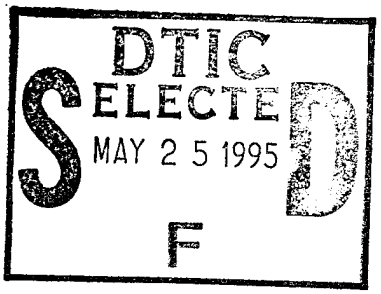
SURVIVABILITY • SUSTAINABILITY • MOBILITY
SCIENCE AND TECHNOLOGY
SOLDIER SYSTEM INTEGRATION

TECHNICAL REPORT
NATICK/TR-94/026

AD_____

INTEGRATED UNIT SIMULATION SYSTEM: METABOLIC WORK RATE SUPPORT STUDY



By
Tammy L. Ramirez
Mary Hoffman

Battelle
Columbus, OH 43201-2693

July 1994

FINAL REPORT
February 1993 - August 1993

Prepared for
UNITED STATES ARMY NATICK
RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
NATICK, MASSACHUSETTS 01760-5000

ADVANCED SYSTEMS CONCEPTS DIRECTORATE

DISCLAIMERS

The findings contained in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of trade names in this report does not constitute an official endorsement or approval of the use of such items.

DESTRUCTION NOTICE

For Classified Documents:

Follow the procedures in DoD 5200.22-M, Industrial Security Manual, Section II-19 or DoD 5200.1-R, Information Security Program Regulation, Chapter IX.

For Unclassified/Limited Distribution Documents:

Destroy by any method that prevents disclosure of contents or reconstruction of the document.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	July 1994	FINAL Feb 1993 - Aug 1993

4. TITLE AND SUBTITLE
Integrated Unit Simulation System:
Metabolic Work Rate Support Study

5. FUNDING NUMBERS
2132040 36T-6T06
P665502 S19129
C DAAK60-93-C-0020

6. AUTHOR(S)
Tammy L. Ramirez and Mary Hoffman

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Battelle
505 King Ave.
Columbus, OH 43201-2693

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Natick Research,
Development and Engineering Center
Kansas St. ATTN: SATNC-AA
Natick, MA 01760

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
NATICK/TR-94/026

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release;
distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The purpose of this study was to develop a method of calculating physical work rate for the type and duration of tasks of soldier performance while in the field. A nomagraph was developed to assist modelers with the simulation of task performance. A literature search revealed over 24 different models. Two of these were selected for further study. These models can be used for detailed analysis of specific tasks. For general data gathering, the method presented in this study presents an adequate representation of physical work performed by soldiers.

14. SUBJECT TERMS

PHYSICAL WORK	COMBAT ENVIRONMENT	MODELS
TASK PERFORMANCE	CHEMICAL THREAT	WORK
ARMY PERSONNEL	PERFORMANCE (HUMAN)	WATER

15. NUMBER OF PAGES
70

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

Table of Contents

Tables

Preface

This research was sponsored by the U.S. Army Natick Research, Development and Engineering Center, Concepts Analysis Division, Advanced System Directorate, Natick , MA. The contract number was DAAK60-93-K-0001, under the Broad Agency Announcement Solicitation. Mr. John O'Keefe was the technical manager and Mrs. Elaine Scarnici was the contracts specialist for the effort.

INTEGRATED UNIT SIMULATION SYSTEM: METABOLIC WORK RATE SUPPORT STUDY

1.0 INTRODUCTION

The development of an automated Integrated Unit Simulation System (IUSS) is in the design stage. The IUSS is in the process of being populated with various tools which will assist the user, developer and system designer with the investigation of the equipment needs for the soldier of the future. This system extends the modeling capability to look at the individual soldier's performance in a combat environment with ballistic and chemical threats.

We have reached the level of modeling sophistication that we can now look more deeply into the performance of the soldier, to portray an individual's task performance in various environments and investigate the outcomes based on the performance options presented to the soldier and do this for many individuals in a combat scenario.

The IUSS simulates combat according to the Battlefield Operating Systems (BOS) tasks as defined in the Army Training and Evaluation Program and Mission Training Plans (ARTEP/MTPS), ensuring a common framework for analysis, training and combat operations by enhancing communication within the soldier/weapon system design process. The IUSS represents the mission capabilities and the soldier status throughout the simulated mission. The mission is represented as a set of networks with the nodes of the network presented as BOS tasks. The soldiers' performance status is represented by a physiological baseline of core temperature, hydration level, heart rate and level of performance degradation as output.

The information gained from this modeling can be used to design clothing and equipment, and to develop training or change doctrine based on the needs of the soldier. Of course, inputs in the form of quantitative data and equations are required to provide a certain level of validation for IUSS. One of the required inputs is the metabolic work rate of military tasks performed over an extended period of time. As the soldiers are tracked through the network of the IUSS, their physical status is displayed while the task environment changes.

1.1 Objective of Study

One of the problems encountered while preparing the soldier system of IUSS was the representation of the metabolic work rate of the soldier as the work rate relates to specific tasks and the ability to vary a work rate over different levels of tasking for long periods of time. Work rate is defined as the total energy expenditure of the body per unit of time, also referred to as metabolic workload.

The US Army Research Institute of Environmental Medicine (USARIEM) is in the process of developing a Metabolic Task Inventory based on empirical measures of task performance, but this inventory will not be complete until late 1994. The IUSS requires a method for representing task/metabolic work rate data within the next six months.

This study was initiated to develop a method of calculating the metabolic work rate for the type and duration of tasks for the total time the soldier is in the field. This calculation becomes an input to the soldier status system of IUSS to determine core temperature, fatigue levels and effects of load-bearing equipment and protective clothing on soldier performance.

To meet this task, four objectives were initiated:

Review the industrial/commercial/military literature for methods, modeling representations and data on metabolic work rate.

Develop a useful algorithm and methodology for calculating work rate based on task time performance of soldiers during an 8 to 12 hour combat environment.

Assist the Government with the insertion of the metabolic work rate formula(e) into the IUSS.

Prepare a preliminary report of the findings, with recommendations as to the best metabolic work rate method to use with IUSS.

1.2 Assumptions for Development and Use of the Algorithm with IUSS

Most of the prediction models of physiological performance tend to underpredict both heart rate and oxygen uptake. These models have historically been based on load carriage while using a treadmill for data collection. Most of the data to validate these models are from field studies, which means there is a change in pace, load carriage is not smooth or accurate and negotiation of the walkway in the field is very different from the treadmill. Therefore, changes to the algorithm must be assumed to account for the field environment.

This method is a very small, but important part of the soldier status system and must be empirically validated with information from the USARIEM program being conducted at Natick, Ma.

The particular method selected may be a composite of different methods or a very simplistic procedure based on the ability to fit the code into the module which will interact with the entire soldier system program of IUSS.

The method of assigning work rate to various tasks to test the algorithm needs validation. A procedure of weighting the work based on mostly dexterous and gross motor tasks has had limited use in the past. The measurement of purely cognitive tasking (decision making, planning etc.) as a measure of work rate requires different methods for determining the energy cost because cognitive tasking is not a matter of movement of musculature, the energy expenditure involves being seated or standing and may be considered as a task which requires very little metabolic work load.

2.0 METHOD

2.1 Literature Search

A search of on-line databases was conducted to find research performed to date on metabolic work rates and algorithms or models for predicting work rate. Only commercial databases were included in this search since DoD sources were gathered from the Defense Technical Information Center (DTIC). The list in Table 1 includes the databases searched within DIALOG. Appendix A contains a brief description of each database.

Table 1. Database Listing

AEROSPACE DATABASE
AMERICAN MEDICAL ASSOCIATION
JOURNALS ONLINE
BIOSIS PREVIEWS
DISSERTATION ABSTRACTS ONLINE
EiCOMPENDEX*PLUS
EMBASE (formerly EXCERPTA MEDICA)
ENERGY SCIENCE AND TECHNOLOGY
FLUIDEX (FLUID ENGINEERING ABSTRACTS)
HEALTH PERIODICALS DATABASE
IHS INTERNATIONAL STANDARDS AND SPECIFICATIONS
INSPEC
INTERNATIONAL PHARMACEUTICAL ABSTRACTS
MECHANICAL ENGINEERING ABSTRACTS
MEDLINE
NATIONAL NEWSPAPER INDEX
NEWSEARCH
NTIS
PASCAL
SCISEARCH
SPORT
STANDARDS AND SPECIFICATIONS
TOXLINE
TRADE AND INDUSTRY ASAP
TRADE AND INDUSTRY INDEX
WORLD TRANSLATION INDEX

The search strategy included the following keywords: metabolic, work rate, physiological, physical, watts, kilocalorie, models, exertion, fatigue, exhaustion, demand, capacity and human performance.

