/Mobility System of the Future,* Robert S. Tripp, Lionel A. Galway, Timothy L. Ramey, Mahyar A. Amouzegar, and Eric Peltz
- MR-1225-AF, *Supporting Expeditionary Aerospace Forces: Expanded Analysis of LANTIRN Options* by Amatzia Feinberg, H. L. Shulman, L. W. Miller, and Robert S. Tripp
- MR-1263-AF, *Supporting Expeditionary Aerospace Forces: Lessons From the Air War over Serbia* by Amatzia Feinberg, Eric Peltz, James Leftwich, Robert S. Tripp, Mahyar A. Amouzegar, Russell Grunch, John G. Drew, Tom LaTourrette, and Charles Robert Roll Jr. (for official use only; not releasable to the general public)
- MR-1431-AF, *Supporting Expeditionary Aerospace Forces: Alternatives for Jet Engine Intermediate Maintenance* by Mahyar A. Amouzegar, Lionel A. Galway, and Amanda Geller
- MR-1536-AF, *Supporting Expeditionary Aerospace Forces: An Operational Architecture for Combat Support Execution Planning and Control* by James Leftwich, Robert S. Tripp, Amanda Geller, Patrick H. Mills, Tom LaTourrette, Charles Robert Roll, Cauley Von Hoffman, and David Johansen.

This report should be of interest to logisticians and planners throughout the Air Force. The software described in this report can be obtained from the authors upon request (contact Don Snyder at snyder@rand.org and Patrick Mills at pmills@rand.org).

RAND Project AIR FORCE

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Summary

The Air Force is transitioning from a threat-based planning posture to a capabilities-based planning posture. Adopting a planning strategy based on a portfolio of capabilities[1] suggests the need to develop a means to calculate swiftly the manpower and equipment required to generate each of the capabilities in that portfolio. This need, in combination with the current expeditionary posture of the Air Force, highlights the value of expediting deployment-planning timelines.

Much of the logistical component of planning involves generating time-phased force deployment data (TPFDD). A TPFDD is a list of which units of capability need to be deployed in order to support the mission objectives, who will supply these capabilities, and details of the timing and routing of their transport. These units of capability are called Unit Type Codes (UTCs), and this list of UTCs is assembled by specialists in each career area, who are called functional area managers. For deliberate plans, this process can take on the order of a year. When a crisis occurs, assembling the TPFDD for a real deployment benefits from the experience of generating the deliberate plans (and sometimes planners use a deliberate plan as a template), thus compressing the time-scale, but the process still takes weeks to months to complete.

An analysis tool that can automate as much of this planning work as possible would greatly expedite the planning process and hence would help to usher along the transition to a capabilities-based,

[1] Rumsfeld, 2001.

expeditionary Air Force. This monograph presents a prototype analysis tool that illustrates a methodology for developing this capability. The analysis tool was developed with two objectives in mind: to demonstrate the feasibility of a tool to generate a parameterized list of UTCs necessary to support a specified mission based on a limited number of inputs, and to estimate the movement requirements to achieve initial operating capability at all deployed locations.

Quantifying Deployment Requirements

Requirements in a theater can be approximated by adding the requirements at each base (including theater-level requirements on at least one base, such as command and control), and then subtracting theater-level efficiencies, such as centralized maintenance facilities. Hence, our analysis focuses on calculating requirements at a base level and aggregates over bases to estimate theater requirements.[2]

At a base, the principal factors that drive which and how many UTCs deploy are

- the existing base infrastructure and working Maximum on Ground (MOG)
- the number, type, and mission of the aircraft bedded down
- the total base population
- the level of conventional and unconventional threats to which the base is exposed.

Using these general inputs, we compiled rules for the deployment of UTCs for the following functional areas: aviation and maintenance, aerial port operations, civil engineering, bare-base support, munitions, fuels mobility support equipment, deployed communications, force protection, medical support, and general-purpose vehicles. These areas constitute the bulk of the deployed manpower and

[2] Galway et al., 2002.

equipment. The rules were compiled from detailed interviews with senior noncommissioned officers and functional area managers at Air Combat Command (ACC) and Air Mobility Command (AMC), as well as consulting published Air Force documents.

The result is a prototype Excel-based model called the Strategic Tool for the Analysis of Required Transportation (START). It translates specified operational capability at a deployed location into a list of UTCs needed to generate that capability. Inputs to the program are type, number, mission, and sortie rate of aircraft bedded down at the site; generalities of the existing infrastructure at the base, selected from a checklist; and levels of conventional and nuclear, biological, and chemical (NBC) threats to which the base is vulnerable.

Using these inputs, the model determines a list of core UTCs needed to support these requirements. This UTC list, along with movement characteristics listed in the Manpower and Equipment Force Packaging (MEFPAK),[3] are then aggregated by functional area to indicate the movement requirements by weight (short tons) and volume (cubic feet). These movement characteristics are then further aggregated into C-17 equivalents. The user can view these aggregate figures in tabular and graphical form, as well as drill down to the UTC lists.

Example Applications

A fully implemented tool based on this prototype should be useful for a range of Air Force planning needs. Three potential applications are as follows:

Crisis-Action Planning[4]

An analysis tool that can generate a first approximation of a TPFDD within minutes without the planner having special experience in lo-

[3] Taken from the December 2001 MEFPAK list.

[4] See pp. 41–42.

gistics would provide operational planners with rapid feedback on the logistical feasibility of their plans, and once a plan is agreed upon, would provide a template for the logisticians to build the execution TPFDD. An analysis tool should greatly accelerate both phases of the crisis-action planning process.

Setting Manpower and Equipment Authorizations[5]

In capabilities-based planning, planners may wish to evaluate dozens of scenarios requiring capabilities of varying scope in unspecified locations.[6] An analytical tool that can rapidly generate a requirements TPFDD would permit such an analysis by providing an assessment of the manpower and equipment needs to achieve each element of the desired portfolio of capabilities.

War Reserve Materiel Prepositioning and Forward Support Locations[7]

The analysis tool described in this report can generate the movement requirements for a range of possible scenarios at a range of locations. This demand can, in turn, be combined with data on storage capacities, transportation times and capacities (air, land, and sea), and other logistical constraints for each potential war reserve materiel (WRM) site to optimize for the location of these sites and distribution of WRM among these sites.

Recommendations

We foresee no theoretical impediments that would prevent the START prototype tool described in this monograph to be developed into an execution-level tool. To facilitate this implementation, we make the following recommendations:

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[5] See pp. 42–43.

[6] Davis, 2002.

[7] See p. 43.

Develop formal definitions for deployed locations.[8] Other than for a bare base, no accepted vocabulary exists that describes common types of sites to which the Air Force typically deploys. Defining a limited number of standard deployment sites will permit UTCs to be tailored and sized according to a common set of planning factors.

Develop formal definitions of conventional and NBC threat.[9] Uniform definitions for these threats agreed by all relevant groups would provide a common vocabulary for advanced echelon (ADVON) teams and facilitate rapid decisions on which UTCs are needed across all functional areas.

Establish an office of primary responsibility to maintain the spreadsheet model.[10] Maintaining a spreadsheet model to generate the UTC lists that are necessary to support operations will give the Air Force a greater expeditionary posture and facilitate its transition to capabilities-based planning.

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[8] See pp. 45–46.

[9] See p. 46.

[10] See pp. 46–47.

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This project was sponsored by both AF/IL and AF/XOX; we thank our sponsors Lt Gen Michael Zettler and Maj Gen Jeffrey Kohler for their support of this work, as well as our action officer Col Connie Morrow (AF/ILGX).

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We thank Lt Col Coert Scoggins (60 OSS/OGT) at Travis AFB and Lt Randolph Lake (965 AACS) at Tinker AFB for arranging our visits and interviews at these active units.

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Groothuis (AFLMA/LGX), Capt Timothy Gillaspie (AFLMA/LGX), CMSgt John Drew (AFLMA/LGM), and SMSgt Cedric McMillon (AFLMA/LGM). At Air Force Studies and Analysis (AFSAA), we thank Lt Col Stephen Alsing (AFSAA/SACE) and his staff for their input, and for introducing us to the staff at AF/CC-AEF. At AF/CC-AEF, we thank Lt Col Rick Cornelio (AF/CC-AEF) and Maj Doreen Pagel (AF/CC-AEF) for information on the Force Module efforts. At Air Forces United States Central Command (CENTAF), conversations with Maj Dennis Long (CENTAF/A4-LGX) about bare-base support were helpful, especially how Harvest Falcon assets are stored and deployed. Visits with the Air Staff were similarly helpful. We especially thank Lt Col Robert Michael Cleary (AF/ILGV), Lt Col William McKinley (AF/ILGE), and Lt Col Jim Reavis (AF/ILMW).

We received considerable assistance in the area of fuels support. We would like to thank the staff of the Air Force Petroleum Office (AFPET) for information on how fuels support deploys and for releasing to us the Fuels Mobility Support Equipment (FMSE) calculator. In particular, we thank CMSgt Thomas Gillenwater (ACC/LGSF), CMSgt William Rozier (AF/ILGP), SMSgt Shawn Simon (AFPET), and SMSgt Robert McGonagle (AFLMA/LGS) for their help.

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Formal reviews by Eric Peltz and James Masters greatly improved the presentation.

We, of course, assume responsibility for any errors or omissions.

Acronyms

ACC	Air Combat Command
ADVON	advanced echelon
AFB	Air Force Base
AFH	Air Force Handbook
AFLMA	Air Force Logistics Management Agency
AFPAM	Air Force Pamphlet
AFPET	Air Force Petroleum Office
AFRES	Air Force Reserve
AFSAA	Air Force Studies and Analysis
AG	Air-to-Ground
AGM	Air-to-Ground Missile
AIM	Air Intercept Missile
AMC	Air Mobility Command
AMCI	Air Mobility Command Instruction
ANG	Air National Guard
APO	aerial port operations
AWACS	Airborne Warning and Control System
BDR	battle damage repair
BEAR	Base Expeditionary Airfield Resources
BOS	base operating support

CAP	combat air patrol
CAS	Close Air Support
CENTAF	United States Central Command Air Forces
CIRF	centralized intermediate repair facility
CONUS	Continental United States
C2ISR	command, control, intelligence, surveillance, and reconnaissance
ECU	environmental control unit
EMEDS	Expeditionary Medical Support
EOD	explosive ordnance disposal
FAM	functional area manager
FMSE	fuels mobility support equipment
FOC	full operating capability
FOL	forward operating location
FSL	forward support location
GBU	Guided Bomb Unit
HMMWV	high-mobility multi-purpose wheeled vehicle
HUMRO	humanitarian relief operation
HQ	Headquarters
ILM	intermediate-level maintenance
IOC	initial operating capability
JEIM	jet engine intermediate maintenance
LANTIRN	Low-altitude Navigation and Targeting Infrared for Night
LIN	liquid nitrogen
LOX	liquid oxygen
LMST	Lightweight Multi-Band Satellite Terminal

LOGFOR	Logistics Force Packaging System
MAJCOM	major command
MDS	mission design series
MEFPAK	Manpower and Equipment Force Packaging
MHE	materiel handling equipment
MISCAP	Mission Capability
MMS	Munitions Maintenance Squadron
MOG	Maximum on Ground
MRC	major regional conflict
MTon	Measurement ton
NBC	nuclear, biological, and chemical
NCO	Noncommissioned Officer
OCONUS	Outside the Continental United States
PAA	Primary Aircraft Authorized
PACAF	Pacific Air Forces
PAR	population at risk
Prime BEEF	Prime Base Engineer Emergency Force
RED HORSE	Rapid Engineer Deployable Heavy Operations Repair Squadron
RSP	readiness spares package
SATCOM	Satellite Communications
SEAD	suppression of enemy air defenses
SIOP	Single Integrated Operational Plan
SOF	Special Operations Forces
SPEARR	Small Portable Expeditionary Aeromedical Rapid Response
SSC	small-scale contingency

START	Strategic Tool for the Analysis of Required Transportation
STon	Short ton
TPFDD	time-phased force deployment data
USAFE	United States Air Forces in Europe
UAV	unmanned aerial vehicle
UTC	Unit Type Code
VBA	Visual BASIC for Applications
WRM	war reserve materiel

CHAPTER ONE

Introduction

The world security environment has recently changed considerably. Because of new and changing threats over just the past several years, the United States military has been called upon to perform more than 80 operations in dozens of countries worldwide,[1] many of which fell outside the scope of its deliberate plans, and some of which it was called upon to do with minimum planning time. It seems that, for the foreseeable future, the United States cannot expect to know with confidence who its enemies may be or where it may need to fight. Deployments may require response at short notice for any level of engagement from humanitarian relief operations through major theater war.

The Department of Defense has responded to this new security environment by transitioning from a threat-based posture to a capabilities-based posture.[2] The threat-based posture revolved around deliberate plans for countering specific threats in particular regions of the world. For each specific threat, detailed operational plans were assembled for how that conflict was to be executed. The new approach to planning is to develop a "portfolio of capabilities that is robust across the spectrum of possible force requirements, both functional and geographical."[3] This change shifts the emphasis from preparing to fight specific conflicts in specified regions, to one of defin-

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[1] Kaplan, 2003.

[2] Rumsfeld, 2001.

[3] Rumsfeld, 2001, p. 17.

ing and maintaining a set of capabilities that the military must possess. Adapting to this new planning environment will require the United States military to develop a new analytic architecture.[4]

From a logistics perspective, one prominent implication of the shift to capabilities-based planning is the desirability of a means to quantify logistical support rapidly. In the previous threat-based mode of planning, the logistical component revolved around generating a limited number of time-phased force deployment data (TPFDD) to support a limited number of specific operations in particular geographic locations. A TPFDD is a list of which units of capability need to be deployed in order to support the mission objectives, who will supply these capabilities, and details of the timing and routing of their transport. These units of capability are called Unit Type Codes (UTCs), and this list of UTCs is assembled by specialists in each career area, who are called functional area managers. For deliberate plans, this process can take on the order of a year. When a crisis occurs, assembling the TPFDD for a real deployment benefits from the experience of generating the deliberate plans (and planners sometimes use deliberate plans as a template), thus compressing the time-scale, but the process still takes weeks to months to complete.

An analytical methodology to shorten this time frame would facilitate the transition to capabilities-based planning. First, it would make tractable the task of generating a portfolio of planning TPFDDs to support the specified portfolio of required capabilities. That is, for each defined capability, the Air Force would have a viable means to generate a planning TPFDD. This capability would provide a ready means to evaluate manpower and equipment authorizations and to provide a framework for posturing UTCs. Second, an analytical tool to assist in TPFDD building would expedite crisis action planning, reducing the time required to generate the TPFDD, and thus reducing the response time to exigencies.

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[4] Davis, 2002.

The Air Force has made progress in this direction with the development of Force Modules.[5] Force Modules are fixed lists of UTCs assembled to perform common Air Force operations. Five Force Modules are being developed: open the airbase, provide command and control capabilities, establish the airbase, generate the mission, and operate the airbase. The idea is that these sets of UTCs will be as lean as possible but sufficient to perform the stated mission. In keeping with capabilities-based planning, they will quantify the capabilities that the Air Force possesses and serve as building blocks for TPFDD development during crisis-action planning.

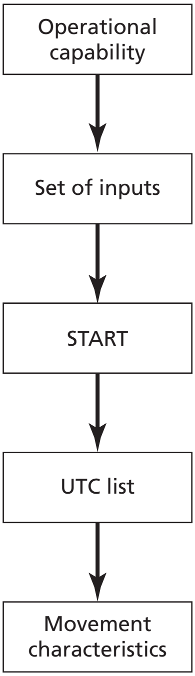
In this monograph, we explore a further parameterization of the TPFDD building process, designed to give planners and Air Force leadership a further refinement for generating a "tailored" TPFDD. The tool described in this report, the Strategic Tool for the Analysis of Required Transportation (START), is a prototype of this method—a tool for the strategic planner that translates an operational capability at a deployed location into a list of needed UTCs, along with their movement requirements. Figure 1.1 shows where START fits into this translation process.

