

UNCLASSIFIED

AD NUMBER
ADB221756
NEW LIMITATION CHANGE
TO Approved for public release, distribution unlimited
FROM Distribution authorized to DoD and DoD contractors only; Critical Technology; 12 Nov 96. Other requests shall be referred to U.S. Army Engineer School, Directorate of Combat Developments, Fort Leonard Wood, MO 65473.
AUTHORITY
USACERL ltr 25 Apr 2001

THIS PAGE IS UNCLASSIFIED



US Army Corps
of Engineers

Construction Engineering
Research Laboratories

USACERL Technical Report 97/38
January 1997

Revised Class IV Planning Factors

by
Carol A. Subick

The Class IV supply category includes fortification materials, obstacle and barrier materials, and construction materials for base development and general engineering. A quick, valid estimate of the Class IV supply requirements for a given contingency is crucial to high-level military planning and analysis. The Total Army Analysis (TAA) planning scenarios and various Army analysis tools use a single planning factor (consumption rate) to estimate the gross tonnage requirements as a function of the number of soldiers deployed. In previous work the U.S. Army Construction Engineering Research Laboratories (USACERL) was tasked to update the Class IV supply planning factor. Subsequently, representatives of the user community requested that the proponent of the study revisit two aspects of the final Class IV computation that could overestimate actual Army Class IV requirements under certain scenarios.

USACERL, in cooperation with user representatives and the proponent, met in October 1996 to discuss ideas for refining the computation of the overall consumption rate to best fit the requirements of the computer model used for the TAA studies. This report documents the computations made and the final algorithm derived for the Class IV planning factor as a result of the new methods adopted at the October 1996 meeting.

19970321 097

DTIC QUALITY INSPECTED 3
CRITICAL TECHNOLOGY

Distribution authorized to Department of Defense and DoD contractors only; ~~the report contains technical data on current technology in areas of significant military application.~~ This determination was made on 12 November 1996. Other requests shall be referred to: U.S. Army Engineer School, Directorate of Combat Developments, Fort Leonard Wood, MO 65473.

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products. The findings of this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

DESTROY THIS REPORT WHEN IT IS NO LONGER NEEDED

DO NOT RETURN IT TO THE ORIGINATOR

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE January 1997	3. REPORT TYPE AND DATES COVERED Final	
4. TITLE AND SUBTITLE Revised Class IV Planning Factors		5. FUNDING NUMBERS MIPR 01CER001F, dated 21 October 1996	
6. AUTHOR(S) Carol A. Subick			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Construction Engineering Research Laboratories (USACERL) P.O. Box 9005 Champaign, IL 61826-9005		8. PERFORMING ORGANIZATION REPORT NUMBER TR 97/38	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Engineer School ATTN: ATSE-CD-SIM Directorate of Combat Developments Fort Leonard Wood, MO 65473		10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES Copies are available from the Defense Technical Information Center, ATTN: DTIC-DDRB, Cameron Station, Alexandria, VA 22304-6145			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Distribution authorized to Department of Defense and DOD contractors only; this report contains technical data on current technology in areas of significant military application. This determination was made on 12 November 1996. Other requests shall be referred to: U.S. Army Engineer School, Directorate of Combat Developments, Fort Leonard Wood, MO 65473.		12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) The Class IV supply category includes fortification materials, obstacle and barrier materials, and construction materials for base development and general engineering. A quick, valid estimate of the Class IV supply requirements for a given contingency is crucial to high-level military planning and analysis. The Total Army Analysis (TAA) planning scenarios and various Army analysis tools use a single planning factor (consumption rate) to estimate the gross tonnage requirements as a function of the number of soldiers deployed. In previous work the U.S. Army Construction Engineering Research Laboratories (USACERL) was tasked to update the Class IV supply planning factor. Subsequently, representatives of the user community requested that the proponent of the study revisit two aspects of the final Class IV computation that could overestimate actual Army Class IV requirements under certain scenarios. USACERL, in cooperation with user representatives and the proponent, met in October 1996 to discuss ideas for refining the computation of the overall consumption rate to best fit the requirements of the computer model used for the TAA studies. This report documents the computations made and the final algorithm derived for the Class IV planning factor as a result of the new methods adopted at the October 1996 meeting.			
14. SUBJECT TERMS supply management planning factors construction materials		mobilization	15. NUMBER OF PAGES 26
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT SAR

Foreword

This study was conducted for U.S. Army Engineer School under Reimbursable Work Unit G27, "Class IV Study"; Military Interdepartmental Purchase Request (MIPR) 01CER001F, dated 21 October 1996. The technical monitor was David Loental, ATSE-CD-SIM.

The work was performed by the Maintenance Management and Preservation Division (FL-P) of the Facilities Technology Laboratory (FL), U.S. Army Construction Engineering Research Laboratories (USACERL). Dr. Simon S. Kim is Chief, CECER-FL-P, and Donald F. Fournier is Operations Chief, CECER-FL. The USACERL technical editor was Gordon L. Cohen, Technical Information Team.

COL James T. Scott is Commander of USACERL, and Dr. Michael J. O'Connor is Director.