The results of the database search produced titles and abstracts which contained the keywords. The abstracts were reviewed and relevant documents ordered. The bibliography (Appendix B) lists all the articles reviewed on metabolic work rate. The references contain information documenting relevant research and/or metabolic work rate algorithms or models which are listed in the matrix in the following section.

2.2 Decision Matrix

The dissertations found from the database search provided an extensive review of the literature on metabolic algorithms, particularly Taboun's dissertation. Twenty-four models were found from the search which calculated metabolic work rate in one form or another. Garg's (1978) model was found to be the most comprehensive model documented in the literature. Konz's (1990) algorithm also accounted for a variety of activities, but the activity metabolism is taken from a table of thirty activities, or a known metabolic rate. The objective of this project was to establish an algorithm which calculates the metabolic work rate of soldiers for the variety of tasks they perform. The metabolic work rates are not known for all those tasks, and more importantly, the work rate is dependent on the individual. Konz's model does not meet this objective because of its limited activities.

Table 2 lists all the equations/algorithms/models found in the literature. A matrix shown in Table 3 indicates the tasks each algorithm models.

Table 2. Metabolic Work Rate Models

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Aberg et al. (1968)	lifting	VO_2 = BWn(k1) + BWcl(k2) + BWcl[GCBh(k3) + GCBv(k4)] + (WWP + WT)[Lha(k5) + u(Lhc)(k6) + Lvu(k7) + Lvd(k8)]	BWn = body wt naked (kg) BWcl = body wt w/ clothing (kg) GCBh = horiz displacement per time unit of body's CG (meters) GCBv = vertical displacement per time unit of body's CG (meters), + up, - down WWP = wt of workpiece (kg) WT = wt of tool (kg) Lha = horiz displacement per time unit of tool and workpiece, arm work (meters) Lhc = horiz displacement per time unit of tool and workpiece, carrying or dragging (meters) Lvu = upward vertical displacement per time unit of tool and workpiece - lifting (meters) Lvd = downward displacement per time unit of tool and workpiece - lifting (meters) u = coefficient of friction k1-k8 constants	VO_2 = oxygen uptake (L/min)	doesn't consider container size dynamic lifting k1 basal metabolism k2 sitting/standing k3 walking k4 bending and rising k5 horiz transport of material (arm working) k6 horiz transport of material (carrying) k7 lifting upwards k8 lifting downwards

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Asfour (1980)	lift/lower	$VO_2 = 545.7538 - 106.77(TA) + (FY)(L^2)(35002.65L)10^{-5} + 17.47(FY)(L)(HT1)(WT)(WID)(LEN)(ANG)10^{-5} + 6435.22(WT)(FY^2)10^{-5}$ $VO_2 = 371.5055 - 51.9573(TA) + (WT)(FY^2)(31856.54 - 2332.8FY)10^{-5} + 12684.91(FY)(L^2)10^{-5} + 12.31(FY)(HT2)(L)(WID)(LEN)(ANG)10^{-5}$	TA = task (1=lift; 2=lower) FY = freq of lift/lower (times/min) L = load (lbs) HT1 = height lift/lower above floor (inches) HT2 = height lift/lower above table (inches) WID = box width (inches) LEN = box length (inches) ANG = angle of twist (1 for 0 degrees, 2 for 90 degrees) WT = body weight (lbs)	VO_2 = ml/min	eqn 1: start/end at floor level eqn 2 start/end at table higher than 30"
Buskirk, Nicholas and Hodgson (1975)	treadmill walking cranking shoveling stepping lifting gripping	METS = 0.017(WT) + 0.019(HR) + 0.116(Ve) - 3.0419 simplified equation: METS = 0.145(Ve) - 0.353 or kcal = 0.06(WT) + 0.025(HR) + 0.158(Ve) - 6.94	WT = body weight (kg) HR = heart rate (beats/min) Ve = minute ventilation (L/min)	METS METS kcal/min	eqns developed from activities of 9 healthy men ages 21-56 at 3 WBGT (26.7C, 29.4C and 32.2C) not good predictor for overweight individuals
Datta et al (1973)	carry weight on head	cost = 6.58(wt + load) - 152	body wt (kg) load (kg)	metabolic cost (watts)	carry only 0-50 kg used only 51 kg subject

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Evans et al. (1983)	load held or carried in front of body	IHR(H) = 7.75 + 0.95F IHR(C) = 31.6 + 0.6F	F = wt of load (kg)	IHR(H) = mean heart rate increases at exhaustion for load holding IHR(C) = mean heart rate increases at exhaustion for load carrying	doesn't consider box characteristics or body weight
Frederik (1959)	lifting	E =(f)(a)(wt)(c)/1000	f = no. lifts/hr a = lifting height (feet) wt = wt of load (lbs) c = consumption of energy in gm-calories/ft-lb	E=kcal/hr	E < 200 kcal/hr c from graph at certain lifting range single lift (not dynamic lifting) body wt and box size not considered

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Garg et al. (1978)	sitting standing lifting squating walking carrying holding pushing pulling arm movement	$\Sigma E_{job} = (\Sigma^{nt} E_{pos} \times t_i + \Sigma^{n} \Delta E_{taski})/T$	E_{pos} = metabolic energy expenditure due to maintenance of ith posture (kcal/min) ti = time duration of ith posture (min) nt = total no. body postures employed in job ΔE_{task} = net metabolic energy expenditure of ith task in steady state (kcal) n = total no. tasks in given job T = time duration of job (min)	E_{job} = ave energy expenditure rate of job (kcal/min)	ΔE eqns provided for various tasks dry bulb 21-25C RH 50-58% any inaccuracy in description of work will significantly affect the metabolic workrate estimate for entire job summing steady state of individual tasks not verified (Asfour (1980) showed not valid for lift/lower) container not considered height ranges other than 0-32" and 32"-60" not considered

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Intaranont (1983)	lifting	$AT = (41171892.555 + 1.439(WT)(FY) - 3461.837(PB) - 11.744(WT^2) - 3771.16(WT)(R) + 24.964(LBW^2))10^{-5}$ $AT = (157396.895 - 21.615(WT)(FY) - 1611.729(PA) + 2.113(WT^2))10^{-5}$	WT = body wt (lbs) FY = freq of lifts (lifts/min) LBW = lean body wt (lbs) R = LBW/WT PB = PWCB (1000)(2.2046)/LBW (ml/kg (LBW) - min) PWCB = PCW determined by bicycling (L/min) PA = PCQA (1000)(2.2046)/LBW (ml/kg(LBW) - min) PWCA = PWC determined by arm cycling (L/min)	AT = anaerobic threshold (L/min)	eqn 1 floor ro knuckle height eqn 2 knuckle to shoulder height
Konz (1990)	various activities	TOTMET = BSLMET + ACTMET + SDAMET BSLMET = BSMET(WT) ACTMET = ACMET(WT) SDAMET = 0.1(BSLMET + ACTMET)	BSLMET = basal metabolic rate ACTMET = activity metabolic rate SDAMET = specific dynamic action metabolic rate BSMET = 1.28 watts/kg males; 1.16 watts/kg females WT = body wt (kg) ACMET = activity metabolism/kg (watts/kg)	TOTMET = total metabolic rate (watts)	use table in Konz text or known metabolic rate; SDAMET = due to digestion

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Konz (1990)	various activities	TOTMET = 60 ENERGY (OXUPTK)	ENERGY = energy equivalent of 1 liter O_2 (watts-hr/liter) OXUPTK = oxygen uptake VO_2 (liter of O_2)	TOTMET = total metabolism (watts)	ENERGY (depends on respiratory quotient, which depends on proportion of fat vs. carbohydrate metabolized during exercise) = 5.36 for RQ = .83 (rest) 5.66 for RQ = .86 (exercise up to 60% max) 6.4 for RQ = 1.0 (100% max) applicable for lab setting where these measurements can be taken
Mahadeva et al. (1953)	not stated	E = 0.197M + 4.27 kJ/min	M = body mass (kg)	energy	at a pace of 4.8 km/hr input units are not additive
Morrissey and Liou (1984)	carry load between arms and in front of body	$M = 75.14 + 3.11(W) + (2.72L + 87.75)V^2 + 13.36(W + L)(L/W)$	L = wt carried (kg) V = treadmill speed (m/sec) W = body wt (kg)	M = metabolic rate (watts)	not for intermittent carrying tasks
Pandolf et al. (1976)	walking	$walkm = C(2.7 + 3.2(v-0.7)^{1.65})$	velocity (m/sec) c = terrain coefficient	metabolic cost (watts/kg of body weight)	c = terrain coefficient: 1.0 treadmill/blacktop 1.1 dirt road 1.2 light brush 1.3 hard packed snow (c=1.3 + 0.082, foot depression, cm) 1.5 heavy brush 1.8 swamp 2.1 sand
Pandolf et al. (1977)	backpack load carriage	$M = 1.5+2.0(W + L)(L/W)^2 + n(W + L)(1.5V2 + 0.35VG)$	W = subject's wt (kg) L = external load (kg) V = speed walking (m/sec) G = grade (%) n = terrain coefficient (n=1 treadmill)	M = metabolic rate (watts)	only for load on back