The user begins with a desired operational capability specified by several parameters (i.e., aircraft, mission, characteristics of deployed location, etc.). The model then outputs a list of UTCs required to effect that operational capability, as well as the movement characteristics of the materiel.

The remaining chapters describe this prototype tool in detail. Chapter Two provides an overview of the tool, including its scope, levels of input and output, methodology and sources of its data, and its uses and limitations. Chapter Three provides details on the logic and sources of data for each functional area treated. The level of description in that chapter provides the user with enough information to evaluate the fidelity of the results for any application of interest. Chapter Four presents some illustrative applications using the analysis

[5] Elliott, 2003.

Figure 1.1
Flow Diagram Showing How START Fits into Translating Operational Capability into Movement Characteristics



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tool. Chapter Five presents our conclusions and recommendations. Finally, the Appendix serves as a detailed user's guide, providing step-by-step instructions on how to input data and how to read the results of the calculations.

CHAPTER TWO

Quantifying Deployment Requirements

The Scope and Output of the START Model

The total amount of materiel and manpower needed in a theater to achieve a certain operational capability can be viewed as an aggregate of what is needed at a given base for it to have its own organic capability, plus theater needs (such as theater-level command and control equipment), minus whatever benefits may be gained by economies of scale and centralization of supply and repair (such as centralized intermediate repair facilities [CIRFs]).[1] The base-level requirements thus form the building blocks for determining the theater-level requirements,[2] and, hence, the prototype analysis tool described in this report operates at the base level. It converts the operational capability desired at a deployed location into a list of materiel and manpower needed to generate that capability. Theater requirements are calculated by summing requirements at multiple bases.

The model builds requirements at the UTC level, when possible,[3] and with the exception of munitions, it does not estimate con-

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[1] Tripp, et al., 1999; Peltz et al., 2000; Feinberg et al., 2001; Amouzegar, Galway, and Geller, 2002.

[2] Galway et al., 2002.

[3] Some commodities do not have a UTC (e.g., most general-purpose vehicles) or are commonly shipped as **Z99 UTCs (e.g., munitions). In these cases, we list the items individually as a "**Z99" UTC. See Galway et al., 2002.

sumables (e.g., food and fuel).[4] The UTC is a natural unit to quantify movement requirements because it forms the components of deployment TPFDDs. START combines the output list of UTCs with the Manpower and Equipment Force Packaging (MEFPAK)[5] movement characteristics for each UTC. We have extended the movement characteristics listed in the MEFPAK to estimate the number of C-17 equivalents that would be needed to move the contents of these UTCs, while keeping in mind both maximum volume and weight constraints.

The analysis tool was developed with two objectives in mind: to demonstrate the feasibility of a tool to generate a candidate list of UTCs necessary to support a specified mission, and to estimate the movement requirements to achieve initial operating capability at all deployed locations. Achieving these objectives can be accomplished without compiling rules for the deployment of each of the 2,000-plus Air Force UTCs. Many UTCs are either seldom deployed (requiring the judgment of an expert) or constitute very little of the manpower or weight of materiel that needs to be in place (contributing little to the movement requirements). We compiled rules for the deployment of UTCs that constitute the core capabilities in the following functional areas: aviation and maintenance, aerial port operations, civil engineering, bare-base support, munitions, fuels mobility support equipment, deployed communications, force protection, medical support, and general-purpose vehicles. In sum, these capabilities constitute the vast majority of the mass and volume of materiel that must be at a site to initiate and sustain operations. Hence, they provide a starting point for a TPFDD and provide an estimate of the movement requirements to reach initial operating capability (IOC) at a base and to sustain a planned sortie rate. UTCs that are not treated (i.e., those for which we did not define a rule) are generally those with isolated personnel in functional areas not treated, those deployed

[4] Munitions are included because they require considerable lift due to their weight and, unlike many consumables, cannot be procured on the local market.

[5] The December 2001 version was used. Newer versions of the MEFPAK can be easily imported.

only under special circumstances, or those that are comparatively light.

The Inputs for the START Model

The aspects of an operational capability that principally drive the materiel and manpower needs are the aircraft, the total base population, and the level of threat to which the base is exposed. For a non-bare base, any existing infrastructure at the base may also reduce the movement requirements. The type, number, mission, and sortie schedule of the aircraft drive materiel needs in areas such as aviation, maintenance, aerial port operations, munitions, and munitions handling. Base population principally drives materiel needs in civil engineering, bare-base support, medical services, and communications. And the threat level, both conventional and nuclear, biological, and chemical (NBC), drives needs in the areas of force protection, explosive ordnance disposal (EOD), and medical support. These relationships will be further detailed in Chapter Three.

Other factors can play a role in materiel and manpower needs, especially the topography and layout of the base. A geographically extended base will increase certain needs, such as the need for vehicles, and place higher demands on force protection. Further, if facilities such as antennae must be erected outside the base perimeter, additional force protection will be required to secure those assets. Topography can impede line-of-sight communications, necessitating additional communications equipment. On the other hand, topography can make the base easier to defend, thereby reducing the force protection requirements.

Base layout and topography substantially affect requirements for only a few of the functional areas. For this reason, and to keep the tool as flexible as possible and to obviate the need for a detailed base survey, we have estimated the requirements for a given operational capability with a "typical" deployed base layout and topography. Hence, for the purposes of this model, the principal characteristics that determine materiel needs at a base are the following:

- The existing base infrastructure and working Maximum on Ground (MOG)[6]
- The aircraft bedded down or using the base as an en-route location
- The total base population
- The threats to which the base is exposed.

As the model is designed for strategic, not tactical, use, we have kept these inputs as general as possible. Details of these inputs are discussed in the next chapter. The inputs to START are

- a checklist specifying the nature of the existing infrastructure at the base (e.g., Is there an adequate hard fuel supply, or is fuels mobility support equipment [FMSE] needed? Is force protection needed?)
- the type and number of aircraft that are bedded down (or that use the base as an en-route location) as well as the mission and sortie rate of those aircraft
- the level of threat to the base, both conventional and NBC.

A option in START allows the user to specify whether the calculation is for IOC or full operating capability (FOC), which we use to mean IOC plus maintenance equipment for operations beyond 30 days, and munitions for operations up to seven days. Although it is not an explicit input to the tool, START uses the total base population to determine the demand for many support UTCs; the base population is estimated from the number of aircraft bedded down using bare-base planning factors.[7] These planning factors give a range

[6] Working Maximum on Ground is the number of aircraft that can be serviced on the ramp, whether refueling or loading or unloading cargo. Parking MOG is the number of aircraft that may be parked at the base. The latter number is typically much larger than working MOG, and we exclude it as a limitation or driver of UTC deployment. For the rest of this report, MOG will be used to mean working MOG and will refer to how many aircraft can be simultaneously loaded or unloaded on the ramp.

[7] Air Force Pamphlet (AFPAM) 10-219, 1996, Vol. 5, p. 34. Because the manpower estimates are incomplete for some of the career fields—viz., command and control (1C), intelli-

of anticipated base population as a function of the number and size of the aircraft bedded down at the site. We use the conservative, upper estimates.

Base Type

For the purposes of this model, the Air Force does not currently define a suite of terms that adequately describes the range of locations to which forces deploy. A "bare base" describes some of the sites recently used, but no formal definitions capture the range of other sites, such as use of international airports, use of non–United States military air bases, and so forth.

In an effort to keep the input as general as possible yet flexible enough to describe a wide range of potential deployment sites, we have defined two types of bases: a bare base and what we call an "established base," which is a user-defined base with infrastructure beyond a bare base. This approach allows a fairly detailed description of the existing base infrastructure without creating a range of base definitions.

A *bare base* is "a site with a usable runway, taxiway, parking areas, and a source of water that can be made potable."[8] The baseline assumption for a bare base is that anything needed for operations must be supplied. As a default, we do not assume that heavy construction is required (e.g., building or runway construction), but if needed, the user can specify this requirement and the appropriate Rapid Engineer Deployable Heavy Operations Repair Squadron (RED HORSE) teams are added to the movement requirements.

We define an *established base,* for the purposes of this tool, as any base with infrastructure beyond that of a bare base. This includes

gence (1N), safety (1S), weather (1W), logistics planners (2G), supply (2S), transportation and vehicle maintenance (2T), historian (3H), public affairs (3N), services (3M), manpower (3U), paralegal (5J), contracting (6C), financial (6F), and special investigations (7S)—the model estimates the total base population expected for the number of aircraft and operations of those aircraft using planning factors, detailed in Chapter Three. A fully implemented model would use planning factors as a seed for the base population, calculate the manpower requirements based on this base population, sum the calculated manpower positions to estimate the base population, and iterate the calculation.

[8] AFPAM 10-219, 1996, Vol. 5, p. 8.

main operating bases, international airports, coalition-country military bases, and so forth. For these cases, the user is able to characterize the additional infrastructure that will be needed to achieve the desired capability. Examples of infrastructure considered by START include whether a new airframe will be introduced to the site, and whether additional billeting, communications, fuels equipment, medical facilities, and force protection are required. If heavy construction is needed, the user can select whether it is horizontal (ramps, runways, etc.) or vertical (buildings, etc.). Chapter Three provides details that assist the user in making these selections.

This range of options should allow the user to tailor the characteristics of a deployed location without having to define a large number of cumbersome base definitions and without being constrained to a limited number of restricted definitions that do not adequately describe the location.

Aircraft

For aircraft input, the user specifies the type of aircraft, their number, the mission (e.g., combat air patrol [CAP]; air-to-ground bombing; suppression of enemy air defenses [SEAD]; transport; refueling; command, control, intelligence, surveillance, and reconnaissance [C2ISR]), whether the aircraft are bedded down or use the site as an en-route base, and the sortie rate (for the strike aircraft). The user can select multiple airframes at the same location. Most aircraft are listed and are grouped as fighters and attack aircraft, Special Operations Forces (SOF) aircraft, bombers, mobility aircraft, and C2ISR assets.

Threat Level

Two threat-level categories are defined with levels within each of them. The first category, which we call the *conventional threat level,* measures the vulnerability of the base to ground attack and is used to determine the level of force protection needed. (It does not include capabilities that are not organic with the Air Force, such as Patriot missile batteries or heavy ground troops.) The second category, which we call *NBC threat level,* is the likelihood of attack by non-conventional weapons. It determines needs in the areas of medical support and engineering readiness.

Methodology and Sources of Data

Knowledge of what materiel is needed at a base to attain IOC given the state of the base, the type and mission of the aircraft, and other parameters exists organically within each functional area of the Air Force. Some functional areas have compiled rules that serve as a template for estimating what manpower and materiel need to be deployed under a range of circumstances. No set of rules, however, exists that embraces more than one functional area, and hence no model exists that compiles a comprehensive list of UTCs needed at a base in order to attain IOC.[9]

When possible, we have taken the rules developed by functional areas and incorporated them directly into the START model. Otherwise, we collected the information necessary to devise these rules. Various sources contributed to this collection effort, the most important of which are

- interviews with functional-area managers and senior noncommissioned officers (NCOs)
- Air Force publications.

We relied primarily on interviews with senior NCOs at Headquarters (HQ) Air Combat Command (ACC) and HQ Air Mobility Command (AMC) in early 2002. These specialists are most familiar with the exact UTCs needed to attain a given capability and are also most familiar with program changes in these commodities. We asked these specialists what considerations drove what they needed to fulfill their various missions, and which specific UTCs they would deploy to achieve a desired capability. We also inquired about any UTC re-

[9] Galway et al., 2002.

engineering foreseen in the near future and any recommendations for changes, including prepositioning of materiel. Their responses not only provided the core of the logic that we implemented to generate the output list of UTCs but also helped refine what the critical inputs of the model should be.

Air Force documents (mostly pamphlets and instructions) supplemented these interviews. In some cases, functional areas have already formalized their requirements as rules (e.g., fuels equipment) and have published them in Air Force documents. In other cases, we used these documents to fill in gaps and ambiguities that arose from the interviews. Finally, in some instances, we used unclassified Mission Capability (MISCAP) statements for guidance. Chapter Three elaborates further on sources for each functional area.

We have not used historical deployment data as a significant input for three reasons. First, for most deployed sites, the nature and quantity of existing infrastructure, manpower, and equipment at the site are poorly documented. Because these resources are needed for operations, yet are not on the TPFDD, the TPFDD underestimates the requirements. Likewise, some materiel is not at the site and also not listed on the TPFDD, because it was readily available locally (for example, leasing of general-purpose vehicles). Second, a large fraction of deployed UTCs are significantly or wholly tailored. Additionally, some are listed in the TPFDD as "**Z99" and, as such, contain insufficient detail for our needs. Third, in historical deployments, the desired operational capability of a site may change with time, making it difficult to correlate a specific capability with materiel on the TPFDD. For example, some materiel sent during Operation Noble Anvil was intended for Operation Papa Bear, although the conflict ended before the latter operation was executed.

CHAPTER THREE

Functional Areas Treated and How They Deploy

This chapter provides a brief overview of each functional area treated by START, highlighting what determines which UTCs are deployed to support a specified mission. As such, this chapter serves two purposes: first, as a primer for how each of the functional areas treated deploys, and second, as a guide to the fidelity of the calculations. For each functional area, we explain what is modeled in START and any UTCs that are omitted from the model. Sources of data for the rules are documented, along with our best assessment of the accuracy of the estimates.

Placing an absolute value on the accuracy of any of the calculations in impracticable. No absolute baseline exists that establishes exactly what is needed to accomplish desired operational effects.[1] Which UTCs are deployed will vary somewhat depending on the judgment of the planner, what level of risks is considered acceptable, and operational priorities. Nevertheless, we can make qualitative assessments of the fidelity of the estimates for each functional area. These assessments take the form of statements of how well established the rules are for the deployment of UTCs in a given functional area and how well the level of inputs to START capture the independent variables of those rules. These qualitative statements give an appraisal of the "robustness" of the estimates in the following sense: how sensitive the list of chosen UTCs would be to factors outside the range of

[1] One of the potential applications of this type of analytical tool is to illuminate the consequences of the current Air Force planning factors, indicating areas that would profit most from footprint reduction efforts. See Galway et al., 2002.

inputs to START and to the vicissitudes of which individual is tasked to make decisions of which UTCs to deploy during contingency operations.

Together, the sections in this chapter provide the user with an introduction to how the Air Force deploys and enough background to understand the limitations as well as the power of this kind of tool. Figure 3.1 summarizes graphically which inputs drive which functional outputs. Further, Figure 3.2 breaks out the subdivisions, if any, of each functional area.