Contents

SF 298	1
Foreword	2
1 Introduction	5
Background	5
Objectives	6
Approach	6
Mode of Technology Transfer	7
Metric Conversion Factors	7
2 Revised Class IV Computations	8
Introduction	8
Original Methodology	8
Revisiting the Issue of Army Support to the Air Force	11
Re-evaluating The Use of Averaged Consumption Rates	12
Other Revisions	14
Revised Class IV Consumption Rates for the TAA Scenarios	15
Algorithm for Computing a Contingency-Specific Class IV Planning Factor	16
3 Summary and Recommendations	19
Summary	19
Recommendations	19
References	21
Abbreviations and Acronyms	22
Distribution	

1 Introduction

Background

The U.S. Army logistics system divides supplies into ten major classes identified by Roman numeral. The Class IV supply category includes fortification materials, obstacle and barrier materials, and construction materials for base development and general engineering. Having a good, quick estimate of the Class IV supply requirements for a given contingency is crucial to high-level military planning and analysis, including Army force structure studies conducted under the Total Army Analysis (TAA) program as well as contingency planning using software support tools and published field manuals. These various analysis processes all use a single material consumption rate—or planning factor—to estimate the gross tonnage requirements as a function of the number of soldiers deployed. The Class IV tonnage requirements in turn affect lift and haul capacities, storage requirements, deployment schedules, etc.

In October 1994, the U.S. Army Construction Engineering Research Laboratories (USACERL) completed a study for the U.S. Army Engineer School with funding from the U.S. Army Training and Doctrine Command (TRADOC) to update the Class IV supply planning factor. The results of the study were reported in USACERL Technical Report FF-95/01, *Class IV Supply Planning Factors*. That report includes a description of the method used to estimate Class IV supply requirements for the two scenarios used for Total Army Analysis 2001 (TAA-01). The report also includes a Class IV supply consumption rate for the Gulf War, calculated from requisition records in the Logistics Intelligence File. Because the consumption rates for these contingencies differed, the final product of the study was not a single Class IV planning factor but a concise algorithm for computing a contingency-specific planning factor. This Class IV algorithm was derived from a spreadsheet model designed to estimate the total daily supply tonnage requirements by summing the estimated requirements for each type of task that uses Class IV materials. The algorithm's input parameters include:

- the type and number of divisions and separate brigades deployed
- the level of the theater's existing infrastructure
- the threat's capability for deep strike

- a descriptor for the maneuver pattern of the force, the Army population in theater on C-day, and the rate of deployment.

Analysts at the Planning Factors Branch of U.S. Army Combined Arms Support Command (CASCOM) reviewed the results of the USACERL study and questioned two key areas in the final computation of the consumption rates, both in the TAA-01 scenarios and in the Class IV algorithm. The first area of concern was the inclusion of materials required to support the Army's airfield work for the Air Force. The second area involved the use of an "average" consumption rate over 10-day time periods, which weighted the overall consumption rate toward the higher consumption during the first 50 days of a contingency when the population is smaller than average. Personnel from CASCOM, the U.S. Army Engineer School (USAES), and USACERL met in October 1996 to discuss how to improve the computation of the overall consumption rate so that the resulting numbers best fit the requirements of the computer model used for the TAA studies.

This report documents the computations made and the final algorithm derived for the Class IV planning factor as a result of the new methods adopted in the October 1996 meeting.

Objectives

The objectives of this work were to

- improve the accuracy of the computed Class IV supply consumption rates for the TAA-01 scenarios
- compute the Class IV consumption rates for the TAA-03 scenarios constructed after the original USACERL study
- update the Class IV planning factor algorithm based on the computational methods adopted by the joint efforts of USAES, CASCOM, and USACERL in October 1996.

Approach

Three sets of computations were required to update the work of the original study. First, the Class IV supply consumption rates for the two TAA-01 scenarios were

recomputed using the same method as the original study, but with the following changes to the data:

- removal of the Class IV supplies required to support the Air Force from the calculation
- adjustment of the material requirements for storage of POL (petroleum, oils and lubricants) to correspond with the planning data used for TAA-03, as documented in *TAA-03 Engineer Regional Construction Planning Data and Assumptions* (U.S. Army Concepts Analysis Agency [CAA] 1995)
- adjustment of the material requirements for non-divisional unit fortification and construction to use the planning data for a well developed theater with minimal threat capability instead of using the data for a developing theater with a highly capable threat.

Second, the Class IV consumption rates for the two TAA-03 scenarios were computed using the same method as described above for the TAA-01 scenarios.

Third, the spreadsheet model for estimating Class IV requirements was adjusted to (1) omit supplies used in support of the Air Force, (2) update the POL storage requirements, and (3) compute an overall average consumption instead of a time-stepped average. The model was then used to generate the comprehensive set of data points needed to develop a new concise algorithm for calculating a contingency-specific planning factor. Using a more extensive set of data points than was used in the original study allows the revised Class IV algorithm to cover a broader range of scenario possibilities than the original version of the algorithm.

Mode of Technology Transfer

It is recommended that the results of these latest computations be used to update the Army Force Planning and Data Assumptions (AFPDA) and related documents and software planning tools referencing Class IV supply consumption rates.

Metric Conversion Factors

U.S. standard units of measure are used throughout this report. A table of metric conversion factors is presented below.