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Passmore and Draper (1965)	various	$E = 4.92V(20.93 - O_e)$ $E = 5$ kcal/min = 1 L O_2/min	V = volume of expired air (L/min) $O_e = O_2$ percentage concentration of expired air	E = energy (kcal/min)	
R.M. Ross and A.S. Jackson (1986)	walking	MET = 75 + (6)(%)	75 = horizontal work constant (MET min/mile) 6 = vertical work constant (MET min/mile/%) % percent grade (slope)	MET min/mile	data based on 58 men temperature, RH and wind not accounted for equation does not account for individual or velocity treadmill or hard surface walking
Ralston (1958)	walking	$E_w = 32 + 0.0050v^2$	v = velocity (m/min) b,m = constants	E_w = energy expenditure (cal/min/kg)	treadmill, floor firm path, grass constants b and m determined from data/equations from various investigators (57 men/29 females)
Randle (1987)	carrying load	$M = 1.25(GV^2) + 0.1(47.33G + 87.75L + 21.96W + 197.51V)$	G = treadmill gradient (%) V = walking velocity L = load wt (kg) W = body wt (kg)	M = metabolic rate (kcal/h)	intermittent load carrying in arms (carry load every other 30 sec while walking continuously)
Shephard (1982)	level walking	E = 5.36V + 2.09 kJ/min	V = velocity (km/hr)	energy	input units are not additive
Taboun (1986)	carrying	$VO_2 = 0.3458 + [(BW + L)(1.4468)(BW + L) + 14.325(F)(D) + (388.826(L)(F)]10^{-5}$	BW = body wt (kg) L = load (kg) F = freq (handling/min) D = carrying distance (meters)	VO_2 = oxygen consumption (L/min)	individual intermittent carrying tasks load held between arms and in front of body best used when L = 8-28; D = 0-12; F = 1-5

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Taboun (1986)	carrying/lifting	$VO_2 = 0.1809 + [(BW + L)(2.6112 (BW + L)(92.594(DH)) + F(318.16L + 7.9815(BW)(D) + 49.1565(L)D)]10^{-5} + 2.2956(WID/L)$	BW = body wt (kg) L = load handled (kg) F = frequency D = carrying distance (meters) H = height range of lift (meters) WID = box width along sagittal plane (meters)	VO_2 = oxygen consumption (L/min)	individual carrying and/or combined carrying and lifting from 75 cm (table height, up to height of 150 cm or less) best used when L = 8-28; F = 1-5; D = 0-12; H = 0-1.5; WID = 0.15-0.55
Taboun (1986)	carrying/lifting	$VO_2 = 0.0738 + [(BW + L)(3.9918)(BW + L) + 61.226(D)(H) + (L)(F)(424.131 + 81.926D)]10^{-5} + 3.851(WID/L)$	BW = body wt (kg) L = load handled (kg) F = frequency D = carrying distance (meters) H = height range of lift (meters) WID = box width along sagittal plane (meters)	VO_2 = oxygen consumption (L/min)	combined lifting and carrying tasks; lifting starts from floor to 150 cm or less best used when L = 8-28; F = 1-5; D = 0-12 H = 0-1.5; WID = 0.15-0.55
Van der Walt & Wyndam (1973)	running	$runm = 0.142/M + 11 + 0.04v^2$	V = velocity (km/h)	metabolic cost (watts/kg of body weight)	M = ? not defined
Van der Walt & Wyndam (1973)	walking	$walkm = 2 + 0.124v^2$	V= velocity (km/h)	metabolic cost (watts/kg of body weight)	

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Winter (1979)	body movements (i.e. walking)	$E(i) = m(i)gh(i) + 0.5m(i)v(i)^2 + 0.5I(i)w(i)^2$ $Wwb = \Sigma^N \lvert\Sigma^S \Delta E(i,j)\rvert$ joules	m(i) = segment's mass (kg) v(i) = segment's absolute translational velocity relative to some datum (m/sec) h(i) = segment's vertical position relative to some datum (m) I(i) = segment's moment of inertia about its mass centroid (kg m^2) w(i) = segment's absolute angular velocity (rad/sec) g = force due to gravity $\Delta E(i,j)$ = total energy change during (i)th segment N = total number of sample periods during one study S = total number of segments modelled	E(i) = total energy of (i)th segment Wwb = energy transfer between and within segments	instantaneous energy level of any segment (i)

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Zarraugh et al. (1974)	walking	$E_w = E_o/\{(1-s^2/s_u^2)(1-n^2/n_u^2)\}$ for natural walking eqn becomes: $E_w = E_o/(1-v/v_u^2)$	s = step length (meters) n = step rate (steps/min) $E_o = E_w$ when s=n=0 (ave value 28 cal/min/kg) s_u = upper limit of s as E_w goes to infinity n_u = upper limit of n as E_w goes to infinity v = speed v_u = upper limit of v, equal to $n_u s_u$ (ave value 240 m/min)	E_w = cal/min/kg	accounts for step length and rate

Table 3. Model Summary Matrix

Model	walk/ run	carry	hold	stoop	bend/ squat	lift	lower	sit	stand	push	pull	crank	shovel	step	grip	various/ not stated
Aberg						x										
Asfour						x	x									
Buskirk, Nicholas and Hodgson	x					x						x	x	x	x	
Datta																
Evans		x	x													
Frederik						x										
Garg	x	x	x	x	x	x	x	x	x	x	x					
Interanout						x										
Konz																
Mahadeva																x
Morrissey and Liou		x														x
Pandolf (1976)	x															
Pandolf (1977)		x														
Passmore and Draper																x
Ralston	x															
Randle		x														
Ross and Jackson	x															
Shephard	x															
Taboun		x														
Taboun						x										
Van der Walt & Wyndam	x															
Van der Walt & Wyndam	x															
Winter	x															
Zarrough	x															

3.0 Results

The results of the literature search revealed three possible methods which could be of use to IUSS. Garg's model, Konz's model (already converted to a software package) and Christensen's nomograph. Garg's equations for various postures are provided and Konz's method for determining work rate (based on VO_2 consumption) is listed. Christensen's nomograph was selected as the best procedure to use with the IUSS. The Energy Expenditure Table (Table 7) was developed using Christensen's work and adding Borg's perceived expenditure method. The nomograph was used to evaluate selected tasks, included in the evaluation are two tasks which were measured during the Metabolic Task Inventory study. These empirical data were analyzed using the same procedure to see if actual data could be used for acquiring metabolic work rate using the Energy Expenditure Table.

3.1 Garg's Model

$$\Sigma E_{job} = (\Sigma^{nt} E_{pos} \times t_i + \Sigma^{n} \triangle E_{taski})/T$$

where

E_{job} = average energy expenditure rate of entire job (kcal/min)
E_{pos} = metabolic energy expenditure due to maintenance of ith posture (kcal/min)
ti = time duration of ith posture (min)
nt = total no. body postures employed in job
$\triangle E_{taski}$ = net metabolic energy expenditure of ith task in steady state (kcal)
n = total no. tasks in given job
T = time duration of job (min)

Maintenance of body postures

sitting

$E_{pos} = 0.023$ BW

standing

$E_{pos} = 0.024$ BW

standing, bent position

$E_{pos} = 0.028$ BW

Net Metabolic Cost of Tasks

stoop lift (kcal/lift)

$\triangle E = 10^{-2}$ [0.325 BW (0.81-h1) + (1.141L + 0.76S x L) (h2 -h1)] for $h1 < h2 \leq 0.81$

squat lift (kcal/lift)

$\triangle E = 10^{-2}$[0.514 BW (0.81-h1) + (2.19L + 0.62S x L) (h2-h1)] for $h1 < h2 \leq 0.81$

one hand lift (kcal/lift)

$\triangle E = 10^{-2}$[0.352 BW (0.81-h1) + 3.03L(h2-h1)] for h1 < h2 7 0.81

arm lift (kcal/lift)

$\triangle E = 10^{-2}$[0.062 BW (h2-0.81) + (3.19L - 0.52S x L)(h2-h1)] for $0.81 < h1 < h2$

stoop lower (kcal/lower)

$\Delta E = 10^{-2}[0.268\ BW\ (0.81-h1) + 0.675\ (h2-h1) + 5.22\ S\ (0.81-h1)]$ for $h1 < h2 < 0.81$

squat lower (kcal/lower)

$\Delta E = 10^{-2}[0.511\ BW\ (0.81-h1) + 0.701L\ (h2-h1)]$ for $h1 < h2\ 7\ 0.81$

arm lower (kcal/lower)

$\Delta E = 10^{-2}[0.093\ BW\ (h2-0.81) + (1.02L + 0.37\ S \times L)\ (h2-h1)]$ for $0.81 < h1 < h2$

walking (kcal)