Sortie Generation

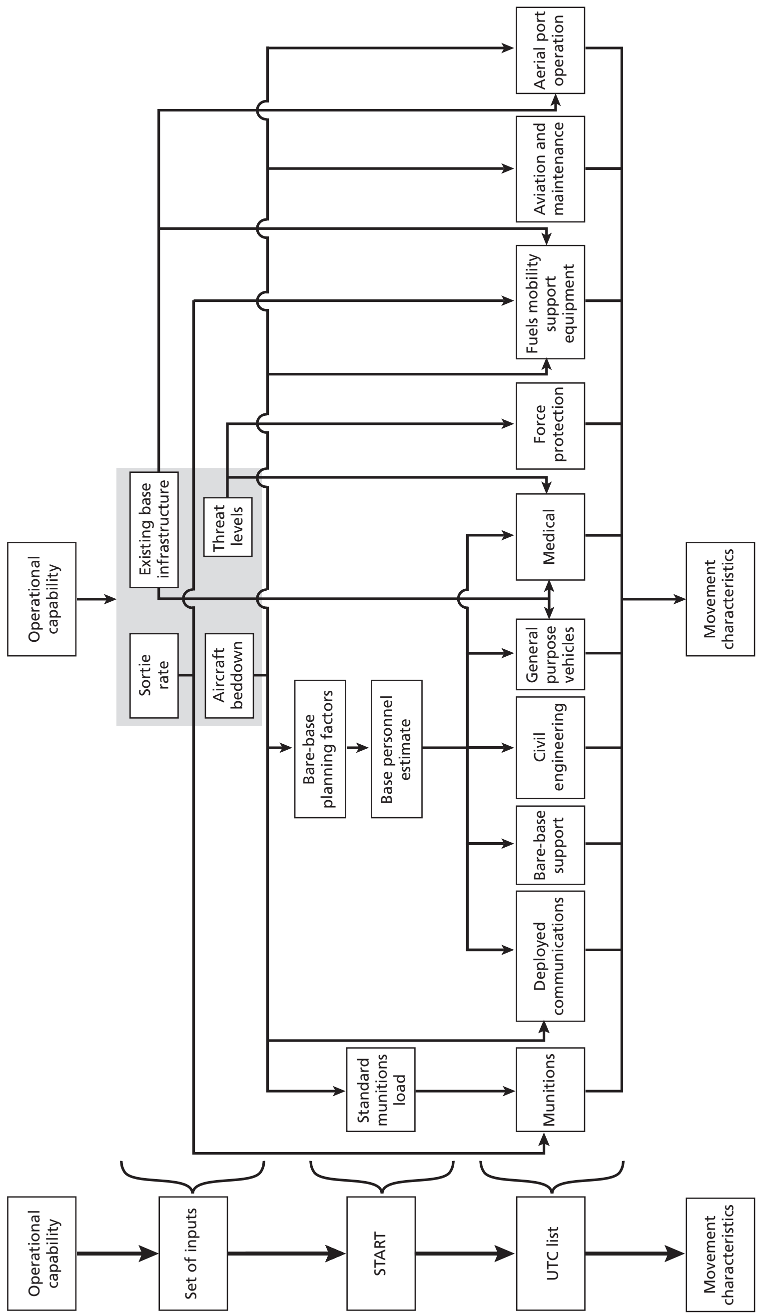
For the purposes of this model, we group together the functional areas that the Air Force deploys directly to support mission generation (as opposed to base operating support [BOS], which indirectly supports operations), and call this group "sortie generation." Sortie generation packages are used to provide a range of services to the warfighter, including, but not limited to, moving aircraft around the flightline, maintaining the aircraft, and loading munitions.

Sortie Generation Functional Areas

We divide sortie generation into the same three categories as the Air Force does: aviation, maintenance, and munitions maintenance. We also include in the discussion in this section the readiness spares packages (RSPs) for the aircraft.

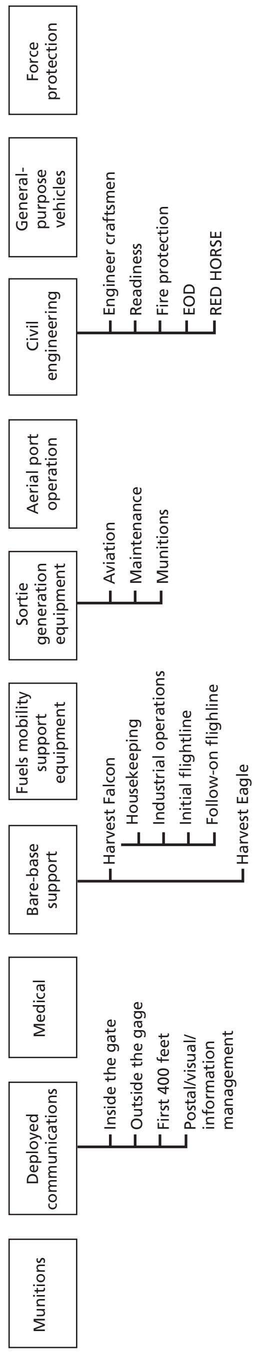
Aviation. Aviation packages roughly correspond to flightline maintenance capability and enable maintainers to move aircraft around the flightline, examine the aircraft, and diagnose and perform a limited number of repairs. These UTCs all begin with 3****. Materiel includes tow vehicles, trailers, maintenance stands, tools, power generators, air conditioners, heaters, and spare parts kits. The principal manpower requirements are aircrew, maintainers, logisticians, and supply specialists. Approximately 280 UTCs (of which we use 65) cover these capabilities. In developing the rules used in this tool, we

Figure 3.1
Relationships of Model Inputs to Functional Outputs



RAND *MG176-3.1*

Figure 3.2
Functional Area Subdivisions



RAND *MG176-3.2*

have consulted unclassified MISCAP statements and a number of functional area managers (FAMs) at ACC and AMC.[2]

Two factors, aircraft mission design series (MDS) and number, determine which of these UTCs are deployed. Simply put, if an aircraft deploys, so do its aviation UTC(s). In reality, numbers of aircraft different from those found in UTCs are deployed, but the model limits the user's choices of aircraft quantities to those found in the corresponding aviation UTCs (or sums of those quantities).

Most aviation UTCs are quite heavy, generally between 100 and 300 short tons each. While fighter UTCs tend to be the heaviest, they usually have equipment for 18 or 24 aircraft versus those for heavy aircraft, which usually have equipment for fewer than ten aircraft. By weight per aircraft, then, C2ISR (e.g., E-3 Airborne Warning and Control System [AWACS]) aviation UTCs outweigh those of smaller airframes.[3]

C-5s and C-17s have no aviation UTCs. Equipment used to turn and repair these aircraft is found in their maintenance UTCs.

Maintenance. Maintenance UTCs, for most aircraft, contain intermediate-level maintenance (ILM) capabilities (e.g., avionics, jet engine intermediate maintenance [JEIM]). These UTCs give maintainers a "backshop" capability where they can disassemble components and perform more-intensive diagnosis and repair than with aviation UTCs. Materiel includes maintenance stands, trailers, and testing equipment. Manpower requirements include maintainers, logisticians, and supply specialists. Approximately 300 UTCs cover these capabilities (60 of which are included in START), all beginning with the prefix HE*** or HF***. Unclassified aviation UTC MISCAP statements specify which maintenance UTCs should deploy

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[2] Interviews at the headquarters of ACC (Langley AFB) on January 27, 2002, and June 10, 2002, and at the headquarters of AMC (Scott AFB) on January 8, 2002.

[3] Fighter UTCs average about ten short tons per aircraft, and C2ISR UTCs average about 50 short tons per aircraft. Small C2ISR aircraft, such as unmanned aerial vehicles (UAVs) or U-2 are exceptions to this rule.

with particular aviation UTCs and when they should deploy.[4] We have followed those rules as closely as possible. This logic was confirmed by interviews with senior NCOs and FAMs.[5]

In START, three factors (aircraft MDS, number of aircraft, and operating capability [i.e., full versus initial]) govern which of these UTCs are deployed. Generally, if IOC is selected, no maintenance capability is added to aviation packages. If FOC is chosen, most corresponding maintenance UTCs are deployed. Many MDS have multiple maintenance UTCs. For example, a squadron of 18 F-16CGs would require only one aviation UTC (3FKM3) but several maintenance UTCs (basic ILM [HFAGC], JEIM [HFAM4], and Munitions Maintenance Squadron [MMS] [HGHAD]).

Mobility aircraft follow a different logic. Because these aircraft may use a base as either an en-route location (to deliver cargo or to refuel) or a beddown location, different factors drive UTC selection. If the base will be en-route for a type of aircraft, the base MOG will drive the number of aircraft supported (maintenance equipment in proportion to the MOG is deployed for each aircraft selected to use the base for en-route support). Therefore, if C-17s will flow through the base, and the MOG is 4, then the UTC for a MOG of four C-17s will deploy. If a base will be a beddown location for a type of aircraft (potentially any mobility aircraft except the C-5), the number of aircraft selected and whether FOC is chosen will drive the deployment of maintenance UTCs (except for C-17s, which only have UTCs designed for increments of MOG).[6] Because C-5 and C-17 UTCs are designed around MOG rather than total number of aircraft, there are no drop-down menus in START for selecting the number of C-5s and C-17s.

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[4] Some aviation UTCs require a corresponding maintenance UTC to be fully operational (e.g., KC-10), and some require them only if operations exceed 30 days.

[5] Interviews at HQ ACC (Langley AFB) on January 27, 2002, and June 10, 2002, and at HQ AMC (Scott AFB) on January 8, 2002.

[6] Although the C-17 was designed with many tactical capabilities, its deployment concept, like that of the C-5, was as a strategic lifter. UTCs are therefore designed to support working MOG in relatively small numbers, rather than bedding down in large numbers (like the KC-135).

Because they constitute a small fraction of the materiel, and are driven by factors beyond the scope of the inputs to START, we excluded four types of equipment that fall into the maintenance series of UTCs: battle damage repair (BDR), surveillance and reconnaissance equipment, war reserve materiel (WRM), and fuel tanks.

Although maintenance UTCs are being redesigned, some are currently not available in increments as small as the aviation UTCs. For example, there are aviation UTCs for F-16CJs in increments of six (i.e., for 6, 12, 18, and 24 aircraft), but maintenance UTCs for only 18- or 24-ship packages. We have matched maintenance UTC quantities as closely as possible to user-selected quantities. Requirements will therefore be overstated in at least two instances: when the smallest available maintenance UTC is designed for a larger number of aircraft than the user-selected quantity and when there are no appropriate dependent maintenance UTCs available.

Munitions Maintenance Squadron. Approximately 100 UTCs (we use 15) cover the Munitions Maintenance Squadron capabilities, all of which start with the prefix HG*** or HH***. These UTCs are used to store, retrieve, assemble, and transport munitions for loading onto aircraft. Materiel includes generators, lights, trailers, bomblifts, forklifts, and bobtails. Manpower requirements largely fall within munitions systems maintainers and supply specialists. Unclassified aviation UTC MISCAP statements specify which MMS UTCs should deploy with particular aviation UTCs. We have followed those rules as closely as possible. This logic was confirmed by interviews with senior NCOs and FAMs.[7]

Aviation and Maintenance Readiness Spares Packages

RSPs are a fourth class of equipment that contain aircraft spare parts. This equipment is sometimes found in aviation UTCs (e.g., fighters), in maintenance UTCs (e.g., C-5, C-17), or in separate UTCs altogether (e.g., KC-135). There are 26 UTCs that cover these capabilities, all beginning with the prefix JFA**. We include three of these

[7] Interviews at the headquarters of ACC (Langley AFB) on January 27, 2002, and June 10, 2002, and at the headquarters of AMC (Scott AFB) on January 8, 2002.

UTCs: JFAFS for C-17s and JFAKN and JFAKP for KC-135s. Note that KC-10s have no RSP UTCs because their supply is wholly supported by their commercial contractor.

Sortie Generation Summary

Four classes of aircraft are modeled in START—strike aircraft (fighters, bombers, and attack), C2ISR, mobility (transport and refueling), and SOF (fixed-wing and helicopters). When an MDS has more than one model (i.e., AC-130 U versus the older H model), the most recent model has been used. Of the Air Force aircraft in the current inventory that deploy in any numbers, the only airframe excluded is the C-141. We omit this airframe because it is being phased out of the inventory. Some other excluded airframes can be approximated by using their analog airframe (e.g., using the A-10 to approximate the OA-10A equipment requirements). Also, no Single Integrated Operational Plan (SIOP) aircraft were included, because they do not typically deploy in any numbers in support of conventional operations. Few UTCs specific to the Air National Guard (ANG) or Air Force Reserve (AFRES) are used in the model.[8] ACC and AMC UTCs generally have enough flexibility to capture the movement characteristics, regardless of which command provides the aircraft. When ANG or AFRES UTCs are used by START, it is done to give the user more flexibility in choosing aircraft quantities and then only for those in which both major commands (MAJCOMs) use identical aircraft.

The model's input choices for quantity of aircraft at a base are limited to the quantities (or sums of quantities) specified in the UTCs. For example, the B-1B has UTCs for three- and six-ship packages. Therefore, the model offers choices such as 3, 6, and 9, but not 8 or 10. All selections should be as accurate as the UTCs themselves, with one exception: Not all MDS have independent and dependent UTCs.

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[8] The ANG and AFRES have UTCs that differ from those of the active forces for two reasons. First, they often fly different models or blocks of aircraft. Second, they generally have different squadron sizes (i.e., ACC has squadrons of 18, while ANG has squadrons of 15).

Independent UTCs are lead UTCs that provide all the capability necessary to support the aircraft in question. *Dependent UTCs* are follow-on UTCs that are deployed to augment the number of aircraft of an MDS already deployed. Because a dependent UTC requires an initial deployment of the corresponding independent UTC, the former excludes some equipment that is in the latter, and is consequently lighter. When a larger-than-squadron-size deployment is selected for an MDS with no dependent aviation UTCs, the model will consequently overestimate the deployment requirements, sometimes significantly.

Aerial Port Operations

Aerial port operations (APO) packages are used to load and unload cargo from aircraft, and to move cargo around a base. About 40 UTCs cover these capabilities, all of which start with the prefix UFB**. Most are for individual apparatus, such as lights, water and latrine trucks, and materiel handling equipment (MHE), such as forklifts and loaders. Most manpower requirements are transporters, but a few fall within supply or information management. Our data for the number of UTCs deployed derive from interviews[9] and from an internal, unpublished Air Force document.[10]

APO support in START is always included for a bare base. (We assume that adequate APO equipment will be present at an established base.) Some basic equipment is required to support aerial port operations at a bare base regardless of cargo flow (e.g., lights, special-purpose trucks). MHE and manpower requirements, however, are driven by MOG. Note that some pieces of aerial port equipment

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[9] Interviews with Lt Col Ascersion and Capt Shigeta of the 60 APS on December 12, 2001, and with Major Brian Fletcher (AMC/LGTR) via telephone on October 30, 2002.

[10] The title of the document is "Methodology and Procedures for Aerial Port Deliberate Planning, AMC/DOZX." This unpublished document describes six different types of MOG for calculating Aerial Port Operations (APO) equipment and manpower requirements and has extended descriptions of each. In this document, our working MOG is referred to as MHE MOG or 90 percent MAX MOG.

are already captured in the general-purpose vehicles section of the model and are therefore not included here.

Civil Engineering

Civil engineers provide a range of services in support of the warfighter, including, but not limited to setting up bare-base support sets, operating and maintaining base facilities, and providing protection and recovery operations (e.g., rapid runway repair). Approximately 70 UTCs cover these capabilities, all of which start with the prefix 4F9**. We group these support functions into five areas: engineer craftsmen, readiness, fire protection, EOD, and RED HORSE teams.