1 in.	=	25.4 mm
1 ft	=	0.305 m
1 sq ft	=	0.093 m ²
1 lb	=	0.453 kg
1 gal	=	3.78 L

2 Revised Class IV Computations

Introduction

This chapter contains a description of the basic methods used in the original USACERL study to determine a contingency's Class IV requirements and to develop a representative planning factor. It also describes the difficulties of dealing with the two areas of concern addressed in the current work and the solutions proposed through the joint efforts of USAES, CASCOM, and USACERL (see Chapter 1, p 6).

Original Methodology

Although the Class IV supply planning factor is expressed in terms of a "pounds per soldier per day" rate, Class IV supplies actually do not fit as neatly into this framework as other classes of supply. The food supplies of Class I, for example, are closely related to the individual soldier, are consumed on a daily basis, and have a consumption rate independent of the size or type of force deployed. The Class I planning factor can be applied as intended: multiply it by the size of the force on the ground to estimate the gross daily requirement for that class. Class IV supply consumption, on the other hand, is not completely related to the requirements of the individual soldier and it varies considerably from day to day—not as a daily consumption but as many types of one-time expenditures to meet longer-term requirements. Also, the Class IV "pounds per soldier per day" rate is very dependent on the size and type of force deployed. Examples:

- An armor division requires less fortification material per soldier than an infantry division.
- The materials required for base development vary considerably from theater to theater; they are not directly related to individual soldier consumption but instead add to the "per soldier" consumption rate in inverse proportion to the size of the population.
- After a maneuver unit has developed a fortified position, its Class IV consumption rate is minimal until it moves to a new location, at which time the consumption rate can easily exceed 50 pounds per soldier per day until the new position is complete.

The computer models used for the TAA process require a single consumption rate, however. To overcome the fact that Class IV supplies do not lend themselves to a “pounds per soldier per day” rate, the original study derived a consumption rate by reversing the logic of planning factors—that is, by determining the gross requirement in “pounds per day” and dividing by the population. Ultimately, the Class IV spreadsheet model was used to derive numerical relationships between the daily consumption and the population.

The daily requirement for Class IV supplies can be calculated as follows:

$$\sum_{\text{TASK}} M_{\text{TASK}} + N_{\text{TASK}} \quad [1]$$

where M_{TASK} is the material requirement for a single task of type TASK, N_{TASK} is the number of tasks of type TASK performed per day, and the sum is taken over all tasks requiring the use of Class IV supplies. The tasks themselves were grouped into two major categories: (1) base development tasks and (2) unit barrier, fortification, and construction tasks. Base development tasks provide the infrastructure to support the warfighting effort: construction, repair, and maintenance of lines of communication (roads, airfields, railways, pipelines, seaports) and construction and repair of facilities (troop camps, storage areas, hospitals, enemy prisoner of war camps, maintenance areas, etc.). Unit barrier, fortification, and construction tasks include construction and fortification of positions (e.g., individual fighting positions, command posts, bunkers), emplacement of nonexplosive barriers and obstacles (e.g., triple-strand concertina, fences, gates), and unit construction (e.g., field latrines, forward helicopter landing facilities).

In Formula [1] above, the types of tasks and the Class IV materials required for each were readily determined and documented (see USACERL TR FF-95/01). The difficult element in the computation is N_{TASK} for each of the different types of tasks. For the TAA-01 scenarios, the original USACERL study used the actual TAA input and output of the Force Analysis Simulation of Theater Administrative and Logistic Support (FASTALS) to calculate the numbers of each type of task as follows:

1. Workload output from FASTALS identifies the number of engineer manhours expended on each type of base development task for each day of the simulation. FASTALS input determines the number of engineer manhours per unit task (See Wright and Ryczek 1992). N_{TASK} is easily computed for base development tasks by dividing the total manhours expended by the manhours per unit task.

2. Workload output from FASTALS provides details about the size, type, and location of divisional and non-divisional forces during each time period of the simulation. FASTALS input provides details about the level of combat and end strength for each divisional unit for each time period. The divisional and non-divisional Class IV requirements were tied to how often each unit moved to a new location and to the level of combat. Table 1 summarizes the Class IV requirements for each new location by type of unit. (See Technical Report FF-95/01 for derivation of these requirements). In periods of rapid movement and/or intense combat, only 25 percent of the requirement was estimated to be used for the corresponding time period. In periods of frequent movement with reduced combat, 50 percent of the requirement was used in the calculation.

From the two steps above, calculation of the total daily Class IV consumption is relatively straightforward using Formula [1]. One problem did arise, however. When the data for these calculations were reviewed by the 412th and 416th Engineer Commands, both commands pointed out that support to the Air Force is a major mission that accounts for as much as 30 percent of total effort for echelons-above-corps (EAC) engineers and that the FASTALS model does not directly represent this effort. FASTALS allows representation of unmodeled engineer tasks through dedicated manhours identified in an "Engineer Manhours, Additional Tasks" section called EZ. For TAA-01, the Major Regional Contingency-East (MRCE) scenario was allotted three combat heavy engineer battalions for support to the Air Force, and Major Regional Contingency-West (MRCW) was allotted one combat heavy engineer battalion. The *FASTALS User Manual* quotes a planning factor of 3827 manhours per day for each battalion. USACERL applied a method similar to the one used to

Table 1. Divisional and non-divisional Class IV supply requirements (pounds per soldier per location).