$\Delta E = 10^{-2}(51 + 2.54\ BW \times V^2 + 0.379\ BW \times G \times V)t$

carrying, loads held at arms length at sodes (in one or both hands) (kcal)

$\Delta E = 10^{-2}[80 + 2.43\ BW \times V^2 + 4.63L \times V^2 + 4.62L + 0.379(L + BW)G \times V]t$

carrying, loads held against thighs or against waist (kcal)

$\Delta E = 10^{-2}[68 + 2.54\ BW \times V^2 + 4.08L \times V^2 + 11.4L + 0.379(L + BW)G \times V]t$

holding, at arms length, against thighs or at sides (both hands) (kcal)

$\Delta E = 0.037\ L \times t$

holding, against waist (kcal)

$\Delta E = 0.062\ L \times t$

holding, at arms length in one hand (kcal)

$\Delta E = 0.088\ L \times t$

pushing/pulling, at bench height (0.8 meters) (kcal/push)

$\Delta E = 10^{-2}\ X(0.112\ BW + 1.15F + 0.505\ S \times F)$

pushing/pulling, at 1.5 meter height (kcal/push)

$\Delta E = X(0.086 + 0.036F)$

lateral movement of arms 180 degrees, both hands (kcal/lateral movement of arms)

$\Delta E = 10^{-2}\ (0.11\ BW + 0.726L)$

lateral movement of arm 180 degrees, one hand (kcal/lateral movement of arm)

$\Delta E = 10^{-2}\ (0.097\ BW + 0.946L)$

lateral movement of arms 90 degrees, standing, one or both hands (kcal/lateral movement of arms)

$\Delta E = 10^{-2}(3.31 + 0.629L + 0.143\ S \times L)$

lateral movement of arms 90 degrees, sitting, both hands (kcal/lateral movement of arms)

$\Delta E = 10^{-2}(3.5 + 0.682L + 0.321\ S\ xL)$

lateral movement of arm 90 degrees, sitting, one hand (kcal/lateral movement of arm)

$\Delta E = 10^{-2}\ (2.54 + 1.1L + 0.248\ S \times L)$

forward movement of arms, standing, one or both hands (kcal/movement of arms)

$\Delta E = 10^{-2} X(3.57 + 1.23L)$

forward movement of arms, sitting, one or both hands (kcal/movement of arms)

$\Delta E = 10^{-2} X(6.3 + 2.71L)$

where

E = metabolic rate (kcal/min)
ΔE = kcal for walking, carrying and holding. For all other tasks, units are Kcal/performance
BW = body weight (kg)
F = average pushing/pulling force applied by hands (kg)
G = grade of the walking surface
h1 = vertical height from floor (meters); starting point for lift and end point for lower
h2 = vertical height from floor (meters); end point for lift and starting point for lower
L = weight of the load (kg)
S = gender; 1 for males, 0 for females
V = speed of walking (meters/sec)
X = horizontal movement of work piece (meters)
t = time (minutes)

Garg's model takes into consideration the gender and body weight of the individual, as well as the parameters of the task being performed (distance, speed, grade, how a load is carried/moved in the hands/arms, etc.). The output of the algorithm is metabolic energy in kcal/min (1 kcal/min = 6.978 watts).

The model is simplified to specific postures and tasks or movements. A separate equation was developed for each defined posture and task. The metabolism for the postures of sitting, standing and standing bent are based on body weight. Tasks such as sitting, standing, lifting, lowering, squatting, walking, carrying, holding, pushing, pulling and arm movements are modeled by Garg's algorithm. The metabolic work rates for each of these postures and movements are summed to determine the total metabolic work rate for the entire task.

Military tasks can be defined using Garg's equations, but the task must be specified precisely. An inaccurate description of work using the defined postures and movements will affect the resulting metabolic estimate for the task.

Garg's model has limitations that must be considered. The lifts/lowers are modeled to occur lower than 0.81 meters in height. This does not account for tasks that require lifting an object above the shoulders and head. Carrying an object in front of the body is modeled, but soldiers also carry backpacks. This was not modeled by Garg.

Even though these equations are additive, they do not consider the fact that the individual may have just performed a task and not totally recovered from the first task (i.e., fatigue, increased heart rate, etc.)

3.2 Konz' Model

Basal Metabolism

BASLMET = BSMET (WT)

where

BASLMT = basal metabolism, W

BSMET = 1.28 W/kg for males

= 1.16 W/kg for females (difference due to body fat)

WT = body weight, kg

Dubois surface area:

DBSA = .007 184 $(HT)^{.725}$ $(WT)^{.425}$

where DBSA = DuBois surface area, m^2

WT = weight, kg

Correction for DuBois prediction inaccuracies:

SA = .208 + .945 (DBSA)

= .208 = .006 789 $(HT)^{.725}$ $(WT)^{.425}$

where SA = surface area m^2

DBSA = DuBois surface area, m^2

Basal metabolism per m^2 of surface area:

BMMALE = 64.95 - .8875 A = .0078 A^2 (5< A < 70)

BMFMLE = 59.43 - .9315A + .0076 A^2 (5 < A < 70)

where BMMALE = basal metabolism for males, W/m^2

BMFMLE = basal metabolism for females, W/m^2

A = age, years

Calculate basal metabolism:

BASLMT = BMMALE (SA)

= BMFMLE (SA)

Activity metabolism is:

ACTMET = ACTFMT (WT)

where ACTMET = activity metabolism, W

ACTFMT = activity metabolism factor, Wkg

WT = weight, kg

When metabolism is measured:

TOTMET = 60 energy (OXUPTK)

where TOTMET = total metabolism, W (usually just basal + activity)

ENERGY = energy equivalent of 1 liter of oxygen, W-hr/liter

Depends on respiratory quotient (RQ) which in turn depends upon the proportion of fat vs. carbohydrate metabolized during the exercise. Astrand and Rodahl indicate a RQ of .86 is satisfactory for exercise up to about 60% of maximum oxygen uptake; then RQ goes to 1.0 as uptake goes to 100%.

For resting, RQ

= .83.

OXUPTK = oxygen uptake, VO_2, liters of oxygen/min

Pulmonary ventilation is:

PULVNT = (LAPLOX) (OXUPTK)

where PULVNT = liters of air/min
LAPLOX = liters of air/liter of oxygen
= 20-25 at rest and for work less than 15 W/min
= 30-35 during maximal work

Vital capacity (an index of an individual's lung capacity), the maximum that can be exhaled following a maximum inspiration, can be estimated with a standard deviation of 10% as:

VITALC(male) = 56.3 (HT) - 17.4 (A) - 4210
VITALC(fmle) = 54.5 (HT) - 10.5 (A) - 5120

where VITALC = vital capacity (standing), mL
HT = height, cm
A = age, years

Heart rates determined by metabolic load (as opposed to emotions or vasodilatation in heat) are highly correlated with incremental metabolic rates; that is given one you can predict the other. The linear equation does have different coefficients for different individuals and different types of work:

INCHR = K = .12 INCMET

where INCHR = increase in heart rate, beats/min
= constant = 2.3 for wrm work only
= - 11.5 for walking or walking + arm work
INCMET = increase in metabolism, W

Due to venous pooling in the legs, arm work without leg work requires 14 more beats/min than leg work at the same metabolic rate.

Heart rate, a good index of task difficulty, can be estimated accurately by asking the individual to provide a perceived exertion level. This perceived exertion scale (Table 4) was designed to be 10% of the heart rate to interpret actual beats per minute by multiplying the subjective estimate of exertion by ten.

Table 4. Perceived Exertion for Heart Rate Prediction

Numerical Predictor	Subjective Description
6	very light
7	very light
8	very light
9	very light
10	light
11	light
12	light
13	moderate
14	moderate
15	hard
16	hard
17	very hard
18	very hard
19	extremely hard
20	extremely hard

3.3 Christensen's Nomograph

A method of measuring pulse rate (heart rate) as described by Astrand (1954) and Christensen (1953) to determine work expenditure in industry is the most applicable to the IUSS as a metabolic work rate input method. This nomograph represents the total work expenditure and not just the portion related only to physical work. Using this method, one can calculate the energy requirement of a job by breaking the job into tasks or subtasks. The limitation to this nomograph as with all of the models is the affect of heat dissipation of the body when wearing MOPP gear. The effect on task performance in MOPP must be accounted for by the addition of increased heart rate added to the heart rate used for the task in MOPP0. The increased heart rate would address the work the body does to remove the heat from the body and the change in respiration when wearing the protective mask.

The data from Table 5 have appeared in the literature over the past five decades and continues to be the benchmark used by physiologists as the basis for their models of physiological (dexterity and gross motor) performance. By using this nomograph and combining the data with the perceived exertion scores for determining heart rate, the algorithm to represent the various work rates to use in IUSS is achievable.