Engineer Craftsmen

These Prime BEEF (Base Engineer Emergency Force) teams set up bare-base support sets (Harvest Falcon and Harvest Eagle) and provide operational maintenance and repair of base facilities. These UTCs all begin with the prefix 4F9E* and consist largely of manpower, with some equipment. Which and how many UTCs are needed are governed by the number of base personnel to be supported. We have adopted the general rules compiled by the functional area managers at AMC and ACC for deployment of these UTCs.[11]

Readiness

Readiness teams are civil engineering teams that respond to NBC incidents and perform recovery operations. Services include risk assessment, detection, and decontamination. All readiness UTCs start with the prefix 4F9D* and include manpower, special equipment, and some rolling stock. Which and how many UTCs are deployed are

[11] Our data for the number of UTCs deployed were provided by the staff of Maj Chris Darling (HQ AMC/CEXR) on January 27, 2002, in response to questions posed during an interview at HQ AMC (Scott AFB) on January 8, 2002. The data were confirmed by interviews at HQ ACC (Langley AFB) on May 8, 2002.

dictated by the NBC threat level (designated as low, medium, or high). We have adopted the general rules compiled by the functional area managers at AMC and ACC for deployment of these UTCs.[12]

Fire Protection

These teams provide fire protection for both aircraft and structural fires throughout the base. All fire protection UTCs start with the prefix 4F9F* and include crash and rescue trucks, water carriers, and the manpower and supporting equipment to fight fires and rescue people. Pumpers to fight structural fires (e.g., a P-24 truck) are no longer maintained as a UTC.[13] Pumpers are deployed as a "**Z99" UTC when needed. Manpower and equipment needs are driven by the number of crash and rescue trucks needed, which is driven by the size of the largest airframe bedded down at the base. Five National Fire Protection Association airport categories (called Categories 4, 7, 8, 9, and 10) determine the minimum water flow rate required (measured in gallons per minute), which is fulfilled by five Air Force vehicle sets (numbered 1 through 5). Various combinations of two fire trucks—the P-19 (4F9FG) and the P-23 (4F9FC)—can satisfy these requirements. We have selected the most economical in terms of numbers.[14] The manpower and equipment needs listed by the model reflect the minimum capability needed to meet fire protection requirements. These UTC numbers reflect what would be needed for initial operating capability; a fully operational base would normally possess greater manning and equipment levels at the discretion of the leadership.

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[12] Our data for the number of UTCs deployed were provided by the staff of Maj Chris Darling (HQ AMC/CEXR) on January 27, 2002, in response to questions posed at an interview at HQ AMC (Scott AFB) on January 8, 2002. The data were confirmed by interviews at HQ ACC (Langley AFB) on8 May 8, 2002.

[13] Personal communication with CMSgt Carl Hodges (AMC/CEXF) on May 29, 2002.

[14] Interviews with SMSgt Timothy Seigal (HQ ACC/CEXF) on May 8, 2002, and CMSgt Hodges (AMC/CEXF) on January 8, 2002; "Air Combat Command Fire Protection Risk Management Guide," unpublished document dated February 2001; AFPAM 32-2004, 1999; and Air Mobility Command Instruction (AMCI) 11-208, 2000, Chapter 10.

Explosive Ordnance Disposal

Explosive ordnance disposal teams are Prime BEEF teams that provide base clearance operations and that respond to munitions accidents, and situations involving terrorist explosive devices, unexploded ordnance, and weapons of mass destruction. These teams also occasionally work beyond the base perimeter in providing mobile armored reconnaissance and securing classified materials at aircraft crash sites. All EOD UTCs start with the prefix 4F9X* and include manpower, special armored high-mobility multi-purpose wheeled vehicles (HMMWVs), a special EOD tank (4F9X7), trailers, and robotic equipment. Which and how many UTCs are deployed are dictated by the threat level (designated as low, medium, or high) and whether the base is a beddown location or en-route location. The general concept always is to deploy an EOD Prime BEEF lead team (4F9X1) consisting of six persons, two special HMMWVs, and one trailer. Follow-on teams and equipment are subsequently deployed according to the base type and threat level.[15]

Rapid Engineer Deployable Heavy Operations Repair Squadron

RED HORSE teams perform heavy construction and are deployed only when large facilities need to be built. Examples of situations requiring RED HORSE support are the construction of a building, runways, or ramp space, quarrying, and so forth. There are four RED HORSE team UTCs (4F9R1 through 4F9R4), and six supporting equipment UTCs (4F9H1 through 4F9H6). RED HORSE teams are of four types: the R-1 advanced echelon (ADVON) team (always deployed when any RED HORSE team is deployed); the R-2 team, balanced in horizontal (airfields) and vertical (buildings) construction; the R-3 team for heavy horizontal construction; and the R-4 team for heavy vertical construction. These teams require a considerable amount of equipment, which may be supplemented by the

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[15] Our data for the number of UTCs deployed were provided by the staff of Maj Chris Darling (HQ AMC/CEXR) on January 27, 2002, in response to questions posed at an interview at HQ AMC (Scott AFB) on 8 January 8, 2002. The data were confirmed by interviews at HQ ACC (Langley AFB) on May 8, 2002.

4F9H1 heavy vehicles package (62-plus short tons of which are not air transportable). Other equipment packages are for specialized needs, such as quarrying and drilling. Because they are for such specific needs and not frequently deployed, they are excluded from our model.[16]

The rules for which and how many civil engineering UTCs to deploy have been well established in advance. These results should be fairly robust, especially for bare-base deployments. The results may somewhat overestimate civil engineering support at established bases if much of the requisite manpower and equipment is already in place.

Bare-Base Support

Two support sets, Harvest Falcon and Harvest Eagle, provide most of the bare-base support needs of the Air Force.[17] Harvest Falcon is designed primarily for U.S. Central Command Air Forces (CENTAF) bare bases, whereas Harvest Eagle is designed primarily for deployment to United States Pacific Air Forces (PACAF) and United States Air Forces in Europe (USAFE), but both sets can be used nearly anywhere. For the purposes of this model, the sets differ in two significant capabilities: size and scope. Harvest Eagle supports up to 550 persons and lacks support beyond billeting, kitchen, and hygiene facilities, whereas Harvest Falcon supports up to 1,100 persons and, in addition to billeting, kitchen, and hygiene facilities, also includes industrial operations and flightline support. The sets, their components, and when and how many are deployed are outlined next.

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[16] Our deployment data for RED HORSE are based on an interview with CMSgt L. Ford (HQ ACC/CEXO) on May 8, 2002.

[17] Harvest Falcon and Harvest Eagle are being replaced over the next few years by newer kits called Base Expeditionary Airfield Resources (BEAR). Because START was created before these developments, the model uses the legacy Harvest Eagle and Falcon kits. The total lift will probably not be very different, although the newer BEAR equipment will be sized in accordance with Force Modules.

Harvest Falcon

Harvest Falcon consists of four sets, each with its own UTC:[18] the housekeeping set (XFBKA), the industrial operations set (XFBRB), the initial flightline set (XFBS1), and the follow-on flightline set (XFBS2). We describe each separately.

The housekeeping set provides billeting, kitchen, and personal hygiene services for up to 1,100 persons. The set contains tents, bedding, water distribution systems, environmental control units (ECUs), maintenance RSPs, generators, and a mortuary. The complete set is large, weighing more than 586 short tons and occupying approximately 256 463-L pallet positions.[19]

The industrial operations set provides utility and shop facilities for base support groups. It includes shelters, additional power generators, AM-2 matting, maintenance RSPs, and other maintenance and support equipment. This set weighs more than 713 short tons and occupies approximately 238 463-L pallet positions.

The initial flightline set is one of the largest UTCs in the MEFPAK. The set provides full flightline support for an 18–primary aircraft authorized (PAA) squadron of aircraft. It includes shelters, airfield lighting equipment, aircraft arresting systems, revetments, AM-2 matting, two hangars, and various shop support. The total set weighs 1,732 short tons and occupies approximately 435 463-L pallet positions.

The follow-on flightline set augments the initial flightline set for an additional squadron of aircraft. It contains additional shelters, spares, and AM-2 matting. This set is comparatively light, weighing just over 129 short tons and occupying approximately 51 463-L pallet positions.

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[18] Departing from the norm in other functional areas, these four UTCs are themselves made up of other UTCs. This modularity allows us, to some degree, to tailor the packages.

[19] Estimates for the number of pallet positions for the Harvest Falcon sets are from an interview with Maj Dennis Long (CENTAF/A4-LGX) on August 13, 2002, at Shaw AFB, and from data assembled by DynCorp, which maintains most of the Harvest Falcon assets for CENTAF. These weight and pallet estimates generally exceed ACC/LGX (49th Materiel Maintenance Group) estimates by 5–15 percent, depending on the UTC. We used the CENTAF figures because most of the sets are in CENTAF.

None of the Harvest Falcon sets contain organic capability for their own erection and maintenance. These functions are provided by Prime BEEF or RED HORSE teams, as discussed in the "Civil Engineering" section above.

Harvest Eagle

The nucleus of the Harvest Eagle set is UTC XFBR3, which supplies billeting and kitchen facilities to support up to 550 persons. Included in this set are tents, power generators, a water distribution system, maintenance RSPs, a few vehicles, and numerous other items, including morgue facilities and chaplain support. The UTC does not include an organic capability for the set to be erected. Erection requires Prime BEEF (or RED HORSE) support, described in the "Civil Engineering" section above. This housekeeping set is often supplemented by a utility set (XFFLU) that includes power generators, maintenance RSPs, and ECUs. The combination of two Harvest Eagle housekeeping (XFBR3) and two utility sets (XFFLU) has capability approximately equal to one Harvest Falcon housekeeping set (HFBKA).[20]

Deployment of Bare-Base Support Sets

Deployment of bare-base assets is driven largely by the base population, which, in turn, is driven by the number of bedded down aircraft and whether these aircraft are fighters or larger airframes. We follow the rules established for bare-base planning.[21] Approximately 1,100 persons are needed for each 18-PAA squadron of fighters or 12 larger aircraft. Likewise, if six to nine fighters are deployed, or three to six larger aircraft, the base population will be approximately 550 persons.[22]

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[20] Air Force Handbook (AFH) 10-222, 1996b, p. 6.

[21] AFPAM 10-219, 1996, Vol. 5, p. 34.

[22] See AFPAM 10-219, Vol. 5, 1996.

The algorithm for the type and number of bare-base UTCs follows the logic of the bare-base planning guide.[23] To satisfy housekeeping needs, we assign one Harvest Falcon housekeeping set for each 1,100-person group that needs billeting and one Harvest Eagle set for any remainder. For example, if the base population is 550 or fewer persons, we assign one each of the Harvest Eagle housekeeping and utility sets. If the population is 1,650, we assign one Harvest Eagle housekeeping and utility set and one Harvest Falcon housekeeping set.

While in practice it is not likely that Harvest Eagle and Harvest Falcon assets would be commonly mixed like this (because of how they are currently authorized to theaters), they can function together, and hence, this mix is a reasonable approximation of how these sets would be tailored in such a case. In a real deployment, if Harvest Falcon assets were deployed, the requirements for populations that were not multiples of 1,100 would be met by heavily tailoring a housekeeping set. Our approach of mixing the Falcon and Eagle sets simulates this tailoring and captures the materiel movement requirements fairly accurately.

For industrial operations and flightline needs, we distinguish between bare bases and any other deployed location. For a bare base, the model always sends one industrial operations and one initial flightline set if the population exceeds 550, and one-half of a set otherwise. The model adds one-half of a follow-on flightline set for each 550-person increment above 1,100 persons. The tool tailors one of the heavy components of the initial flightline set, the aircraft revetments, according to how many aircraft are deployed and the threat level.

The accuracy of the model for calculating the required bare-base support equipment should be robust for any deployment to a bare base. The model should also be fairly accurate in calculating the materiel needed to supply supplemental billeting when deploying to an established base. Its only weakness will be in estimating industrial op-

[23] AFPAM 10-219, 1996, Vol. 5, p. 169.

erations and flightline support to an established base. Whether or not a deployed site requires industrial operations or flightline support will depend on the particular circumstances of that base. We have estimated that, on average, industrial operations support will not be needed at an established base, and flightline support will be needed only if a new airframe is deployed, and these needs will be fulfilled by roughly the materiel in a Harvest Falcon follow-on flightline set.

Munitions

Munitions are the only consumables calculated by the model. We include munitions because they must be present before operations begin, they are quite heavy, and unlike food and fuel, they cannot be acquired locally. Consequently, they can potentially consume considerable lift. The purpose of the munitions calculation is to estimate movement characteristics by estimating roughly how many munitions should be in place for three days of operations, not to calculate which munitions are needed, as the latter depends on the nature of the targets. The model estimates the weight of bombs and missiles needed to support the specified aircraft, their missions, and their sortie rates. Chaff, flare, and ammunition are not included.

For each aircraft, we assign a munition typical for that aircraft and mission during the initial stages of an engagement. The number of each bomb or missile carried per sortie is listed in Table 3.1.

The model estimates bomb and missile requirements differently. We assume that enough bombs must be in place to allow each aircraft to drop its entire bomb load on every sortie for a specified period (three days is the default). For missiles, we assume that enough missiles must be in place to arm every aircraft with its full missile load, plus enough to cover a given missile expenditure rate for the same period. These figures are not meant to be estimates of actual expenditure rates of bombs and missiles, or indicators of which munitions will be used, but an estimate of the movement characteristics for the

Table 3.1
Bomb and Missile Loadings Used in START for Movement Calculations

Aircraft	Mission	GBU-10	GBU-31	AIM-9	AIM-120	AGM-65	AGM-86C	AGM-88
F-15C	CAP	0	0	4	4	0	0	0
F-15E	Air-to-ground (AG) bombing	3[a]	0	2	2	0	0	0
F-16CG	AG bombing	2	0	2	2	0	0	0
F-16CJ	SEAD	0	0	2	2	0	0	2
F-22	CAP	0	0	2	6	0	0	0
F-22	AG bombing	0	2	2	2	0	0	0
F-117A	AG bombing	0	2	0	0	0	0	0
A-10	Close air support (CAS)	0	0	2	0	4	0	0
B-1B	AG bombing	0	24	0	0	0	0	0
B-2	AG bombing	0	16	0	0	0	0	0
B-52	AG bombing	0	12	0	0	0	8	0

NOTE: GBU = guided bomb unit; AIM = air intercept missile; AGM = air-to-ground missile.
[a] The F-15E can carry more than three bombs, depending on fuel tank configurations and mission requirements. These figures are PACAF Configuration 611. See PACAF Instruction 21-202, 1997, Attachment 1.

munitions that should be on hand to support operations for a specified number of days.

Fuels Mobility Support

All Continental United States (CONUS) and some outside the Continental United States (OCONUS) air bases have permanent storage and hydrant systems for dispensing fuel to aircraft. When aircraft deploy to a base that either does not have this capability or where U.S. forces are denied access to such facilities, equipment that replicates this capability must be deployed. Such equipment is called fuels mobility support equipment. FMSE and its requisite manpower supply all the necessary capability to store, filter, and dispense fuel at an air base. Materiel includes storage bladders, filters, trucks, hoses, and pumps. There are 61 fuels UTCs, all of which start with JF***. Also, each piece of equipment has its own UTC, so no paring or tailoring is done within UTCs. Our data for the number of UTCs deployed derive from an unpublished Air Force fuels manpower planning document[24] and a FMSE calculating computer program[25] developed by the Air Force Petroleum Office (AFPET). We use only the manpower and equipment UTCs prescribed by these two sources.[26]

The fuels manpower UTCs from the planning document are fairly straightforward. The requirements key off of numbers of various kinds of aircraft—fighters, bombers, KC-10, etc. (For the sake of brevity, we consider only fighter aircraft in the following discussion; the model handles all types.) The three kinds of manpower UTCs are managers, "building blocks," and bare-base-only UTCs. For each base, one nine-level manager deploys. Three seven-level managers (JFA7S or JFA7M) deploy for 6-PAA of fighters. Roughly, an additional seven-level manager deploys for each additional 6-PAA of fighter aircraft, up to 24-PAA.[27] Finally, two "building block" UTCs (either JFABA or JFABB) deploy for each 6-PAA of fighter aircraft, and one to each base of JFAFT (FMSE setup) and JFASA (fuels lab).