Type of Unit	With Overhead Cover (Initial Location)	No Overhead Cover (Initial Location)	No Overhead Cover or Field Facilities (Initial)	With Overhead Cover (Subsequent Locations)	No Overhead Cover (Subsequent Locations)	No Overhead Cover or Field Facilities (Subsequent)
ARMOR	375	314	NA	179	149	NA
MECHANIZED	372	312	NA	178	148	NA
INFANTRY (LT)	523	421	NA	250	199	NA
AIRBORNE	489	379	NA	238	184	NA
AIR ASSAULT	486	381	NA	247	195	NA
ACR	308	218	NA	154	109	NA
ARMOR SEP BDE	349	293	NA	159	131	NA
MECH SEP BDE	336	281	NA	153	126	NA
INF (LT) SEP BDE	433	320	NA	198	141	NA
NONDIVISIONAL UNIT	437	366	252	216	181	114

derive manhours per unit task and Class IV pounds per unit task for the other base development tasks modeled in FASTALS to determine a pounds per manhour requirement for Air Force support. That rate was then multiplied by the FASTALS-specified 3827 manhours per day for each battalion, and the weight was added to the total daily consumption.

Given the total daily consumption of Class IV for each day of each scenario in TAA-01, the next task was to derive an overall consumption rate for the scenario. The original study looked at the consumption rates in 10-day time intervals and used the average of those individual rates over the 130–140 days of the contingency. Based on this approach, the computed consumption rates were 15.9 lb/soldier/day for MRCW and 22.35 lb/soldier/day for MRCE.

USACERL used the experience of working with the TAA-01 scenarios and FASTALS design elements as the basis for constructing a computer spreadsheet model to estimate a contingency's daily Class IV requirements as determined by the type of force deployed, the level of theater infrastructure in place, the level of host nation and contractor support, the capabilities of the threat, the maneuver pattern of the divisional and non-divisional forces, and population changes over the course of a 180-day scenario. The spreadsheet model, called C4, was based on a detailed calculation of each task's requirements within the circumstances described by the model inputs. C4 was able to predict the consumption rates calculated for MRCW, MRCE, and Operation Desert Shield/Desert Storm, for which the study used requisition records to determine a Class IV consumption rate. A variety of scenarios was entered into C4, and C4's predicted consumption rates were recorded. These data were used to develop a simple, concise algorithm capable of closely approximating the consumption rates predicted by C4 for the range of scenarios studied.

Revisiting the Issue of Army Support to the Air Force

As stated in the preceding section, determining the daily Class IV supply requirement in support of airfield work for the Air Force was accomplished with far less accurate data than were used for the other 23 base development tasks in the TAA-01 scenarios. The 23 tasks modeled in FASTALS have an associated manhour requirement that is based on model-generated demands. The manhour requirements for each task rise and fall according to established relationships with other data in the simulation. However, the manhours required for support of the Air Force were entered as a static amount. When a material requirement was calculated for this dedicated effort, support to the Air Force became a major part of the total daily base development requirement for Class IV materials in both MRCE and MRCW. This

large requirement, entered without a detailed calculation of demand, is one of the areas of concern addressed by the current work.

Personnel from USAES, CASCOM, and USACERL agreed in a joint October 1996 meeting that the best way to handle this concern with the original study's calculations was to delete the Class IV material requirements in support of the Air Force, recompute the requirements, and publish the results with the note that the final numbers do not include support to the Air Force.

The decision to omit the Air Force requirements from the calculation was based on three reasons:

1. After the original USACERL study, engineer planning assumptions for TAA no longer represented support for the Air Force as a manhours requirements in FASTALS.
2. Changes in doctrine and mission in recent years have left unanswered questions about whether the Army or the Air Force would actually be responsible for procuring Class IV supplies for airfield work.
3. The TAA scenarios did not contain sufficient data to provide an auditable estimate of the supply requirements for Air Force support.

The results of this change are reported later in this chapter, under the heading "Class IV Consumption Rates for the TAA Scenarios."

Re-evaluating The Use of Averaged Consumption Rates

As previously noted, Class IV materials do not fit the framework of a "lbs/soldier/day" consumption rate. Figure 1 illustrates the problem of having to assign a single overall planning factor to a contingency. The *Computed Consumption* line in Figure 1 refers to the total daily Class IV consumption for the Northeast Asia (NEA) scenario (TAA-03) using Formula [1] with the method described under "Methodology." Typically, Class IV consumption is very high during the first 30 to 50 days of a contingency: as new troops arrive, large quantities of Class IV materials are required to establish an initial position, and again later when base development is at its peak. To capture this pattern, the original USACERL study looked at the consumption rates in 10-day periods and used their average as the overall planning factor for a given scenario. However, this approach weighted the planning factor toward the higher consumption rates of the first 30 to 50 days. The current work addresses the concerns expressed about this unintended overestimation of the overall planning factor.