Table 5. Energy Expenditure Nomograph

Work Level	Energy	Males	Females	Rectal Temp	0_2
	k/cal/min	beats/min	beats/min	C°	L/min
Very Light	< 2.5	< 75	85	< 37.5	0.5
Light	2.5 - 5.0	75 - 100	85 - 110	37.5	1.0
Moderate	5 - 7.5	100 - 125	110 - 135	37.5 - 38.0	1.5
Hard	7.5 - 10	125 - 150	135 - 165	38.0 - 38.5	2.0
Very Hard	10 - 12.5	150 - 175	165 - 185	38.5 - 39.0	2.5
Extremely Hard	> 12.5	> 175	> 185	> 39.0	3.0

3.4 Task Calculations

The following is an example using the nomograph method for calculating the total job for a preselected set of infantry tasks. Since one of the jobs depicted in IUSS is Occupy Assembly Area, tasks were selected from the task listing to use as the test case. The infantry tasks and the Occupy Assembly Area tasks are provided in Appendix C.

The kcal/min from the nomograph was changed to watts/hour (1 kcal/hr = 1.163 watt) for this example. Each category of energy expenditure was linearly scaled to the watts for work rate, the beats per minute for the heart rate and the subjective perceived exertion scores. The times assigned for task performance are based on subject matter experts suggested times for the tasks. The construction of such a table based on the task performance for the purpose of modeling the tasking within the IUSS is the simplest and believed to be the best method for the programmers to use to develop the required module. This method may have application to the soldier in the field, since he would be able to judge how hard he is working by taking his pulse and determining energy expenditure, especially when wearing MOPP gear.

To examine how applicable this table is to empirical data, USARIEM was consulted to see if any of the tasks they measured during the Metabolic Task Inventory study matched any of the tasks we were looking at. There were two tasks which matched the ones selected for the analysis. These tasks were: Maintain M-16 Rifle and Construct Individual Fighting Position. The empirical data are presented with the calculated data taken from the Energy Expenditure Table. The empirical data, provided in Table 6, are reported in $V0_2$ (Liters per min) and heart rate (beats per minute)*. The data presented in Table 8 were converted to energy expenditure using the Energy Expenditure Table (Table 7).

* Information provided by John Patton, MTI Test Director

Table 6. Empirically Measured Tasks

Maintain Rifle(male)	VO_2 L/min	Heart Rate(bpm)(female)	VO_2 L/min	Heart Rate(bpm)
MOPP0	0.88) .12	107) 13	0.54) .09	108) 21
MOPP4	1.04) .23	124) 10	0.58) .08	118) 21

Construct Individual Fighting Position (male)	VO_2 L/min	Heart Rate(bpm)(female)	VO_2 L/min	Heart Rate(bpm)
MOPP0	1.33) .18	122) 13	0.88) .07	128) 13
MOPP4	1.49) .28	131) 18	0.95) .14	135) 12

Using the Energy Expenditure Table, heart rate column and selecting the watts associated with the corresponding heart rate to accomplish the tasks these tasks are considered light to moderate. When these numbers are input into Konz' tables, they provide approximately the same watts of expended energy. This, in a small way, validates the utility of the energy expenditure table. More data will be required to provide a thorough validation, but it is clear that for modeling purposes this table will provide the programmer what is required for the input of metabolic work rate into the individual soldier module. For more precise data, one needs to consult Konz' software or Garg's algorithm. This model asks for height and weight of individual and type of task being performed and is based on VO_2.

Table 7. Energy Expenditure Table

Type of Work	Energy Expenditure (watts)	Heart Rate Male/Female (bpm)	Perceived Exertion Scale (M/F)
Very Light	105	60/60	6/6
Very Light	115	64/64	6.5/6.5
Very Light	125	68/73	6.5/7
Very Light	150	72/79	7/8
Very Light	175	75/85	7.5/8.5
Light	176	77/86	7.5/8.5
Light	200	79/91	8/9
Light	225	83/97	8.5/9.5
Light	250	87/99	8.5/10
Light	275	91/103	9/10
Light	300	96/107	9.5/10.5
Light	350	100/110	10/11
Moderate	375	102/112	10/11
Moderate	400	104/114	10.5/11.5
Moderate	425	110/119	11/12
Moderate	450	113/123	11/12
Moderate	475	116/128	11.5/12.5
Moderate	500	121/131	12/13
Moderate	525	125/135	12.5/13.5
Hard	550	126/137	12.5/13.5
Hard	575	128/139	12.5/14
Hard	600	131/149	13/15
Hard	625	136/150	13.5/15
Hard	650	141/154	14/15.5
Hard	675	146/160	14.5/16
Hard	700	150/165	15/16.5
Very Hard	725	154/167	15.5/16.5
Very Hard	750	157/168	15.5/16.5
Very Hard	800	163/172	16/17
Very Hard	825	168/175	16.517.5
Very Hard	850	172/181	17/18
Very Hard	875	175/185	17.5/18.5
Extremely Hard	900	180/190	18/19
Extremely Hard	925	185/195	18.5/19.5
Extremely Hard	950	197/210	19.5/21
Extremely Hard	975	211/220	21/22
Extremely Hard	1000	220/230	22/23

Table 8. Task and Energy Expenditure Data for IUSS

Assembly Tasks	Watts Used for Task	Heart Rate (bpm/sd)	Performance Time	Task Type
Camouflage Equipment	425	110	25 minutes	Moderate
Maintain M16 Rifle	298 300	m: 107/±13 f: 108/±21	15 minutes	Light Light
Select Fighting Positions	237	85	15 minutes	Light
Construct Individual Fighting Position	450 475	m: 122/±13 f: 128/±13	60 minutes	Moderate Moderate
Send Radio Message	115	65	3 minutes	Very Light
Construct M60 Fighting Position	650	140	60 minutes	Hard
Deploy Chemical Agent Detectors	350	100	30 minutes	Light
Establish Observation Post	350	100	5 minutes	Light
Conduct Area Reconnaissance	525	125	60 minutes	Moderate
Conduct Local Security Patrol	525	125	60 minutes	Moderate
Perform Road Guide Duties	300	96	120 minutes	Light
Perform Search and Scan Procedures	225	85	5 minutes	Light
Engage Hostile Aircraft with Small Arms	675	145	2 minutes	Hard

4.0 Discussion

The analysis of the Occupy Assembly Area tasks indicates work rate can be determined easily and effectively by using the nomograph. We can gather the information using the software tool developed by Konz, if we have very specific data and if we need even greater specificity we can use Garg's method. Garg's method would be applicable in a laboratory environment or when a detailed task analysis was required for specific procedures.

The Energy Expenditure Table can be used in different ways. If empirical data are available (heart rate) then the corresponding work rate can be selected from the table. If perceived exertion data from soldiers performing the tasks is obtained the exertion score can be converted to a work rate. If only a verbal term is available (light, moderate or hard) then a random selection from the work rate column for that term can be made.

Physiological researchers may be concerned that this procedure of selecting work rate is too simplistic, but remembering the many variables which make up work rate; the approach selected to interact with the heat model in IUSS provides the level of data required without complex calculations which were designed for much more specific types of work studies.

This method also has application in some of the other ongoing programs. If one wanted to determine work rate for dexterity tasks or gross motor tasks or a combination of both this method is applicable. There is a change in heart rate and therefore, in work rate for small muscle (dexterous) tasks as discussed in Section 3.2 of this report.

When the empirical data were used with the Energy Expenditure Table, the energy expenditure was easily selected. The empirical data are being collected (VO_2 and heart rate) by USARIEM and will be converted into the energy expenditure. The equation or table of equations was not known when the information was obtained from USARIEM for this analysis, this means there may be a slight variation in the expenditure based on the conversion method used. It is not believed there will be much difference between the method presented in this report and the empirical data developed by USARIEM.

This study had four objectives. The first objective was accomplished with 24 different models found which, in one form or another, represent physiological performance of tasking. The second objective of a useful algorithm has been accomplished. By combining Christensen's nomograph and Borg's perceived energy table a programmer has the tool required to select a set of work rate values to use as input into the soldier status system. The third objective was to assist in the insertion of the formula into the IUSS. This will be accomplished after the review of this methodology and concurrence from the government that this is an accepted direction.

The assumptions stated in Section 1.2 have not changed. Changes to this method, based on empirical data, will be required. As the database of physiological performance grows, this method should be replaced with more robust task data.

The procedure for calculating work rate, in fact, was based on different models and was kept as simple as possible. This allows for ease of use for those unfamiliar with physiological terms and equations and does not overwhelm the programmer with unnecessary information.

The recommendations to be considered are:

Validate the work rate method with data from the Metabolic Task Inventory study.

Implement this method into IUSS and begin collecting field data to populate the database within the soldier system.

Where data can not be obtained in the field, use subject matter experts to rate the tasks using the Energy Expenditure Table and a questionnaire designed to gather the required data.