For FMSE, UTCs are broken up into three main categories: trucks, stationary fueling systems, and other storage. A fuels squadron can support different requirements using only trucks or no trucks and only stationary systems (also called "pits"). If a host nation allows it,

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[24] The unpublished document, "FMSE Personnel Sourcing Methodology," ACC/LGSIF, was received from MSgt Tony W. Parris on December 16, 2002. The methodology was developed and approved by all MAJCOMs and is updated with Air Staff functionals annually.

[25] All of the equipment inputs and logic were taken directly from an Excel-based program called the "FMSE Calculator" developed by AFPET at Ft. Belvoir, Virginia. The model's uses, limitations, and logic were explained to us in an interview with SMSgt Shawn Simon (AFPET). Permission to incorporate it into START was granted by AF/ILGP. The FMSE calculator is in broad use by the MAJCOMs for detailed FMSE deployment planning.

[26] The exceptions to this rule are JFXX1 and JFXX2, two composite FMSE UTCs proposed by the creators of the FMSE Calculator but not yet in any MEFPAK. To closely match the movement characteristics of these two UTCs, we applied the requirements to their component UTCs, which were in the MEFPAK. Details on these components can be found in the FMSE Calculator.

[27] Current fuels planning factors do not extend beyond 24-PAA fighters. Exact requirements for additional aircraft are difficult to resolve without specifying more details about the base, flying operations, and other such factors.

the fuels personnel can set up bladder storage relatively near the flightline and pump fuel directly into the aircraft. They create "hot pits" for fighters and "cold pits" for heavy aircraft. These pits consist principally of pumps, bladders, and hoses to reach the flightline. The pits can create many offload points and refuel almost constantly. This gives fuels teams the ability to turn many sorties very efficiently, for either small or large aircraft. If they use only trucks, they must fill the pipeline of trucks (which can be large if it is a long way from the flightline to storage) and orchestrate the movement of the trucks back and forth (plus additional manpower). To meet a demanding sortie rate, many trucks might be required. In actuality, fuels personnel usually use a combination of trucks and stationary fueling systems.

START uses the same logic as the FMSE Calculator and calculates the full requirements for both trucks[28] and refueling pits.[29, 30] The user may choose to calculate either one or both of these requirements. Or, the user may adjust the fuels inputs if more information is known about the required capability.

Other storage consists of bladders for bladder farms (often located some distance from the flightline) and smaller receptacles for non–jet fuel liquids—diesel and unleaded fuel, liquid oxygen (LOX), and liquid nitrogen (LIN). Inputs for each of these commodities are

[28] The truck (R-11) calculation is from standard Air Force factors for calculating R-11 requirements. These factors do not consider distances from storage to the flightline or travel times, but only gross fuel requirements. AFPET personnel said that the actual R-11 requirement would be much lower than what the model suggests.

[29] START initially assumes one "hot pit" per nine fighter aircraft and one "cold pit" per five heavy aircraft. These numbers are based on the averages currently in unclassified MISCAP statements and in AFPAM 23-221 (1998b). The user may adjust these inputs to suit the actual requirements if more information is available.

[30] To calculate fuel consumption, we make three assumptions: All sorties planned will be launched; all sorties launched will be completed; and an aircraft will return with 20 percent of its fuel capacity after each sortie. Therefore, the daily consumption for a given aircraft MDS is (Daily sorties) × (Fuel storage capacity) × 0.8.

This MDS total is then summed for all MDS. For strike aircraft, the daily sorties equal the product of the number of aircraft and the sortie rate. For cargo aircraft, we use the total number of sorties input by the user. For C2ISR aircraft, given their capacity and mission, we assume one sortie per day will be launched.

available to the user by clicking on the "Fuels" tab on the Input dialog box in START.

Note that START focuses on equipment, not consumables. Hence, fuel and its additives are excluded from START. In terms of equipment, we have excluded three fuels-related UTCs: cryogenics production (JFDJC),[31] pipeline (JFDEE), and air bulk fuel delivery system (JFDEW). These were not included in the FMSE Calculator and are deployed only in extraordinary cases.

Deployed Communications

Deployed communications packages enable on-base personnel to communicate with other on-base personnel, aircraft operating from the base, and other bases (e.g., headquarters) located in theater or CONUS. Approximately 250 UTCs cover these capabilities, all of which start with the prefix 6K***. Our rules derive principally from an interview with an Air Force contractor.[32] Following the same communications divisions that the Air Force uses, we group deployed communications into four categories:

- **Inside the gate.** These packages form the backbone of the on-base communications infrastructure. These UTCs all begin with 6KTE*.[33] UTCs in this group are the initial hub (6KTEA), a network control center (6KTEB), augmentation nodes (6KTEC), radio systems (6KTED), large capability expansion (6KTEE), and an augmentation/sustainment package (6KTEF). The initial hub always deploys, and new nodes are added to ac-

[31] Cryogenics are rarely generated at a forward operating location (FOL), but are rather transported to FOLs on a regular schedule.

[32] Our data for the number of UTCs deployed were provided by Robert Potter (ACC/SCCO) in an interview on May 8, 2002, and subsequent personal communications.

[33] New UTCs were created for inside-the-gate capability during the course of this study but await Air Staff approval. Unlike the UTCs they replace, they will be common to both ACC and AMC. We use the new UTCs in our model in anticipation of their being approved. Robert Potter (ACC/SCCO) provided the MEFPAK entries for these UTCs.

commodate additional personnel (in increments of 400 persons).[34] Manpower in these UTCs and most communications UTCs include an assortment of communications and computer technicians.

- **Outside the gate.** Using these packages, personnel can communicate with "home base" or theater bases—basically they can communicate a long distance from the deployed location. Materiel includes satellite communications such as a Lightweight Multi-Band Satellite Terminal (LMST) and Satellite Communications (SATCOM) link. Deployed forces can sometimes connect to the already existing communications infrastructure of a host nation, reducing or eliminating the need for outside-the-gate equipment.
- **First 400 feet.** Previously called "last 400 feet," these packages are used to connect on-base end users to the network so that they can communicate with the base's deployed aircraft, a command center, or other on-base personnel. These packages include everything from a simple laptop connection for electronic mail to complete air traffic control capability.
- **Postal/visual information/information management.** Several manpower UTCs supply information and communications services not directly related to combat capability. Postal services consist mainly of two UTCs (6KDB2 and 6KDB4), one each per 1,000 base personnel. Visual information services are supplied by 6KPVS (one per base), which can process and transmit still or video images. Information management (6KAAC and 6KAAE) provides services such as management of official communications, document security, records maintenance, and publications and forms management and distribution. These deploy one per base.

Most communications UTCs are relatively light (the entire inside-the-gate capability required to support a single fighter squadron

[34] Technically, base topography also plays a role in how much inside-the-gate equipment is needed. Because the UTCs are based on 400-person increments, START uses this logic.

would weigh about 30 short tons). The TPN-19 (6KBV1) provides sequencing and separation of aircraft, and also provides precision guidance from approach through touchdown in all weather conditions. Another heavy UTC is AN/MSN-7 (6KBS2), which provides a mobile control tower for controlling traffic in the vicinity of the field and on the ground. These UTCs weigh 63.2 and 21.6 short tons, respectively, and both are required if indigenous capabilities are not available at the deployed base.

While a handful of basic communications UTCs is needed in all circumstances to establish communications on and off base, further details of what needs to be deployed in this functional area can be complicated. We have included all basic communications UTCs that would deploy to most operating locations, but we have excluded some more-specialized UTCs that might be deployed given more-detailed input data than the model allows.

Force Protection

Force protection UTCs provide air-base ground defense, base perimeter security, law enforcement, and counterterrorism services.[35] These UTCs all begin with the prefix QFE**. Materiel includes armored vehicles, weapons, dogs, and equipment to support these assets. The *Security Police Deployment Planning Handbook* details the capabilities of these UTCs and typical circumstances of their deployment.[36] In developing the rules used in this tool, we have followed the deployment concepts in this handbook, except for modifying the vehicle requirements following interviews at AMC and ACC.[37]

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[35] Ground-based air defense (e.g., Patriot missile batteries) are not included, as the Air Force has no such organic capability.

[36] AFH 31-305, 1994.

[37] Interview with Don Gariglietti (Chief Plans/AMC Security Forces) on January 9, 2002, at Scott AFB. Interview with CMSgt James Johnston (ACC/SFXC) on May 8, 2002 at Langley AFB.

Two threat levels, low and high, determine which and how many assets are deployed. However, many of the factors that drive force protection needs are at a level of detail not resolved by the inputs to START. For example, specific topographic features of a deployed location may require or obviate the need for certain defenses. Or, if some base assets must be located outside the base perimeter, such as a communications antenna, this isolation of base assets greatly increases the needs of force protection. If joint operations are conducted outside of the base, other branches of the military may supply some of the force protection. Host nation support may also decrease some force protection needs. And, the level of risk acceptable to the combatant commander will determine the level of force protection deployed.

In real deployments, some component of the base defense is often provided by the host nation or by joint forces. The estimates here assume no such support. Nor do the planning factors in the handbook include deployments to international airports and other sites requiring little force protection. Considering all these influences, we expect that the estimates for force protection needs given by this model are an upper bound for actual deployments.

Medical

Medical teams at FOLs perform three main functions: inspect a base for potential health hazards (diseases and NBC threats), prepare the base for safe living, and treat injuries and illnesses (from routine examinations to surgery). Materiel includes NBC detection equipment, controlled environment test equipment, shelters, hospital beds, and assorted medical supplies. Manpower needs include generally or specifically trained doctors, nurses, and technicians. Approximately 100 UTCs cover these capabilities, all of which start with the prefix FF***. Two factors determine the medical support needed at a base:[38]

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[38] Rules were derived from electronic mail correspondence with Maj John Klein (CENTAF/AF-SG) on April 12, 2002, interviews with Maj Kelli Thomas and TSgt Randy

the population at risk (PAR) and the presence of an NBC threat. PAR drives basic treatment equipment needs: beds, shelters, and consumable medical supplies.

We use three levels of capability for basic medical UTCs:

- **SPEARR.** If any personnel deploy to an FOL, a Small Portable Aeromedical Expeditionary Rapid Response (SPEARR) package deploys. This consists of a mobile field surgical team (emergency medical and surgical trauma care), a critical care team (provides holding capability prior to aeromedical evacuation), and a preventive aerospace medicine team (part of ADVON for initial site survey and medical planning).
- **EMEDS.** The Expeditionary Medical Support (EMEDS) packages and their corresponding manpower deploy when PAR exceeds 500. The basic package handles up to 2,000 PAR, the plus-10 package (which adds 10 beds) handles up to 3,000 PAR, and the plus-25 package (which adds 25 beds) handles up to 5,000 PAR.
- **Regional hospital.** In most contingencies, at least one regional hospital per theater will be created that has greater capability for treatment (i.e., surgery) than do the facilities at FOLs. Typically, injured persons would be stabilized at their FOL and then transported to a regional facility for further treatment. For this reason, we have included an option to make the base that is being modeled a regional or centralized medical facility. This selection adds greater patient retrieval and movement capability, more beds and personnel, and more NBC-related assets, as discussed next.

Peterson HQ ACC (Langley AFB) on May 8, 2002, an interview with Capt Brian Gouveia (HQ ACC/SGXO) on March 3, 2003, and three Air Force documents—*Air Force Tactics, Techniques, and Procedures* (AFTTP) 3-42.3 (2002), "Air Force Medical Service CONOPS for Medical NBC Defense Team" (HQ ACC/SGP), and "Air Force Medical Service CONOPS for EMEDS System" (HQ ACC/SGX) (the latter two are unpublished draft documents).

If an NBC threat is anticipated, NBC detection and treatment equipment is deployed. In terms of the model input, the NBC threat levels (low, medium, and high) are terms used by the civil engineers. To avoid proliferation of categories, we use the same levels for the medical area. Selecting "Medium" or "High" NBC threat levels will cause these packages to be deployed. For FOLs, these UTCs include mainly decontamination teams and their equipment. When an NBC threat *and* regional hospital are selected, the model sends several more UTCs—biological augmentation, infectious disease detection/treatment, epidemiology, and radiation detection/treatment teams.

We include ambulances (they are sometimes in composite packages) but assume vehicles used for inspection and detection (for NBC threats or normal base area health concerns) will be included in general-purpose vehicles, reflecting normal practice.

In practice, the amount of medical support deployed to a base depends on existing infrastructure (e.g., buildings, beds) and services provided by the host nation. In this model, we give the user the option of choosing whether medical support will be deployed. If the "Need medical support?" button in START is clicked, all medical equipment necessary to support the estimated base population is sent.

Medical UTCs are not very heavy compared with some other functional areas. Within the medical area, though, the EMEDs UTCs are the heaviest. Packages for 25 (FFEE1), 35 (FFEE2), and 50 beds (FFEE3) weigh 6.7, 33.1, and 22 short tons, respectively.

General-Purpose Vehicles

A number of general-purpose vehicles not included in specific functional area UTCs is needed at a deployed base. Those vehicles include passenger buses, multistops (small bus-type vehicles), pick-up trucks, forklifts, some construction vehicles, and so on. Because the current Air Force practice is to lease many of these vehicles upon deployment, most of them do not have UTCs. We have listed these vehicles as UFZ99, as they would generally appear on a TPFDD. The list of vehicles that we use is derived from a list of general-purpose vehicles prepared for a study for the Air Force Logistics Management Agency (AFLMA).[39] The list is generally consistent with the proposed (but not implemented) bare-base vehicle UTCs outlined in Annex D of Volume 1 of AFH 10-222 (1996a). Note that special-purpose vehicles, such as refuelers, fire trucks, armored HMMWVs for EOD and force protection, APO loaders, and ambulances are included in the UTCs of those functional areas.

The list is probably representative of the general-purpose vehicle needs of a bare-base deployment. For other than bare-base deployment, vehicle requirements will, of course, depend on the constitution of the available fleet. We assume that additional construction vehicles will not be needed at an established base, and that general-purpose vehicle needs will largely scale with the increase in base population. These approximations are rough, rendering the estimates less robust than for the bare-base case. We expect that, in most cases, the tool will overestimate the general-purpose vehicle requirements for deployment to an established base.

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[39] Personal communication with MSgt G. LaRue Jenkins (CENTAF/A4-LGTV) and Capt Todd Groothuis (AFLMA/LGX), September 26, 2002.

CHAPTER FOUR

Example Applications of the START Analysis Tool

A fully implemented analytical tool that follows the methodology of the prototype described in this monograph should be useful for a diverse array of Air Force applications. We cite three examples illustrating some potential applications of the tool.

Crisis-Action Planning

A tool like START should be useful at multiple junctures during crisis-action planning. Crisis-action planning often begins with operational planners exploring various possible target sets and engagement strategies, and hence a range of associated deployment plans. Logistical input at this stage is often limited, both to expedite the planning process and to keep to a minimum the number of participants who are knowledgeable about the plans. An analysis tool that can generate a first approximation of a TPFDD within minutes without the planner having special experience in logistics would provide operational planners with rapid feedback on the logistical feasibility of their plans, and can do so without the time and security concerns associated with the current TPFDD-building process. For example, operational planners could explore candidate deployment plans to estimate the manpower and materiel needed across all deployment sites. A comparison might be used to dismiss one plan in favor of another based on logistical efficiencies. Or, the tool could be used in conjunction with movement planning factors to estimate how rapidly each proposed deployment site might reach initial operating capability.