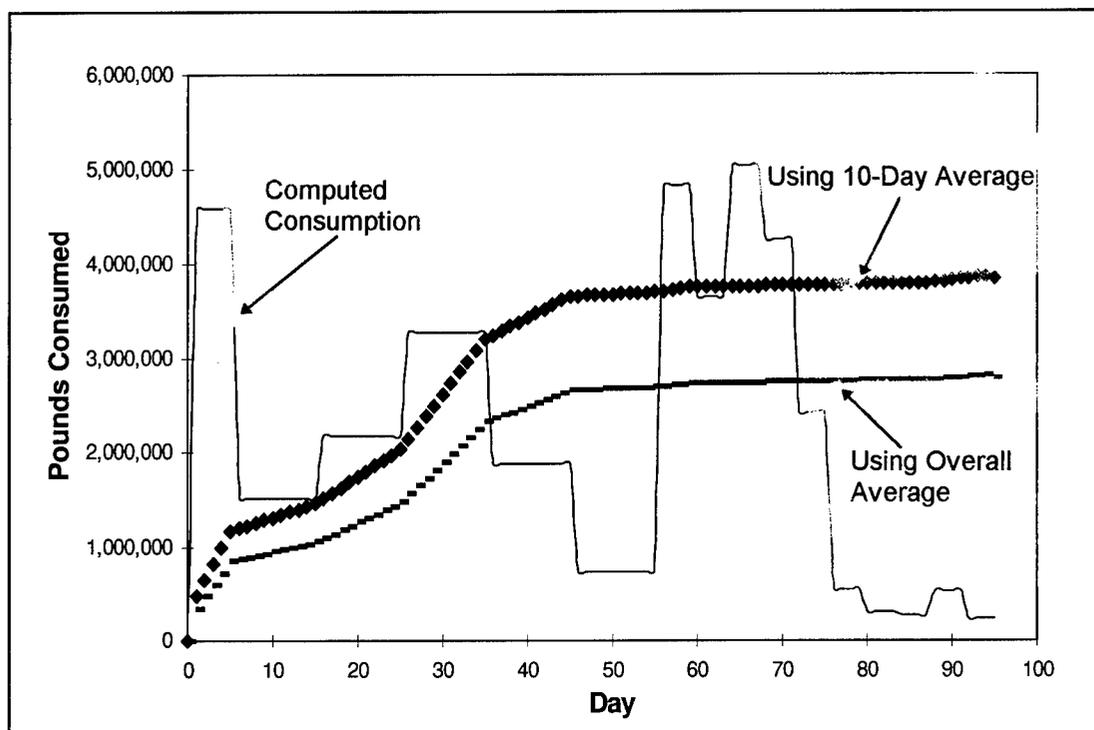


Figure 1. Comparison of computed daily consumption, 10-day average consumption, and overall planning factors (North East Asia scenario, TAA-03).

In its intended use, the planning factor would be multiplied by the day's population to determine the quantity of material required for that day. In Figure 1, the curve labeled *Using 10-Day Average* represents the daily requirement as computed by multiplying the day's population by a planning factor derived by averaging the consumption rates in 10-day time periods. This method was used in the original study to establish an overall planning factor for the scenario. The curve labeled *Using Overall Average* represents the daily requirement as computed by multiplying the day's population by a planning factor derived as follows:

$$\text{Overall Average} = \frac{\text{Total Class IV Materials Consumed in Contingency}}{\text{Average Population} \times \text{Number of Days in Contingency}} \quad [2]$$

Neither the 10-day average nor the overall average yields a good prediction for the first 5 days. Furthermore, both tend to overestimate after day 50, with the 10-day average performing worse than the overall average during that span of time.

The concern expressed about using the 10-day average was the mathematical soundness of averaging the rates, because averaging overemphasizes the higher consumption rates of the first 30–50 days, when the population is relatively small. While the overall average *can* be used to calculate the overall Class IV requirement without overestimating, the overall average is *not* good at capturing the huge fluctuation

tuations likely to occur in daily requirements. However, due to the inherent nature of Class IV consumption, it must be conceded that no single number would be able to capture such fluctuations.

The recommendation of the joint USAES/CASCOM/USACERL meeting was to compute the overall Class IV planning factor for a contingency by using Formula [2] instead of using the average of the 10-day rates.

The joint discussions addressed concern about the higher rates typically found during the first 30–50 days of a contingency, which tend to be 2 to 3 times the average consumption rate. The C4 model was used in an attempt to establish rules of thumb for multiplying the planning factor by given multiples during the early period of the contingency. Examination of the data, however, indicates that no general rules can be established. If a contingency has a large initial force that is already in place on C-day, has a very slow deployment rate for additional troops, and requires no change of location during the first 30 days, the consumption rate during that phase can actually be lower than the overall average. At the other end of the spectrum, if a contingency has a small initial force on C-day, requires a very rapid deployment of new troops into the theater, and has little existing infrastructure to use, then Class IV consumption rates during the first 30 days can be 3 times the average rate or more. The data in Table 1 indicate that 100 to 500 lb of Class IV material per soldier would be required to establish a unit position in a mid-intensity conflict. Information gathered during the original study about materials required for a base camp in Somalia supports the notional estimate that 900 lb or more per soldier would be required for peace-keeping operations where more substantial housing requirements place a heavy burden on lumber and plywood.