Questionnaires should be developed which can elicit the data from the SMEs in an effective and efficient manner. The use of the questionnaire data will provide valid data for the IUSS database.

Begin implementation of the next phase of this study:

Develop methods for representing fatigue and other physiological degradation.

Design a set of algorithms representing the mental and physical constructs of physiological, cognitive and psychological inputs to the IUSS.

This document reports research undertaken at the U.S. Army Natick Research, Developmen and Engineering Center and has been assigned No. NATICK/TR-94/026 in the series of reports approved for publication.

5.0 References

1. Astrand, P.O. and I. Ryhming, (1954) A nomogram for calculation of aerobic capacity (physical fitness) from pulse rate during submaximal work, Journal of Applied. Physiology, 7, 218.

2. Borg, G. (1973) Perceived exertion: a note on history and methods, Medicine and Science in Sports, 5 (2), 90-93.

3. Buskirk, E. R., Nicholas, W. C. and Hodgson, J. L., (1975) Measurement of work metabolism. Use of cardiorespiratory parameters for estimating metabolic heat production in hot environments, Pennsylvania State University, Laboratory for Human Performance Research.

4. Christensen, E.H. (1953) Physiological valuation of work in Nykroppa Iron Works, In Symposium on Fatigue (eds. Floyd, W.F and A.T. Welford). London, H.K. Lewis.

5. Epstein, Y., Rosenblum, J., Burstein, R. and Sawka, M. N., (1988) External load can alter the energy cost of prolonged exercise, European Journal of Applied Physiology, Vol. 57, 243-247.

6. Garg, A., Chaffin, D.B. and Herrin, G.D., (1978) Prediction of metabolic rates for manual materials handling jobs, American Industrial Hygiene Association Journal. Vol. 39, 661-674.

7. A. Garg (personal communication, May 12, 1993).

8. Goldberg, J.H. and A. J. W Alfred., (1988) Prediction of physical workload in reduced gavity. Aviation, Space and Environmental Medicine, Vol. 59, 1150-1157.

9. Grandjean, E., (1980) Fitting the task to the man, Taylor and Francis, New York.

10. Inman, V., Ralston H. and Todd, F.(1981) Human walking, Williams and Wilkens, Baltimore.

11. Johnson, A.T., (1991) Biomechanics and exercise physiology, John Wiley and Sons, New York.

12. Konz, S. Work design: Industrial ergonomics, (chapters 11 and 14), Grid Publishing, Inc. Columbus, Ohio.

13. S. Konz (personal communication, April 22, 1993).

14. Lamb, D.R., (1984) Physiology of exercise. Responses and adaptations, MacMillan Publishing Company, New York.

15. J. Patten (personal communication, August 2, 1993).

16. Poole, D.C., Ward, S.A. and Whipp, B.J.,(1990) The effects of training on the metabolic and respiratory profile of high-intensity cycle ergometer exercise, European Journal of Applied Physiology and Occupational Physiology (Berlin), Vol. 59, (6), 421-429.

17. Randle, I.P.M, Legge, S.J. and D.A. Stubbs, (1989) Task-based prediction models for intermittent load carriage, Proceedings of the Ergonomics Society, 1989, ed.by E.D. Megaw, Taylor and Francis, London.

18. Rodahl, K. (1989) The physiology of work. Taylor and Francis, New York.

19. Ross R.M. and Jackson A.S., (1986) Development and validation of total-work equations for estimating the energy cost of walking, Journal of Cardiopulmonary Rehabilitation, pp. 185-192.

20. Schacherer, C., Rowe, A. and Jackson, A., (1992) Development of prediction models for physical work capacity: Practical and theoretical implications, Proceedings of the Human Factors Society 36th Annual Meeting, pp. 674-678, Report No. AD-A113578.

21. Shephard, R. J. (1982) Physiology and biochemistry of exercise. Praeger Publisher.

22. Smith, J.L. and Ramsey, J.D., Ergonomics-Part Four: Designing physically demanding tasks to minimize levels of worker stress, Industrial Engineering, Vol. 14, (5), 44-50.

23. Taboun, S. M., (1986) Models of individual and combined manual materials handling tasks. Doctoral Dissertation, University of Windsor .

24. Verma, S.S. and Sen Gupta, J., (1990) Regression models for estimation of maximal aerobic power in man, Defense Science Journal, Vol. 40, (3), 293-298.

25. Williams, K. R., (1980) A biomechanical and physiological evaluation of running efficiency. Doctoral Disseration, The Pennsylvania State University.

APPENDICES

BLANK PAGE

APPENDIX A

Database Descriptions

APPENDIX A
Database Descriptions

AEROSPACE DATABASE: Provides references, abstracts and controlled-vocabulary indexing of key scientific and technical documents, as well as books, reports and conferences, covering aerospace research and development in over 40 countries. This database supports basic and applied research in aeronautics, astronautics, and space sciences, as well as technology development and applications complementary and supporting fields, such as chemistry, geosciences, physics, communications and electronics.

BIOSIS PREVIEWS: Contains over 8.3 million citations from Biological Abstracts, Biological Abstracts/RRM and BioResearch Index. These publications constitute the major English-language services providing comprehensive worldwide coverage of research in the biological and biomedical sciences.

DISSERTATION ABSTRACTS ONLINE: Subject, title and author guide to virtually every American dissertation accepted at an accredited institution since 1861. In addition, citations for thousands of Canadian dissertations and an increasing number of papers accepted abroad are included in the database. All subject areas are included. British and European dissertations are included in the database from January 1988 forward. Also abstracts are included for masters theses from Spring 1988 to the present.

EiCOMPENDEX*PLUS: Version of The Engineering Index, which provides abstracted information from the world's significant literature of engineering and technology. Provides worldwide coverage of approximately 4,500 journals and selected government reports and books. Subjects include: civil, energy, environmental, geological and biological engineering; electrical, electronics, and control engineering; chemical, mining, metals, and fuel engineering; mechanical, automotive, nuclear and aerospace engineering; and computers, robotics and industrial robotics.

EMBASE (formerly EXCERPTA MEDICA): One of the leading sources of biomedical literature. It consists of abstracts and citations of over 3,500 biomedical and pharmacological journals published throughout the world.

ENERGY SCIENCE AND TECHNOLOGY: Database of the Department of Energy, one of the largest sources of literature references on all aspects of energy and related topics.

FLUIDEX (FLUID ENGINEERING ABSTRACTS): Indexing and abstracting literature on every aspect of fluid engineering, from theoretical research to the latest technology and applications. Nearly 1,000 technical journals are indexed as well as books, conference proceedings, standards, some British patents and research reports from relevant institutions worldwide.

HEALTH PERIODICALS DATABASE: Provides indexing and full text of journals covering a broad range of health subjects and issues. Subjects covered include pre-natal care, dieting, drug abuse, AIDS, biotechnology, cardiovascular disease, environment, public health, safety, paramedical professions, sports medicine, substance abuse, toxicology and much more. Articles are collected from core health, fitness and nutrition publications.

IHS INTERNATIONAL STANDARDS AND SPECIFICATIONS: Contains references to industry standards and military and federal specifications and standards covering all aspects of engineering and

related disciplines. The file includes 90% of the world's most referenced standards from over 70 domestic, foreign and international standardizing bodies.

INSPEC: The Database for Physics, Electronics and Computing corresponds to the three Science Abstracts print publications: Physics Abstracts, Electrical and Electronics Abstracts and Computer and Control Abstracts. Approximately 16% of the database's source publications are in languages other than English, but all articles are abstracted and indexed in English.

INTERNATIONAL PHARMACEUTICAL ABSTRACTS: Provides information on the development and use of drugs and on professional pharmaceutical practice. The IPA database indexed and abstracted from over 650 pharmaceutical, medical and related journals. The scope of the database ranges from clinical, practical, and theoretical to the economic and scientific aspects of the field.

MECHANICAL ENGINEERING ABSTRACTS: Information Service in Mechanical Engineering (ISMEC) indexes significant articles on all aspects of mechanical engineering from approximately 750 journals published throughout the world. Books, reports and conference proceedings are indexed. The principal areas covered are mechanical, nuclear, electrical, electronic, civil, optical, medical, and industrial, mechanics, energy and power, transport and handling and applications of mechanical engineering.

MEDLINE: Major source of biomedical literature, corresponds to three print indexes: Index Medicus, Index to Dental Literature and International Nursing Index. MEDLINE covers practically every subject in the broad field of biomedicine, indexing articles from over 3,700 international journals published in the United States and 70 other countries.

AMERICAN MEDICAL ASSOCIATION JOURNALS ONLINE: Part of the MEDTEXT database. Full-text articles from 10 medical journals, including JAMA.