Once a plan is agreed upon and logisticians are brought in to generate the execution TPFDD, a tool such as START could provide a quick first estimate of the requirements TPFDD. Specialists could then edit and redact the requirements TPFDD by considering details that go beyond the resolution of the inputs to the model. This process would be similar to executing an operation for which the Air Force has previously worked out deliberate plans, and should substantially reduce the planning time.

Setting Manpower and Equipment Authorizations

A second potential use of the model is to estimate the appropriate authorized manpower and equipment levels to support the portfolio of capabilities prescribed by Air Force leadership. Such an application would greatly facilitate the transition from threat-based planning to capabilities-based planning. Threat-based planning revolves around generating a limited number of detailed plans for specific conflicts in particular regions. Most of the logistical effort goes into making a TPFDD to support these deployments. Because of the limited number of plans, it is feasible to generate these TPFDDs with dozens of specialists over many months. Authorized manpower and equipment levels are partly based on these requirements.

In capabilities-based planning, planners may wish to evaluate dozens of scenarios requiring capabilities of varying scope in unspecified locations.[1] The current staffing and temporal requirements for generating a TPFDD preclude analyzing a vast array of scenarios by assembling teams of functional-area specialists. An analytical tool that can rapidly generate a requirements TPFDD would permit such an analysis by providing an assessment of the manpower and equipment needs to achieve each element of the desired portfolio of capabilities.

[1] Davis, 2002.

War Reserve Materiel Prepositioning and Forward Support Locations

Prepositioning WRM in well-selected forward support locations (FSLs) can both reduce the movement requirements and accelerate the time to IOC. The effectiveness of prepositioning materiel on decreasing time to IOC depends on the location of the FSLs (or, the intra-theater transport time to the FOL), the throughput capacity of those FSLs, and whether commodities are optimally distributed among those FSLs given the demand at the FOLs. The starting point for analyzing where materiel should be prepositioned, and how that materiel should be distributed among those preposition sites is the magnitude and location of the demand for prepositioned materiel.[2]

Although the nature, location, and scope of future operations are uncertain, the expeditionary Air Force can prepare for a spectrum of engagements by prepositioning materiel in a configuration that is optimal for a range of contingencies, including a major regional conflict (MRC), small-scale contingency (SSC), terrorist response, humanitarian relief operation (HUMRO), and so on. For example, if, for a given operational scenario, the movement requirements can be determined, this demand can, in turn, be combined with data on storage capacities, transportation times and capacities (air, land, and sea), and other logistical constraints for each potential FSL to be optimized for the location of FSLs and distribution of materiel among FSLs. The tool described in this report—the Strategic Tool for the Analysis of Required Transportation—is the first step in this method. It provides a tool for the strategic planner that translates an operational capability into the requisite movement requirements.

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[2] Tripp et al., 1999.

CHAPTER FIVE

Conclusions and Recommendations

The United States military is transforming from a threat-based planning posture to a capabilities-based posture. Improving the swiftness with which the Air Force can quantify what materiel and manpower are required to accomplish effects requested by a regional unified combatant commander would facilitate this transition. The START tool described in this report demonstrates the feasibility of expediting this process by collecting deployment rules for UTCs from each functional area into a parameterized computer program. It shows that a requirements TPFDD can be generated from a small number of specified inputs—the nature of the existing base infrastructure; the number, type, and mission flow by the aircraft; and measures of the threats to which the base is exposed.

A fully implemented tool of this type would provide a starting point for parameterized TPFDD building in support of a range of Air Force planning needs. We see no theoretical barriers that would prevent the prototype decision support tool from being developed into a fully implemented decision support tool. We make the following recommendations to facilitate such an implementation.

Develop Formal Definitions for Deployed Locations

Most UTCs are currently engineered for bare-base deployment. Definitions for other types of bases exist but were constructed to meet Cold War rather than expeditionary needs. They are consequently outdated and could benefit from revision. Especially lacking are categories that characterize the typical types of locations to which the Air Force has recently deployed, such as international airports, coalition air bases, and bases where United States aircraft are already present. Because most deployed locations are not true bare bases, this lack of adequate base characterization causes a significant fraction of UTCs having to be tailored at the time of execution. Tailoring at execution prolongs the deployment timeline and can be mitigated by building UTCs to meet the range of current expeditionary deployment sites. Defining a limited number of base categories that captures the range of sites to which the Air Force currently deploys and tailoring UTCs to these base types in advance of deployment would save time at execution and provide a more accurate estimate of manpower and equipment requirements.

Develop Formal Definitions of Conventional and NBC Threat

Civil engineering, force protection, and medical support all use various "stovepiped" definitions of base threats to characterize their deployment needs. Uniform definitions for these threats agreed upon by all relevant groups would provide a common vocabulary for ADVON teams and facilitate rapid decisions on which UTCs are needed across all functional areas. UTCs could be scaled and tailored to a common standard in all functional areas, making the UTCs function better together, and could create a common standard for strategic planning purposes.

Establish an Office of Primary Responsibility for Maintaining the Model

UTCs should be sized and tailored to the planning factors discussed in this chapter for base types and threat levels. Each time an existing UTC is modified or a new UTC is created, rules governing its deployment should be established and entered into the model. Such a procedure would maintain a deployment rule base, result in less tailoring of UTCs at execution, and yield UTCs more consistently sized across all functional areas. Maintenance of a tool that would generate the UTC lists that are necessary to support operations will make the Air Force more expeditionary and facilitate its transition to capabilities-based planning.

APPENDIX

User's Guide to the START Program

Launching START and Inputting Data

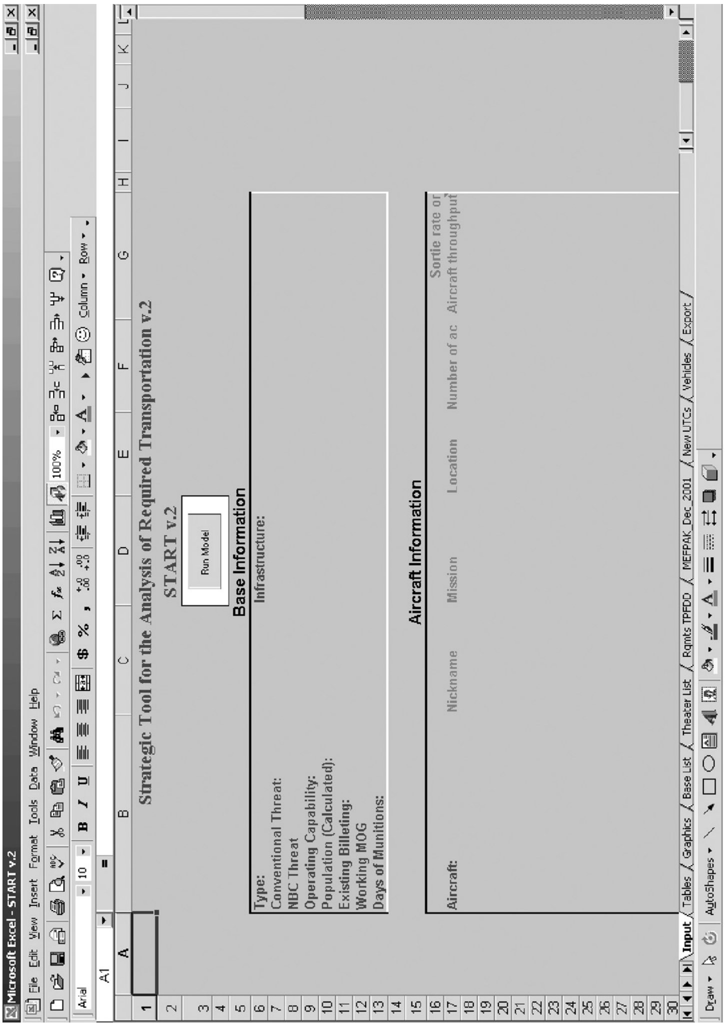
The START program[1] application is a Microsoft Excel–based spreadsheet model named the Strategic Tool for the Analysis of Required Transportation (file name start-v2.11xls). (We assume that the user has working familiarity with Excel.) When START is opened, the user is asked whether macros should be enabled or disabled. The user should choose to enable the macros.[2] After this is done, the Input worksheet should appear, as illustrated in Figure A.1.

If this worksheet does not appear, the user should click on the Input tab at the bottom of the screen. It is through this worksheet that the desired operational capability is specified and the manpower and equipment demands are calculated. Results are displayed via tables and charts in other worksheets, which are discussed in detail in this appendix.

[1] The START program was created in Microsoft Excel version 9.0 for Windows 2000, and the description in this appendix reflects the user interface of that version.

[2] If no such option appears after opening the program, go to the Excel Tools menu and select Macro, then select Security. Under the tab Security Level, select Medium. After changing this setting, exit and restart the program.

Figure A.1
START Program Input Worksheet



RAND *MG176-A.1*

Overview

START calculations focus on the base level. Each time a calculation is done by START, UTC requirements are determined given the inputs specified by the user for a deployed site. This base is a notional site to which the user can assign a name for reference purposes. During a session, the user can examine the requirements for a number of bases, thus accumulating requirements for a theater. After each base-level calculation, data are stored for all the bases analyzed, and all the bases examined up to that point are summed.

Input Interface

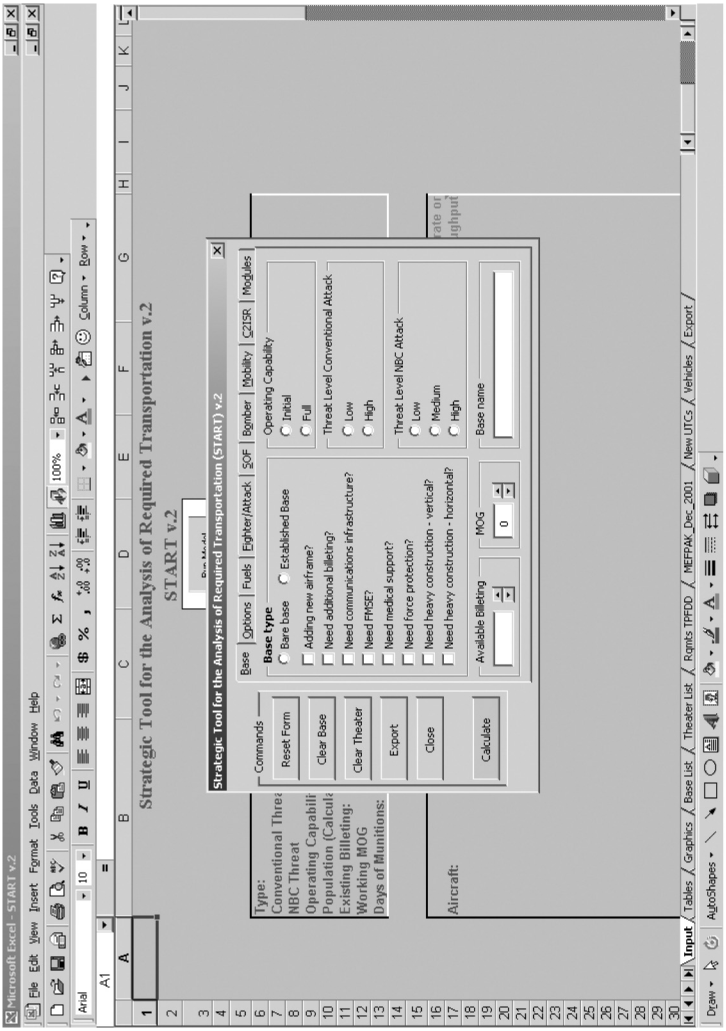
The user enters all input parameters through the Input dialog box. To open this window, click on the button labeled Run Model (at the top center of the screen on the Input worksheet), which displays the Input dialog box. The screen should then look like Figure A.2.

Along the left-hand side of the input dialog box are six buttons:

- **Reset Form.** This button resets all the inputs to their defaults (mostly zeros).
- **Clear Base.** This button resets all the outputs from the most recent run to zero.[3]
- **Clear Theater.** This button resets all the outputs from all runs to zero.
- **Export**. This button allows the user to export some of the output data (UTC and quantity) to a separate file.
- **Close.** This button closes the window.
- **Calculate.** This button calculates the requirements after all the input data are entered.

[3] START has the capability to calculate and aggregate the results from up to 50 bases into a theater requirement. There are separate outputs for the base and for the theater, which are discussed below.

Figure A.2
START Program Input Dialog Box



RAND *MG176-A.2*

It is important to know that when the Input dialog box is opened, it does not automatically reset all the input values to their defaults. This feature allows the user to do multiple runs of similar inputs without the need to reenter all the input data. Hence, at the start of a session, the user should click the Reset Form button on the Input dialog box to reset the values to their defaults (otherwise, if the user enters only a few input parameters and calculates the results, the dialog box will be missing parameters that are important to ensure results that are consistent with all the input values). If the dialog box is simply being restored after running the model, the values on the input dialog box will be fully restored from the last run.

To the right of the six buttons are several tabs to input the specified operational capability. These tabs are largely self-explanatory from their labels, but additional clarification is provided next. The tabs, from left to right, are Base, Options, Fuels, Fighter/Attack, SOF, Bomber, Mobility, C2ISR, and Modules.

Base

The user defines the characteristics of the base via checklists that appear on the Base tab. Inputs are grouped into the following seven boxes:

- **Base Type.** At the top of the box labeled "Base type," an option appears for one of two types of bases: a Bare Base or an Established Base. A bare base is "a site with a usable runway, taxiway, parking areas, and a source of water that can be made potable."[4] If this option is selected, all of the options listed below it are automatically selected, except for large horizontal construction (e.g., runways and ramp space) and vertical construction (e.g., large buildings), both of which require RED HORSE teams. If bare base is selected, the user should *not deselect the other options*, as this deselection would be inconsistent with the bare-base definition assumed in the programmed logic. If the user selects

[4] AFPAM 10-219, 1996, Vol. 5, p. 8.

the established base option, he or she must then specify the nature of the existing infrastructure, as well as whether large horizontal or vertical construction is needed. Below the base type selection box is a series of option boxes. "Adding new airframe?" inquires whether a new airframe is being added to the base. Unless the base is already operating the aircraft that are being deployed, and this deployment is only supplementing the number of those aircraft, this box should be checked. "Need additional billeting?" should be checked unless the base has excess billeting sufficient to accommodate all the new personnel that will arrive. "Need communication infrastructure?" should be checked unless the base already has a sufficient infrastructure to accommodate the communications needs of the additional deployment. "Need FMSE?" should be checked unless the base already has hard fuels capacity sufficient to supply the additional aircraft *and* the forces will have access to it. Some international airports, for example, will have an adequate fuels capability, but access to this fuels support will be denied, creating a need for a fuel bladder farm, pumps, and trucks. "Need medical support?" should be checked unless the base has sufficient medical facilities to handle the additional personnel. "Need force protection?" should be checked unless the base already has sufficient force protection (military police and perimeter guards).

- **Available Billeting.** Below the base type selection box is a box for inputting any available billeting on the base. The model will estimate the total billeting needed and subtract the available billeting from this number to determine the quantity of bare-base billeting sets needed (Harvest Falcon/Eagle housekeeping sets). (A bare base, by definition, has no available billeting, so the entry in this box should remain at zero for the bare-base case.)
- **MOG.** In the MOG box, the user specifies the working Maximum on Ground, which is the number of aircraft that can be simultaneously serviced on the runway for loading or unloading cargo. This number drives the cargo aircraft maintenance requirement, aerial port operations requirements, and base throughput capacity.