Other Revisions

The planning guidance for TAA-03 indicated a substantial change in the manhour and material requirements for POL storage facilities. The original USACERL study included both tactical petroleum terminals (TPT) and inland POL storage facilities using the Army Facilities Component System (AFCS) facilities listed in Table 2. Engineer planning data for TAA-03 indicated planning for tank farms consisting only of TPT facilities (12665BB). During the current effort, USACERL personnel verified these new planning data with the proponent for AFCS at U.S. Army Engineer Division, Huntsville, U.S. Army Corps of Engineers. The new material

requirements data were subsequently used both in the TAA calculations and in the revised C4 model.

The original USACERL study had computed Class IV requirements for the TAA-01 scenarios (MRCW and MRCE) based on an assumption that both scenarios could be described as having theaters needing substantial infrastructure development and facing high-capability threats. The revised calculations were based on the assumption that both theaters have well developed infrastructures and face minimal threat capabilities. This change in assumptions did not affect base development consumption because that requirement was derived from computed engineer manhours. However, the revised assumptions did affect the quantities of material used by non-divisional forces. The assumption of a well developed theater with minimal enemy capability indicates no need for overhead cover or field facilities—i.e., the assumption is that non-divisional forces are housed in existing protected structures.

Table 2. Facilities used for workload calculations for POL storage (TAA-01).

AFCS Facility	Facility No.
TPT Tank Farm Module, 10mbbl Cap	12665BB
3 Fuel/Water Stor 50,000 Gal Fab Bag	41180BD
Fuel/Water Stor 10,000 Gal Fab Bag	41180BC
Tank Pump (2800 Bph)	12530AK
Switch Manifold (6in W/O Pump)	12510AB
6in-Switch Mnfld F/Tnk Farm W/O Pmp	12510AB
Tank Pmp Pol 700 Bph W/6 In Manifd	12510AH
Trans Pmp Pol 700 Bph W/6 In Mnfd	12510AN
P/L Set 6in Alum W/Clmp Coup 1000ft	12510DG
P/L Set 6in Alum W/Clmp Coup 1000ft	12510DG
Flood Pump (785 Bph W/8 In Dia)	12510AE
Lightweight Tubing (1000 Ft W/6 In Dia)	12510AU
Flood Pmp 785 Bph 6 In Manifold	12510AE
Api Pipe (1000 Ft W/6 In Diameter)	12510BJ
Tank Pump (700 Bph W/6 In Dia)	12510AH
Transfer Pump (700 Bph W/6 In Dia)	12510AN
Hardstand (350 Sy) And Facility (800 Sf)	61050YA
Security Fence	87210AR
Security Gate	87210AT
Fuel Sys Sup Pt (120000 Gal)	12640BA

Revised Class IV Consumption Rates for the TAA Scenarios

USACERL used FASTALS input and output data in the steps described above to calculate a Class IV supply consumption rate for each of the scenarios of TAA-01 (MRCW and MRCE) and TAA-03 (NEA and SWA). Support to the Air Force was removed from the calculations; the material requirements for POL storage were updated; and non-divisional requirements were changed to those of a well-developed infrastructure with minimal threat capability. The overall planning factor was calculated using Formula [2] instead of the average of the 10-day consumption rates. The results of these new calculations are given in Table 3.

Table 3. Revised Class IV supply requirements for TAA-01 and TAA-03 scenarios.

	Unit of Measure	MRCE (TAA-01)	SWA (TAA-03)	MRCW (TAA-01)	NEA (TAA-03)
Average Daily Population	Soldier	317,799	272,228	174,457	238,654
Total Number of Days (C-Day to End)	Day	115	130	140	95
Total Class IV Materials Consumed	Pound	354,625,109	298,142,542	225,803,021	207,205,304
Total Base Development Consumption	Pound	113,459,581	65,709,550	34,197,321	34,540,101
Total Unit Barrier/Fortification/Construction	Pound	241,142,847	232,432,992	191,605,700	172,665,203
Calculated Consumption Rate	Lb/Soldier/Day	9.70	8.42	9.25	9.14
Class IV Algorithm Estimate	Lb/Soldier/Day	10.04	8.09	10.32	9.92
Percent Difference Estimated vs Calculated		3.5%	-4.0%	11.6%	8.5%
Base Development as Percent of Total		32.0%	22.0%	15.1%	16.7%

Algorithm for Computing a Contingency-Specific Class IV Planning Factor

The original C4 spreadsheet model designed by USACERL to estimate a contingency's Class IV supply requirements from detailed calculations for each task was updated with the changes described above. In the original study, only 486 scenarios were used to generate data points. These scenarios were generated by using various combinations of force composition (heavy, light), level of infrastructure (well developed, developing, austere), level of threat capability for deep strike (none, moderate, high), force movement pattern (stationary, a withdraw/defend/attack flow of battle, move every 20 days), initial force size (5K, 10K, 50K), the number of days required to deploy half of the total force (60, 90), and the length of the contingency (120 days, 180 days). In the current work, a more exhaustive set of scenarios was generated. A mixed force of heavy and light divisions was added. Initial force sizes of 0, 10K, 20K, 30K, 40K, and 50K were used. The number of days to deploy half of the force could be 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120. The length of the contingency could be 120, 130, 140, 150, 160, 170, 180. Except for infeasible combinations, such as a 120-day contingency in which half the force was deployed in 120 days, all possible combinations were explored. This generated over 32,000 data points. In other words, for each combination of the seven factors used to describe a scenario, C4 estimated the average consumption rate. The SOLVER tool in Microsoft Excel 7.0* was used to minimize the sum of the square of the differences between the C4 estimate and the estimate generated by a proposed product of common scenario multipliers.