NATIONAL NEWSPAPER INDEX: Provides indexing of the Christian Science Monitor, New York Times, and The Wall Street Journal. All articles, news reports, editorials, letters to the editor, etc. are included. Also included in the database are three newswires: PR Newswire, Japan Economic Newswire and Reuters Financial Report.

NEWSEARCH: Daily index of more than 2,000 news stories, articles and book reviews from over 1,700 of the most important newspapers, magazines and periodicals. Also includes the Area Business Databank (ABD), which contains indexing and abstracts from over 100 local and regional business publications, and the complete text of PR Newswire.

NTIS: Provides access to the results of government-sponsored research, development, and engineering, plus an analyses prepared by federal agencies, their contractors or grantees. It is a means through which unclassified, publicly available, unlimited distribution reports are made available for sale from agencies such as NASA, DDC, DOE, HUD, DOT, Department of Commerce and some 600 other agencies. In addition, some state and local government agencies contribute their reports to the database. NTIS also provides access to the results of government-sponsored research and development from countries outside the U.S. Organizations that currently contribute to the NTIS database include: the Japan Ministry of International Trade and Industry (MITI), laboratories administered by the United Kingdom Department of Industry, the German Federal Ministry of Research and Technology (BMFT), the French National Center for Scientific Research (CNRS) and many more.

PASCAL: Multidisciplinary database equivalent to the 79 print Pascal journals. Literature from international sources is indexed and abstracted, including journals, doctoral dissertations and masters theses, reports, conference proceedings, and books. Some patents are included in the area of biotechnology. Major subject areas are: life science, biology, medicine, chemistry, pollution, energy, metallurgy, mechanical and civil engineering, transportation, food and agricultural sciences, earth sciences, physics and space sciences and computer science and engineering. The file is bilingual (French and English) and approximately 50% of the records have abstracts.

SCISEARCH: Multidisciplinary index to the literature of science and technology. Prepared by the Institute for Scientific Information (ISI), it contains all records published in Science Citation Index (SCI) and additional records from the Current Contents series of publications that are not included in the print version of SCI. Includes 90% of the world's significant scientific and technical literature. SCISEARCH covers every area of pure and applied sciences.

SPORT: Bibliographic database, international in scope, covering the practical and research literature for all aspects of sport and physical fitness. The database annually indexes over 1,000 international sports periodicals along with many medical and other related journals in English, French and other languages. Subjects covered include sports medicine, exercise physiology, biomechanics, psychology, training, coaching, physical education, physical fitness, sport for the disabled, facilities, equipment and recreation and leisure.

STANDARDS AND SPECIFICATIONS: Provides bibliographic access to all U.S. government and industry standards, specifications and related documents that specify terminology, performance testing, safety, materials, products, or other requirements and characteristics of interest to a particular technology or industry.

TOXLINE: Covers adverse effects of chemicals, drugs and physical agents on living systems. About 45% of the approximate 120,000 records added per year are from the TOXBIB subfile, which is derived from MEDLINE. The database is composed of several subfiles, each of which covers a different aspect of toxicology.

TRADE AND INDUSTRY ASAP: Provides selective complete text and indexing for over 200 journals chosen from the more than 400 journals covered in TRADE AND INDUSTRY INDEX, plus news releases from PR Newswire. The full text of each article is searchable and complete articles may be retrieved online.

TRADE AND INDUSTRY INDEX: Business journals relating to trade, industry and commerce are indexed and selectively abstracted. This database provides current and comprehensive coverage of major trade journals and industry-related periodicals representing all Standard Industrial Classification. Provides indexing and abstracts of over 300 trade and industry journals, as well as a comprehensive but selective coverage of business and trade information from nearly 1,200 additional publications.

WORLD TRANSLATIONS INDEX: Unique source for existing translations of literature relating to all fields of science and technology. The database is the machine-readable version of the publication World Translations Index (WTI). WTI contains bibliographic references to both the original and translated documents, reflecting the translation announcements collected by the International Translations Centre (ITC), the Centre National de la Recherche Scientifique et Technique (CNRS/INIST) and various national centers such as the U.S. National Translations Center(NTC).

APPENDIX B

Bibliography

Appendix B
Bibliography

Anstrand, P. O. and Rodahl, K. (1986). Textbook of work physiology. Third edition. New York, NY: McGraw-Hill.

Buskirk, E. R., Nicholas, W. C. and Hodgson, J. L., (1975) Measurement of work metabolism. Use of cardiorespiratory parameters for estimating metabolic heat production in hot environments, Pennsylvania State University, Laboratory for Human Performance Research.

Celentano, E.J., Nottrodt, J.W. and P.L. Saunders, (1984) Relationship between size, strength and task demands, Ergonomics, Vol. 27, (5).

Chaffin, D.B. (1967). The development of a prediction model for metabolic energy expended arm activities. Doctoral Dissertation. Ann Arbor: University of Michigan.

Chwalbinska-Moneta and O. Hanninen, (1989) Effect of active warming-up on thermoregulatory, circulatory and metabolic responses to incremental exercise in endurance-trained athletes, International Journal of Sports Medicine, Vol. 10, 25-29.

Consolazio C.F., Johnson H.L., and R.A. Nelson, (1975) Protein metabolism during intensive physical training in the young adult, Bioenergetics Div., Dept. Nutr., Letterman Army Inst. Res., Presidio San Francisco, Calif. 94129 American Clinical.Nutrition, 28/1, 29-35

Davis, H. L., Faulkner, T. W. and C.I. Miller, (1969) Work physiology. Human Factors, 11(2) 157-166.

Dusek, E. R., (1957) Manual performance and finger temperatures as a function of ambient temperature Tech. Rpt. No. EP-68. Natick, MA: Headquarters Quartermaster Research and Engineering Center Environmental Protection Research Division.

Enander, A. E., Effects of thermal stress on human performance. Scandinavian Journal of Work, Environment and Health, 15(1), 27-33, 1989.

Epstein, Y., Rosenblum, J., Burstein, R. and Sawka, M. N., (1988) External load can alter the energy cost of prolonged exercise, European Journal of Applied Physiology, Vol. 57, 243-247.

Fredrick, W.S., (1959) Human energy in manual lifting. Modern materials handling. 14(3), 74-76.

Gamberale, F., (1972) Perceived exertion, heart rate, oxygen uptake and blood lactate in different work operations. Ergonomics, 15(5), 545-554.

Garg, A., (1976) A metabolic prediction model for manual materials handling jobs. Doctoral Dissertation. Ann Arbor: University of Michigan.

Garg, A., Chaffin, D.B. and G.D.Herrin, (1978) Prediction of metabolic rates for manual materials

handling jobs, American Industrial Hygiene Association Journal. Vol. 39, 661-674.

Goldberg, J.H., (1987) Prediction of physical workload in reduced gravity environments (Final report) In NASA, Lyndon B. Johnson Space Center, Houston, TX. NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, Vol. 1.

Goldberg, J.H. and J.W. Alfred, (1988) Prediction of physical workload in reduced gravity. Aviation, Space and Environmental Medicine, Vol. 59, 1150-1157.

Gutin, B., J.E. Wilkerson, S.M. Horvath and R.D. Rochelle, (1981) Physiologic response to endurance work as a function of prior exercise, International Journal of Sports Medicine, Vol. 2, 87-90.

Haberg, M., (1981) Workload and fatigue in repetitive arm elavations, Ergonomics, 24(7), 543-555.

Hafez, H.A., (1984) Manual lifting under hot environmental conditions. Doctoral Dissertation. Lubbock: Texas Tech University.

Hagberg, J. M., J.P. Mullin and F.J. Nagle, (1978) Oxygen consumption during constant load exercise, Journal of Applied Physiology, Vol. 45, 381-384.

Hagberg, J. M., J.P. Mullin and F.J. Nagle, (1980) Effect of work intensity and duration on recovery of oxygen, Journal of Applied Physiology, Vol. 48, 540-544.

Inman, V, Ralston, H. and F. Todd.(1981) Human walking Williams and Wilkens, Baltimore.

Johnson, A. T., (1991) Biomechanics and exercise physiology. John Wiley and Sons, New York, 1991.

Kamon, E., and Belding, H.S., (1971) The physiological cost of carrying loads in temperature and hot environment. Human Factors, 13(2), 153-161.

Kamon E., Soto K. and J. Benson, (1982) Physiological responses to high radiant heat exposure, Environmental Research, Vol. 28, No. 1, 96-105.

Kawowski, W. and A. Mital, (Eds.). (1986) Applications of fuzzy set theory in human factors (Vol 6). Amsterdam, The Netherlands: Elsevier Science Publishers B.V.

Kleitman, N., and D. P. Jackson, (1950) Body temperature and performance under different routines. Journal of Applied Physiology, 3, 309-328.

Knapik, J., (1983) Physiological, biomechanical and medical aspects of lifting and repetitive lifting: A review, Report No. AD-A136689, USARIEM-T-7/83.