- **Operating Capability.** To the right of the Base Type box is a box for choosing the operating capability. The user may choose between Initial and Full. Choosing Initial (the default setting) will cause the tool to list only those UTCs needed to attain IOC. Choosing Full will add to these UTCs additional UTCs that are necessary to sustain operations for more than 30 days (e.g., intermediate-level maintenance).
- **Threat Level Conventional Attack.** Directly below the Operating Capability box is the Threat Level Conventional Attack box. The user may choose between Low and High. Conventional threat refers to the threat from external ground attack and drives force protection needs. Because the Air Force does not have organic capabilities for missile defense, missile defense UTCs (e.g., Patriot missile batteries) are not included in the program.
- **Threat Level NBC Attack.** Directly below the conventional threat-level box is the Threat Level NBC Attack box. The user may select Low, Medium, or High. NBC threat refers to the threat from non-conventional attack and drives the need for medical and EOD resources.
- **Base Name.** The Base name input box (directly below the Threat Level NBC Attack box) allows the user to specify a name as it will appear on the requirements TPFDD that is generated. This feature is useful if theater requirements are being calculated and the user wishes to match UTCs with bases. The base name has no functional role.

Options

The user defines optional input parameters on this tab. Inputs are made within the following four boxes:

- **Missile Expenditure Rates.** In this box the user enters separate expenditure rates for both the AIM-9 and AIM-120 missiles. How the total missile requirements are calculated is discussed in the "Munitions" section in Chapter Three.
- **Days of Munitions.** Munitions are the only consumable for which START estimates requirements. The default setting com-

putes requirements for three days of operations if the IOC button is selected and seven days if the FOC button is selected. The text box displays the requisite number of days for the operating capability selected. The user may adjust this number if more or fewer days of munitions are required.
- **Fuel Servicing.** Here the user may specify whether fuels support is satisfied using trucks, stationary refueling "pits," or a combination of the two. The default selection is a combination of trucks and pits.
- **Theater Options.** Here the user can specify whether the base will serve as a regional hospital or as an air operations center, thereby serving other bases in the theater.

Fuels

The inputs on the fuels tab are optional. They are provided to incorporate all the options in the AFPET FMSE calculator. Most users who are unfamiliar with FMSE should use the default settings.

Here the user defines detailed input parameters for FMSE. Although the fuels manpower and equipment calculations incorporate aircraft types, numbers, and sortie rates, this tab enables the user to enter more-detailed information about the required fuels capability. Inputs are made within the following four boxes:

- **Refueling Pits.** The "Simultaneous hot refueling capability" item inquires how many, if any, hot refueling pits (for fighter aircraft) are required. "Cold pit refueling points" inquires how many, if any, cold refueling pits (for heavy aircraft) are required. "Refueling unit fillstand" inquires how many additional refueling unit fillstands are required. These three items all deploy similar equipment for servicing aircraft without the use of fuel trucks.
- **Ground Fuel/LOX/LIN.** Requirements for ground fuel, liquid oxygen (LOX), and liquid nitrogen (LIN) storage are handled within the fuels area and are included in FMSE considerations. "Daily diesel fuel requirement" inquires how many gallons of diesel fuel will be consumed each day at the base. "Daily un-

leaded fuel requirement" inquires how many gallons of unleaded fuel will be consumed each day at the base. "Daily liquid oxygen (LOX) requirement" inquires how many gallons of LOX will be consumed each day at the base. "Daily liquid nitrogen (LIN) requirement" inquires how many gallons of LIN will be consumed each day at the base.

- **Days of Capacity.** Here the user specifies how many days of aircraft fuel consumption the base must have the capacity to store. The default (when the form is reset) is three days.[5]
- **Miles from Base Perimeter to Storage.** The "Miles from base perimeter to storage" box inquires on the mileage from the base perimeter to the fuels storage area. Data should be entered here only if there is a requirement (most likely force protection) to have fuel pumped rather than trucked from the base perimeter to the fuels storage area. If this distance is above a certain threshold, hoses and related equipment will be sent.

Fighter/Attack

This tab lists fighter and attack aircraft. Here the user specifies the number, the mission type (when applicable), and the sortie rate.[6]

SOF

This tab lists helicopters and supporting fixed-winged aircraft used by Special Operations Forces. The user specifies the number of aircraft and sortie rate.

Bomber

This tab lists bombers. The user specifies the number of bombers, the sortie rate, and whether the bombers are bedded down or are using the base as an en-route location. If they are en-route, no intermediate

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[5] This number was suggested to us by SMSgt Shawn Simon at AFPET.

[6] Sortie rate for combat aircraft is number of sorties per day per aircraft. In practice, the sortie rate affects requirements for maintenance equipment, munitions, and fuels. In START, only munitions and fuels are affected, however, because maintenance UTCs are designed specifically to satisfy WMP-5 sortie rates.

maintenance capability will deploy (regardless of selected operating capability).

Mobility

This tab lists cargo aircraft and refueling aircraft. The user specifies the number of aircraft, mission type (when applicable), number of sorties per day, and whether the aircraft are bedded down or are using the base as an en-route location. The number of sorties per day for mobility aircraft differs from the sortie rate for combat aircraft. Here the user specifies the *total* number of sorties per day for each aircraft type. For example, if ten KC-10s are located at a base, each flying one sortie per day, the number to input in the sorties per day box is 10. If the base will service any cargo aircraft, the user must select "En-route" under "Beddown status" for each aircraft.

C2ISR

This tab lists C2ISR aircraft. The user specifies the number of aircraft and whether the aircraft are bedded down or are using the base as an en-route location.

Modules

With this tab, the user specifies which functional areas (detailed in Chapter Three) should be included in the calculations. The default is to calculate every functional area, but if the user wishes to omit an area (say, munitions), he or she can do so by deselecting that module.

Calculating the Requirements and Interpreting the Output

After the user has specified the desired capability by completing the relevant areas in the Input dialog box, the calculation is executed by clicking on the Calculate button in the lower left-hand corner of that dialog box (refer back to Figure A.2). Each functional area has a subroutine, written in Visual BASIC for Applications (VBA) that computes a list of UTCs needed to support the desired parameterized operation. The number of UTCs needed is posted to one of three worksheets—"MEFPAK_Dec_2001," "New UTCs," or "Vehicles"—containing the UTCs and their movement characteristics. From these worksheets, several summaries are generated—a master list for that particular base, a master list for all bases included in the theater, and aggregated, tabular results for both.

Reading the output results is easier if the Input dialog box is closed. All input values will be restored when the window is reopened, so closing the window will not cause any data to be lost. All input parameters are duplicated in three boxes on the Input worksheet—Base Information, Aircraft Information, and Fuels Detail. An exception is Population (Calculated). Estimated base population comes from bare-base planning factors.[7]

Summary data are posted to the Tables worksheet, which contains a tabular summary for the base and for the theater. Two charts each for the base and theater are found in the Graphics worksheet. Additional details of the output can be found on the Base List, Theater List, Rqmts TPFDD, and the three UTC output sheets. These worksheets are described in the next section.

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[7] AFPAM 10-219, 1996, Vol. 5, p. 34. For the purposes of estimating base population, we consider helicopters and unmanned aerial vehicles (UAVs) to require equivalent numbers of support personnel as fighters.

The Individual Worksheets

While the inputs from the user are accessed from the Input worksheet, the outputs are located in a number of different sheets. They are described here for the reader's reference. We group the sheets into three categories.

Input and Output Worksheets

Seven worksheets constitute this group: Input, Tables, Base List, Theater List, Rqmts TPFDD, and Graphics. These are the sheets that the user will most frequently use and consult.

- **Input** is the principal worksheet for inputting data, already described in detail previously.
- **Tables** contains two tables, one for base and one for theater, that summarize the UTC outputs in the three UTC output worksheets (e.g., MEFPAK_Dec_2001). These data are aggregated by functional area, and the first five columns in both tables (starting from the left) mirror several fields found in the MEFPAK. From left to right, the columns in the tables are labeled BULK, OVER-SIZED, OUT-SIZED, NON-AIR TRANS, and UTC TOTAL.[8] The sixth column, CUBE, gives volume in cubic feet from level-four detail in the Logistics Force Packaging System (LOGFOR). The seventh column, C-17s, gives an estimate of how many C-17s would be required if all this materiel were shipped by air. We consider maximum weight[9] and cube constraints of the C-17. The eighth column,

[8] "Bulk" is cargo that fits within the dimensions of a 463-L pallet (84 inches wide by 104 inches long by 96 inches high) and is transportable on all mobility aircraft. "Oversized" cargo exceeds the usable dimensions of a 463-L pallet but is less than 1,090 inches long, 117 inches wide, and 105 inches high. Oversized cargo can be shipped in a C-5, C-17, C-141, C-130, or KC-10. "Outsized" cargo exceeds the dimensions of oversized cargo and requires a C-5 or C-17 for air transport. "Non-air trans" cargo cannot be shipped on any mobility aircraft. See Air Force Manual (AFMAN) 10-401, 1998, pp. 173–174.

[9] We use 45 short tons as the functional capacity of a C-17. See AFPAM 10-1403, 1998a, Table 3.

MTONS, gives the volume of the cargo in measurement tons.[10] The ninth column, Days, gives the number of days it would take to download the cargo, given the MOG input by the user and the estimated number of C-17 equivalents.[11] The tenth column, STons per deployed aircraft, gives the short tons of cargo for each functional area divided by the total number of deployed aircraft. The totals for each functional area are then totaled in the last row to give the total short tons per deployed aircraft. An example Tables worksheet is shown in Figure A.3.

- **Base List** gives the complete list of UTCs generated by START for the most recent base calculation. (This sheet refreshes each time the Calculate button is clicked, whether or not input parameters change.) The first column in the Base List worksheet gives the UTC identifier; the second gives its descriptive name as it appears in the MEFPAK; the third gives the number of UTCs needed as determined by START; the fourth gives the UTC's functional area (which appears as "UNIT" in the MEFPAK); the fifth gives the short tons (as given by the MEFPAK); the sixth gives the volume in cubic feet (as given by the LOGFOR); the seventh gives the authorized personnel (as given by the MEFPAK); and the final columns give the total weight in short tons (i.e., the number of UTCs required times the weight of an individual UTC), the total volume in cubic feet, and the total authorized personnel. An example Base List worksheet is shown in Figure A.4.

[10] A "measurement ton" (MTon) is a unit of volume used for measuring the cargo of a ship, truck, train, or other freight carrier. It is equal to exactly 40 cubic feet, or approximately 1.1326 cubic meters.

[11] This calculation assumes 24-hour airfield operations, a C-17 unload time of 2.5 hours, and 80 percent efficiency in overall operations (to reflect delays).

Figure A.3
Example Tables Worksheet

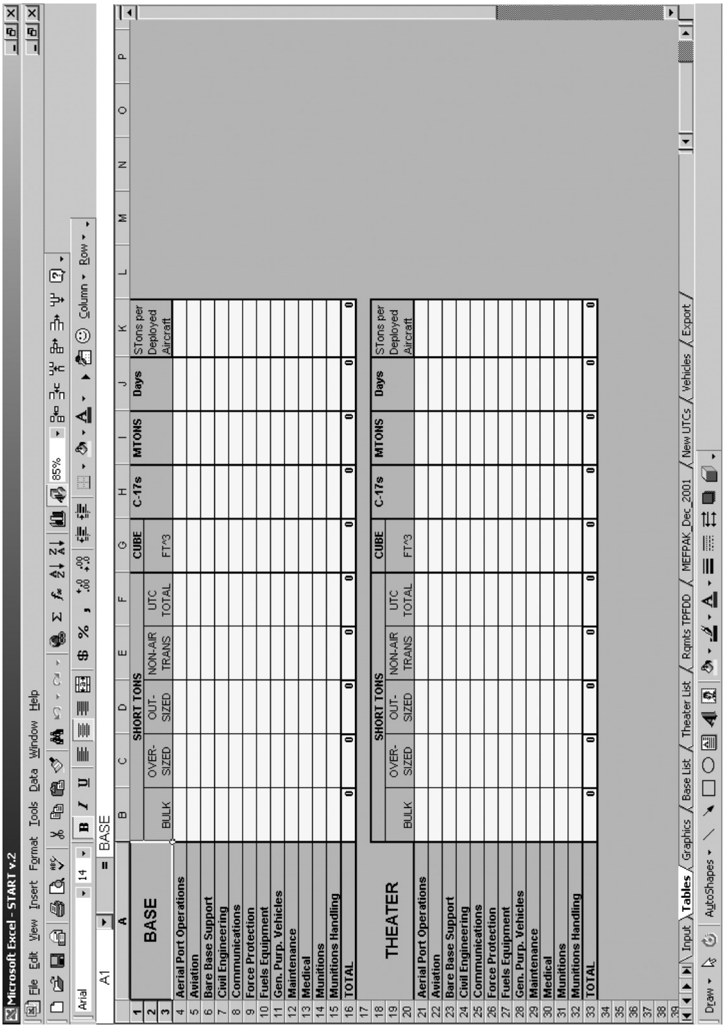

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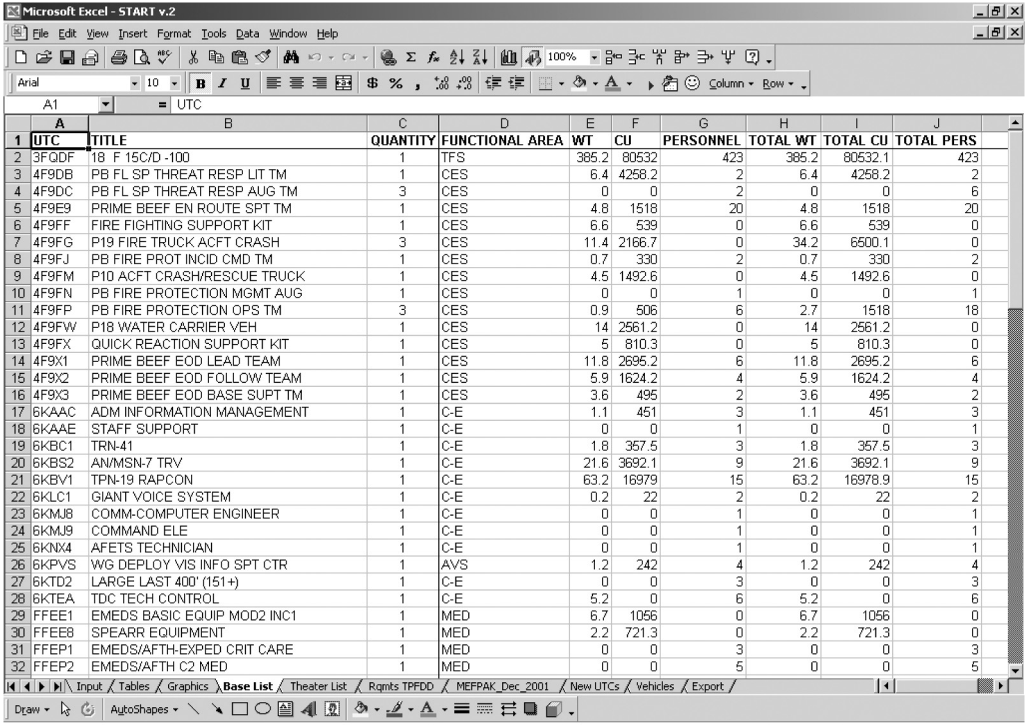
Figure A.4
Example Partial Output of the Base List Worksheet