* Microsoft Excel is a trademark of Microsoft Corp., Redmond, WA.

The results of this effort are given in the Class IV algorithm (Figure 2). Using this algorithm produces a planning factor within one pound of the C4 rate for the given scenario in 85 percent of the 32,000-plus scenarios generated. The algorithm is within 15 percent of the C4 rate in 91 percent of the scenarios. In 7 percent of the cases, the algorithm overestimates by more than 15 percent of the C4 rate. The overestimated cases are all scenarios in which the consumption rate is under 5 lb/soldier/day, the initial force is very large, deployment is rapid, and the force is stationary. The algorithm underestimates by more than 15 percent of the C4 rate in 2 percent of the 32,000-plus scenarios. The underestimated cases are all characterized as short contingencies (120–130 days), small initial force, and extremely slow deployment (100–110 days to deploy half of the force).

The revised Class IV algorithm is a simple method for determining a contingency-specific Class IV planning factor that generally provides a better estimate than a single Class IV planning factor.

A Class IV consumption rate for a Corps-sized 180-day contingency may be computed by using the following formula with factors from the appropriate tables below. This method assumes base development tasks are limited to road, pipelines, troop camps, supply storage facilities, and EPW camps using austere initial standard construction. This method excludes material requirements in support of the Air Force.

$$\text{CLASS IV CONSUMPTION RATE} = \text{BASE RATE} \times \text{CONTINGENCY FACTOR} \times \text{MANEUVER FACTOR} \times \text{DEPLOYMENT RATE FACTOR} \times \text{INITIAL FORCE FACTOR}$$

BASE RATE

Type of Force	Factor
Heavy Force	3.6
Light Force	4.0
Mixed Force	3.8

CONTINGENCY FACTOR

	Threat's Deep Strike Capability		
	None	Moderate	High
Threater Infrastructure	1.00	1.24	1.29
Developing	1.30	1.55	1.60
Austere	1.31	1.56	1.59

FACTOR FOR LENGTH OF CONTINGENCY

Length (Days)	Factor
170	1.07
160	1.08
150	1.18
140	1.19
130	1.33
120	1.37

DEPLOYMENT RATE FACTOR

Days to Deploy First Half of Force	Factor
120	1.09
110	1.07
100	1.03
90	1.00
80	0.96
70	0.93
60	0.91
50	0.9
40	0.88
30	0.87

MANEUVER FACTOR

Movement Pattern	Factor
Stationary	1.00
Withdraw, defend, attack	1.84
Move every 20 days	2.32

INITIAL FORCE FACTOR

Size of Initial Force	Factor
0 - 10000	1.00
10000 - 20000	0.98
20000 - 30000	0.96
30000 - 40000	0.95
40000 - 50000	0.93
50000+	0.92

If the contingency is planned for less than 180 days, use these factors to adjust the consumption rate computed above. Consumption during the first 30 to 50 days of a contingency will be much higher than the computed rate, perhaps as high as 20 to 40 lbs/soldier/day when the initial force is small and the rate of deployment is high. Contingencies shorter than 180 days reflect this front-end requirement by having higher overall consumption rates than those expected in longer contingencies.

Figure 2. Method for computing contingency-specific Class IV supply consumption rate.

3 Summary and Recommendations

Summary

In this work, four major changes were made to the computations of Class IV planning factors previously formulated by USACERL and documented in USACERL TR-FF-95/01. The four changes were:

1. omission of Class IV materials required in support of the Air Force
2. updating of the Class IV supply requirements for POL storage
3. assumption that the scenarios for TAA-01 and TAA-03 represent theaters with well developed infrastructures and minimal threat capabilities, instead of the previous assumption that they have developing infrastructures and face a highly capable threat
4. use of the average consumption as the overall planning factor instead of an average of consumption rates over 10-day time intervals.

Each of these four changes lowered the overall planning factor previously reported for all scenarios and for the Class IV algorithm used for computing a contingency-specific planning factor. Overall, the changes suggested by the joint committee of personnel from USAES, CASCOM, and USACERL improve the accuracy and utility of the resulting planning factors for TAA scenarios and for the concise Class IV algorithm.

Recommendations

It is recommended that the results of the revised Class IV computations be used to update the Army Force Planning and Data Assumptions (AFPDA) and related documents and software planning tools referencing Class IV supply consumption rates.

Because using the average consumption rate will frequently result in underestimating the requirements during the first 30 to 50 days of a contingency, as in the NEA scenario shown in Figure 1 (Chapter 2), it is recommended that further investigations be conducted to develop a method for predicting the higher Class IV

requirements during that period. Operations plans and logistics plans should be developed with more detailed data than can be supplied by the Class IV planning factor to ensure that initial forces can be supported with sufficient fortification and barrier materials.