UTC	TITLE	QUANTITY	FUNCTIONAL AREA	WT	CU	PERSONNEL	TOTAL WT	TOTAL CU	TOTAL PERS
3FQDF	18 F 15C/D -100	1	TFS	385.2	80532	423	385.2	80532.1	423
4F9DB	PB FL SP THREAT RESP LIT TM	1	CES	6.4	4258.2	2	6.4	4258.2	2
4F9DC	PB FL SP THREAT RESP AUG TM	3	CES	0	0	2	0	0	6
4F9E9	PRIME BEEF EN ROUTE SPT TM	1	CES	4.8	1518	20	4.8	1518	20
4F9FF	FIRE FIGHTING SUPPORT KIT	1	CES	6.6	539	0	6.6	539	0
4F9FG	P19 FIRE TRUCK ACFT CRASH	3	CES	11.4	2166.7	0	34.2	6500.1	0
4F9FJ	PB FIRE PROT INCID CMD TM	1	CES	0.7	330	2	0.7	330	2
4F9FM	P10 ACFT CRASH/RESCUE TRUCK	1	CES	4.5	1492.6	0	4.5	1492.6	0
4F9FN	PB FIRE PROTECTION MGMT AUG	1	CES	0	0	1	0	0	1
4F9FP	PB FIRE PROTECTION OPS TM	3	CES	0.9	506	6	2.7	1518	18
4F9FW	P18 WATER CARRIER VEH	1	CES	14	2561.2	0	14	2561.2	0
4F9FX	QUICK REACTION SUPPORT KIT	1	CES	5	810.3	0	5	810.3	0
4F9X1	PRIME BEEF EOD LEAD TEAM	1	CES	11.8	2695.2	6	11.8	2695.2	6
4F9X2	PRIME BEEF EOD FOLLOW TEAM	1	CES	5.9	1624.2	4	5.9	1624.2	4
4F9X3	PRIME BEEF EOD BASE SUPT TM	1	CES	3.6	495	2	3.6	495	2
6KAAC	ADM INFORMATION MANAGEMENT	1	C-E	1.1	451	3	1.1	451	3
6KAAE	STAFF SUPPORT	1	C-E	0	0	1	0	0	1
6KBC1	TRN-41	1	C-E	1.8	357.5	3	1.8	357.5	3
6KBS2	AN/MSN-7 TRV	1	C-E	21.6	3692.1	9	21.6	3692.1	9
6KBV1	TPN-19 RAPCON	1	C-E	63.2	16979	15	63.2	16978.9	15
6KLC1	GIANT VOICE SYSTEM	1	C-E	0.2	22	2	0.2	22	2
6KMJ8	COMM-COMPUTER ENGINEER	1	C-E	0	0	1	0	0	1
6KMJ9	COMMAND ELE	1	C-E	0	0	1	0	0	1
6KNX4	AFETS TECHNICIAN	1	C-E	0	0	1	0	0	1
6KPVS	WG DEPLOY VIS INFO SPT CTR	1	AVS	1.2	242	4	1.2	242	4
6KTD2	LARGE LAST 400' (151+)	1	C-E	0	0	3	0	0	3
6KTEA	TDC TECH CONTROL	1	C-E	5.2	0	6	5.2	0	6
FFEE1	EMEDS BASIC EQUIP MOD2 INC1	1	MED	6.7	1056	0	6.7	1056	0
FFEE8	SPEARR EQUIPMENT	1	MED	2.2	721.3	0	2.2	721.3	0
FFEP1	EMEDS/AFTH-EXPED CRIT CARE	1	MED	0	0	3	0	0	3
FFEP2	EMEDS/AFTH C2 MED	1	MED	0	0	5	0	0	5

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- **Theater List** gives the complete list of UTCs generated by START for all bases in the theater. The columns mirror those in the Base List worksheet.
- **Rqmts TFPDD** contains much of the same information as the Theater List worksheet in the form of a TPFDD (all UTCs listed separately). Many columns are blank because START does not currently generate sourcing, routing, or timing information, as are found in an execution TPFDD. The columns that do contain data are as follows: The second column gives the UTC's descriptive name as it appears in the MEFPAK; the third gives the UTC identifier; the fifth gives the service code ("F" stands for Air Force); the twelfth, thirteenth, and fourteenth give the total number of passengers, authorized personnel, and short tons, respectively (as given by the MEFPAK), and the twenty-sixth column gives the base name as specified by the user. An example Rqmts TPFDD worksheet is shown in Figure A.5.
- **Graphics** displays graphical summaries of the short-ton data found in the Tables worksheet. The worksheet contains one bar chart and one pie chart each for base and theater data. The bars and slices correspond to the functional areas found in the base and theater summary tables. An example Graphics worksheet is shown in Figure A.6.

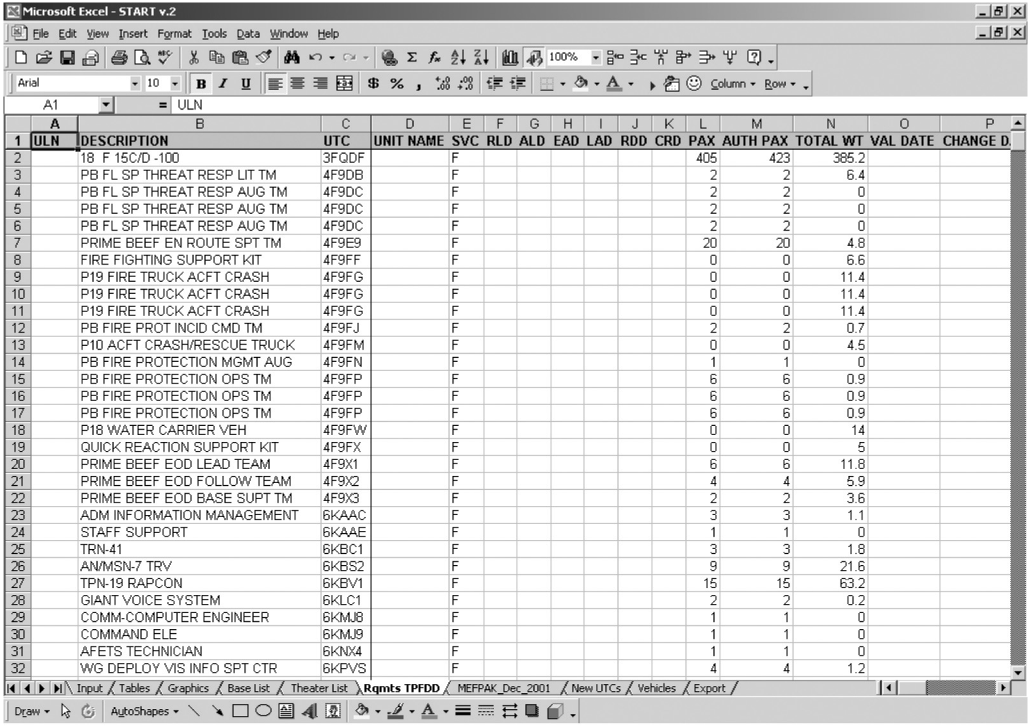
Intermediate UTC Worksheets

The quantities of UTCs calculated by START are output to one of three worksheets—MEFPAK_Dec_2001, New UTCs, and Vehicles.

- **MEFPAK_Dec_2001** is the main UTC output sheet. The first 16 fields are identical to those in the MEFPAK, and the user may consult the relevant Air Force documentation[12] for more detailed information about these fields. The seventeenth column provides volume data from the LOGFOR, and the remaining

[12] AFMAN 10-401, 1998, Vol. 1, Section 6.

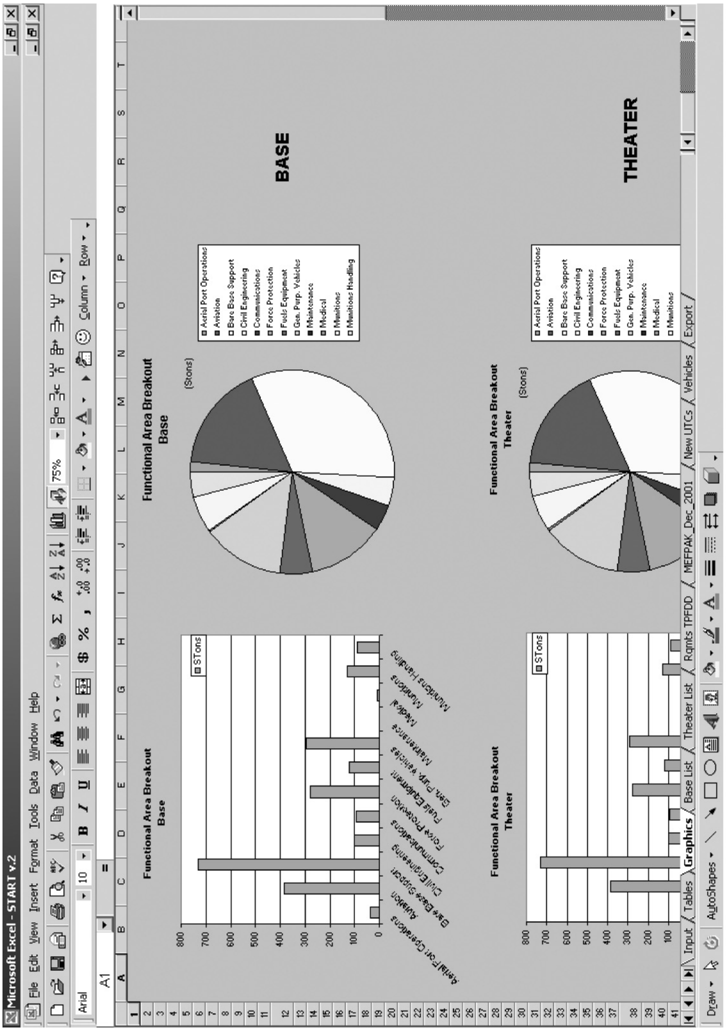
Figure A.5
Example Partial Output of the Rqmts TPFDD Worksheet



1	ULN	DESCRIPTION	UTC	UNIT NAME	SVC	RLD	ALD	EAD	LAD	RDD	CRD	PAX	AUTH PAX	TOTAL WT	VAL DATE	CHANGE D.
2		18 F 15C/D -100	3FQDF		F							405	423	385.2		
3		PB FL SP THREAT RESP LIT TM	4F9DB		F							2	2	6.4		
4		PB FL SP THREAT RESP AUG TM	4F9DC		F							2	2	0		
5		PB FL SP THREAT RESP AUG TM	4F9DC		F							2	2	0		
6		PB FL SP THREAT RESP AUG TM	4F9DC		F							2	2	0		
7		PRIME BEEF EN ROUTE SPT TM	4F9E9		F							20	20	4.8		
8		FIRE FIGHTING SUPPORT KIT	4F9FF		F							0	0	6.6		
9		P19 FIRE TRUCK ACFT CRASH	4F9FG		F							0	0	11.4		
10		P19 FIRE TRUCK ACFT CRASH	4F9FG		F							0	0	11.4		
11		P19 FIRE TRUCK ACFT CRASH	4F9FG		F							0	0	11.4		
12		PB FIRE PROT INCID CMD TM	4F9FJ		F							2	2	0.7		
13		P10 ACFT CRASH/RESCUE TRUCK	4F9FM		F							0	0	4.5		
14		PB FIRE PROTECTION MGMT AUG	4F9FN		F							1	1	0		
15		PB FIRE PROTECTION OPS TM	4F9FP		F							6	6	0.9		
16		PB FIRE PROTECTION OPS TM	4F9FP		F							6	6	0.9		
17		PB FIRE PROTECTION OPS TM	4F9FP		F							6	6	0.9		
18		P18 WATER CARRIER VEH	4F9FW		F							0	0	14		
19		QUICK REACTION SUPPORT KIT	4F9FX		F							0	0	5		
20		PRIME BEEF EOD LEAD TEAM	4F9X1		F							6	6	11.8		
21		PRIME BEEF EOD FOLLOW TEAM	4F9X2		F							4	4	5.9		
22		PRIME BEEF EOD BASE SUPT TM	4F9X3		F							2	2	3.6		
23		ADM INFORMATION MANAGEMENT	6KAAC		F							3	3	1.1		
24		STAFF SUPPORT	6KAAE		F							1	1	0		
25		TRN-41	6KBC1		F							3	3	1.8		
26		AN/MSN-7 TRV	6KBS2		F							9	9	21.6		
27		TPN-19 RAPCON	6KBV1		F							15	15	63.2		
28		GIANT VOICE SYSTEM	6KLC1		F							2	2	0.2		
29		COMM-COMPUTER ENGINEER	6KMJ8		F							1	1	0		
30		COMMAND ELE	6KMJ9		F							1	1	0		
31		AFETS TECHNICIAN	6KNX4		F							1	1	0		
32		WG DEPLOY VIS INFO SPT CTR	6KPVS		F							4	4	1.2		

RAND *MG176-A.5*

Figure A.6
Example Partial Output of the Graphics Worksheet



RAND *MG176-A.6*

columns are calculated values from START. The eighteenth and nineteenth columns, labeled Base Q and Theater Q, give the numbers of UTCs needed for the base and for the theater, respectively. The next ten columns are row totals for each movement characteristic. To keep track of multiple bases for a theater calculation, the model outputs the results for each base (in addition to the eighteenth column) in separate columns to the right of the columns described above. Each time a new calculation is performed, the model shifts over one column and outputs the new results. The Theater Q column keeps a running total of all of these base columns. When the Clear Base button is clicked, the most recent base column and the Base Q column are cleared. The Clear Theater button clears all columns of output.

- **New UTCs** mirrors the format of the MEFPAK_Dec_2001 worksheet. This sheet is available if the user would like to add UTCs that are not in the MEFPAK. Several UTCs have already been entered into this worksheet. The first seven are communications UTCs that had not been finalized as of this writing.[13] The next series of UTCs are munitions UTCs. These differ in name from those in the December 2001 MEFPAK.[14] The final UTC is a FMSE UTC that was found in our source for the fuels logic but was not in the December 2001 MEFPAK.
- **Vehicles** contains information for general-purpose vehicles. The first column, UTC, contains UFZ99, which would generally appear on a TPFDD for this field. The second through ninth columns were from the same source as the rules for general-purpose vehicles. The tenth column contains the weight of each vehicle in short tons. The eleventh and twelfth columns give the number of UTCs needed for the base and theater, respectively. The thirteenth through fifteenth columns give the short tons, volume, and area totals, respectively. Starting in the seventeenth

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[13] These data and movement characteristics were supplied by Robert Potter (ACC/SCCO).

[14] These data and movement characteristics were supplied by SMSgt Cedric McMillon (AFLMA/LGM).

column are the columns that contain the base requirements that will be totaled in the Theater Q column. The output and totaling work the same way as in the MEFPAK_Dec_2001 worksheet.

Most of the calculations in START are done via modules written in VBA. Hence, most fields that are calculated in START do not have associated code within the Excel worksheet. The code resides in VBA modules, which can be accessed via a window within Excel.[15] Hence, to see the logic or modify the code, the user must consult the corresponding VBA module. One other feature of the code will interest users who wish to update or maintain the model. UTCs within the MEFPAK and New UTCs sheets are referenced by searching by the UTC name, not by cell reference. This approach facilitates modifying the MEFPAK and New UTCs sheets with minimal alteration of the VBA code.

Detailed information on the sources of data, logic of the calculation, and estimates of the robustness of the results for each functional area are given in Chapter Three.

The Export Worksheet

One spreadsheet in START, Export, has no function in calculating either the intermediate or final results for the model. The purpose of this spreadsheet, as with the Export button on the Input window (in Figure A.2), is to integrate START with another model. During the calculating process, the UTC and quantity values from the Theater List worksheet are copied into this sheet. The user may find this summary useful for his or her own analytic purposes.

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[15] From the Tools menu, select Macro, then select Visual Basic Editor. This menu selection will launch the VBA editor. From the View menu of the VBA editor window, select Project Explorer. The algorithms for each functional area can be found in the Modules folder.

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