The current results apply only to mid- to high-intensity conflict. Troop support in peacekeeping operations requires considerably more Class IV materials than do the austere accommodations typically planned for combat situations. It is recommended that Class IV consumption data from recent U.S. military operations be gathered and analyzed so comparable planning factors can be developed for these new types of deployments.

References

Subick, Carol, *Class IV Planning Factors*, Technical Report FF-95/01/ADA294539 (U.S. Army Construction Engineering Research Laboratories, March 1995).

TAA-03 Engineer Regional Construction Planning Data and Assumptions, CAA-MR-95-52 (U.S. Army Concepts Analysis Agency, 1995).

Wright, Larry, and Stephan Ryneczek, *Revised Engineer Workload Factors Study (FASTALS Construction Model)*, CETEC-ES-R-92-4 (U.S. Army Topographic Engineering Center, Engineer Strategic Studies Center, July 1992).

Abbreviations and Acronyms

AFCS	Army Facilities Component System
AFPDA	Army Force Planning and Data Assumptions
CAA	U.S. Army Concepts Analysis Agency
CASCOM	U.S. Army Combined Arms Support Command
FASTALS	Force Analysis Simulation of Theater Administrative and Logistic Support
MRCE	Major Regional Contingency–East
MRCW	Major Regional Contingency–West
NEA	Northeast Asia
POL	petroleum, oils and lubricants
SWA	Southwest Asia
TAA	Total Army Analysis
TPT	tactical petroleum terminals
TRADOC	U.S. Army Training and Doctrine Command
USACERL	U.S. Army Construction Engineering Research Laboratories
USAES	U.S. Army Engineer School

USACERL DISTRIBUTION

Chief of Engineers
ATTN: CEHEC-IM-LH (2)
ATTN: CEHEC-IM-LP (2)
ATTN: CECC-R
ATTN: CECW-OE-P
ATTN: CERD-L

U.S. Army Engineer School
ATTN: ATSE-CD-A (150)
ATTN: ATSE-CD-SIM

Headquarters, Army
ATTN: DAEN-ZCM

U.S. Army Concepts Analysis Agency
ATTN: CTSA-RSF

U.S. Army Combined Arms Support Command
ATTN: ATCL-FSP

U.S. Army Engineer Strategic Studies Center

U.S. Army Engineer Division, Huntsville
ATTN: CEHND-ED-SY

Transatlantic Division, USACE
ATTN: CETAD-DE

U.S. Army Logistics Evaluation Agency
ATTN: LOEA-PL

USAMC Logistics Support Activity
ATTN: AMXLS-RA

412th Engineer Command
ATTN: AFRC-ENMS-EN

416th Engineer Command
ATTN: AFRC-ENIL-PT

Assistant Corps Engineer Forward
ATTN: AFZH-EN

Commander, III Corps
ATTN: AFZF-GT

Commander, HHC, 20th Engineer Brigade
ATTN: AFZA-AE-CDR

Commander, 36th Engineer Group
ATTN: S-3

Defense Tech Info Center 22060-6218
ATTN: DTIC-O (2)

174
1/97



REPLY TO
ATTENTION OF:

DEPARTMENT OF THE ARMY
ENGINEER RESEARCH AND DEVELOPMENT CENTER, CORPS OF ENGINEERS
CONSTRUCTION ENGINEERING RESEARCH LABORATORY
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

April 25, 2001

Technical Information Group

Defense Technical Information Center
ATTN: Mr. Larry Downing
8725 John J. Kingman Road
Ft. Belvoir, Virginia 22060-6218

Reference: USACERL Technical Report 97/38, ADB221756, Distribution Change

Dear Sir:

The referenced report, submitted in 1997, should now be listed with the following distribution code: A: Approved for Public Release; distribution is unlimited. The proponent has determined that the data contained in the report is no longer sensitive in nature.

If you have any questions, please contact Ms. Pat Lacey, Library Technician, at 217-373-7217.

Sincerely,

A handwritten signature in black ink, appearing to be "D. P. Mann", followed by a horizontal line.

D. P. Mann
Chief, IT Coordination Center

Enclosure

Mann, Diane P ERDC-ITL-IL

From: Finney, Dana L ERDC-CV-IL
Sent: Tuesday, April 10, 2001 7:27 AM
To: Mann, Diane P ERDC-ITL-IL; Krites, Debra K ERDC-ITL-IL
Cc: Subick, Carol A ERDC-CERL-IL
Subject: FW: Release, part 2

-----Original Message-----

From: Wineinger, Robert MAJ [mailto:WineingR@WOOD.ARMY.MIL]
Sent: Monday, April 09, 2001 4:41 PM
To: 'Finney, Dana L ERDC-CV-IL'
Subject: RE: Release, part 2

The Distribution statement to the Revised Class IV Planning Factors Technical Report By Carol A Subick (USACERL Technical Report 97/38) should be change to "Distribution Unlimited." It has been determined at this time that the data contained in the report is no longer sensitive in nature.

MAJ R. Kent Wineinger
Simulations and Analysis Center
DCD, MANSCEN
Ft. Leonard Wood, MO 65473-8929
Comm: (573) 563-4084 or (573) 596-0131 ext. 3-5293
DSN: 676-5293
E-mail: wineingr@wood.army.mil

4/25/2001