Konz, S. (1990) Work design: Industrial ergonomics. Grid. Publishing, Inc. Columbus, Ohio.

Kroemer, K.H.E., Kroemer, H.J. and K.E. Kromer-Elbert, (1990) Engineering physiology: Bases of human factors/ergonomics, Van Nostrand Reinhold, New York.

Kuoppasalmi, K., Smolander, I.R., and M. Harkonen, (1986) Relationship between physiological responses and perceived exertion of muscular exercise under various environmental conditions.

Psychiatria-Fennica, 69-77.

Kvalseth, T. O. (Ed.), (1983) Ergonomics of workstation design. London, U.K: Butterworth & Co.

Lamb, D.R., (1984) Physiology of exercise. Responses and adaptations. MacMillan Publishing Company, New York.

Louhevaara, V., P. Teraslinna, Piirilas, P., Salmio, S. and J. Ilmarinen, (1988) Physiological responses during and after intermittent sorting of postal parcels, Ergonomics, Vol. 31, (8), 1165-1175.

Mathiassen, S. E. and Winkel, J., (1992) Can occupational guidelines for work-rest schedules be based on endurance time data? Ergonomics, 35(3), 253-259, 1992.

Megaw, E.D., eds. Proceedings of the Ergonomics society's 1989 Annual Conference, Reading, England, 3-7 April 1989, Taylor and Francis.

Metz, B., (1959) Fitting the job to the worker. International Conference of Zurich. The European Productivity Agency.

Mihal, C. P., Jr., (1981) Effect of heat stress on physiological factors for industrial workers performing routine work and wearing impermeable vapor-barrier clothing. American Industrial Hygiene Association Journal, 42, 97-103.

Morehouse, L.E., Miller, A.T., (1967) Physiology of exercise, The C.V. Mosby Co.

Moonan, W.J., (1982) On models and methods for performance measurement, Navy Personnel Research and Development Center.

Moritano, T., A. Nagata, H. deVries and M. Muro, (1981) Critical power as a measure of physical work capacity and anaerobic threshold, Ergonomics, Vol. 24, (5) 339-350.

Murrell, K.F.H., (1965) Human performance in industry, Reinhold Co., New York, New York, 1965.

Naitoh, P., C.E. Englund and D.H. Ryman, (1987) Sustained Operations: Research Results (Interim Report) Naval Health Research Center, San Diego, CA., Report No.: NHRC-87-17.

Nave, C. R. & Nave, B. C., (1980) Physics for the health sciences. Second edition. Philadelphia, PA: W. B. Saunders Company.

Passmore, R., and J. V. G. A. Durin, (1955) Human energy expenditure, Physiological Reviews, 35, 801-840.

Poole, D.C., Ward, S.A. and Whipp, B.J., (1990) The effects of training on the metabolic and respiratory profile of high-intensity cycle ergometer exercise, European Journal of Applied Physiology and Occupational Physiology (Berlin), Vol. 59, (6) 421-429.

Price, A. D., (1990) Calculating relaxation allowances for construction operatives: I. Metabolic cost. Applied Ergonomics, *21*(4), 311-317.

Ramonatxo, M., J. Mercier, R. Cohendy and C. Prefaut, (1991) Effect of resistive loads on pattern of respiratory muscle recruitment during exercise, Journal of Applied Physiology, Vol. 71, 1941-1948.

Rodahl, K., (1989) The physiology of work. Taylor and Francis, New York.

Rodgers, S. H., (1978) Metabolic indices in materials handling tasks, In Safety in Manual Materials Handling, edited by Colin G. Drury, pp. 52-56, Cincinnati: U.S. Department of Health, Education and Welfare National Institute for Occupational Safety and Health.

Ross R.M. and Jackson A.S., (1986) Development and validation of total-work equations for estimating the energy cost of walking, Journal of Cardiopulmonary Rehabilitation, 185-192.

Schacherer, C., Rowe, A. and A. Jackson, (1992) Development of prediction models for physical work capacity: Practical and theoretical implications, Proceedings of the Human Factors Society 36th Annual Meeting - 1992, pp. 674-678 Report No. AD-A113578.

Schneck, D. J. (1992). Mechanics of muscle: Second edition. New York, NY: New York University Press.

Shephard, R. J., (1992) Physiology and biochemistry of exercise. Praeger Publisher.

Shibayama H. and H. Ebashi, (1980) Characteristics of well-trained athletes in prolonged exercise from the viewpoint of aerobic power, Journal of Human Ergology (Japan), 55-68.

Simonson, E. & Keys, A., (1971) Physiology of work capacity and fatigue. Springfield, IL: Charles C. Thomas.

Smith, J. L. and J.D. Ramsey, (1982) Ergonomics-Part Four: Designing physically demanding tasks to minimize levels of worker stress, Industrial Engineering, Vol. 14, (5), 44-50.

Smoak, B.L., A. Singh, B.A. Day, J.P. Norton, S.B. Kyle, S.J. Pepper and P.A. Deuster, (1988) Changes in nutrient intakes of conditioned men during a 5-day period of increased physical activity and other stresses, European Journal of Applied Physiology and Occupational Physiology, Vol. 58, 245-251.

Soule, R and R.Goldman, (1969) Energy cost of loads carried on the head, hands and feet, Journal of Applied Physiology, Vol. 27, (5), 687-690.

Taboun, S.M., (1986) Models of individual and combined manual materials handling tasks. Doctoral Dissertation: University of Windsor Dissertation.

Tichauer, E. R., (1968) Potential of biomechanics for solving specific hazard problems. Proceedings of ASSE 1968 Conference. Park Ridge, IL: American Society of Safety Engineers, pp. 149-187.

Tichauer, E. R., (1978) The biomechanical basis of ergonomics. New York, NY: John Wiley & Sons.

Van De Linde, F. J., (1987) Safe working time limits in Impermeable protective clothing: Recommendations based upon experimental measurements (DTIC No. AD-B123776). Soesterberg, The Netherlands: Institute for Perception RVO.

Verma, S.S. and J. Sen Gupta, (1990) Regression models for estimation of maximal aerobic power in man, Defense Science Journal, Vol. 40, (3), 293-298.

Vos, H.W., (1973) Physical workload in different body postures, While working near to, or below ground level, Egonomics, Vol. 16, (6), 817-828.

Williams, K. R., (1980) A biomechanical and physiological evaluation of running efficiency. Doctoral Dissertation: The Pennsylvaia State University.

Wilson J.R., Raven P.B., Zinkgraf S.A., Morgan W.P. and A.W. Jackson, (1989) Alterations in physiological and perceptual variables during exhaustive endurance work while wearing a pressure-demand respirator, American Industrial Hygiene Association Journal, 139-146.

White, M. K., Vercruyssen, M. and T.K. Hodous, (1989) Work tolerance and subjective responses to wearing protective clothing and respirators during physical work. Ergonomics, *32*(9), 1111-1123.

Yamamoto, Y., Kawakami, Y., Nakamura, Y., Mokushi, K., Mutoh Y. & M. Miyashita, (1988) New method for detecting anaerobic threshold from heart rate recording. Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society Annual Conference. Piscataway, NJ: IEEE Service Center (Cat. No. 88CH2566-8).

APPENDIX C

Military Tasks for IUSS

Appendix C
Military Tasks for IUSS

Infantry Tasks

071-000-0002	Supervise Zeroing of Organic Weapons
071-000-0003	Supervise Boresighting of Organic Weapons
071-002-0001	Perform Operator Maintenance on a .45 Caliber Pistol
071-002-0002	Perform a Function Check on a .45 Caliber Pistol
071-002-0005	Operate a .45 Caliber Pistol
071-004-0001	Perform Operator Maintenance on an M9 Pistol
071-004-0002	Perform a Function Check on an M9 Pistol
071-004-0003	Load an M9 Pistol
071-004-0003	Operate an M9 Pistol
071-004-0004	Unload an M9 Pistol
071-004-0005	Correct Malfunctions of an M9 Pistol
071-004-0006	Engage Targets With an M9 Pistol
071-008-0001	Mount a Night Vision Sight AN/PVS-4 on an M16A1 or M16A2 Rifle
071-008-0002	Dismount a Night Vision Sight AN/PVS-4 From an M16A1 or M16A2 Rifle
071-010-0001	Zero a Night Vision Sight AN/PVS-4 to an M249 Machine Gun
071-010-0002	Mount a Night Vision Sight AN/PVS-4 on an M249 Machine Gun
071-010-0003	Dismount a Night Vision Sight AN/PVS-4 From an M249 Machine Gun
071-010-0006	Engage Targets with the M249 Machine Gun
071-010-0007	Engage Targets with the M249 Machine Gun Using Night Vision Sight AN/PVS-4
071-020-0001	Mount a Night Vision Sight AN/PVS-4 on an M60 Machine Gun
071-020-0002	Dismount a Night Vision Sight AN/PVS-4 From an M60 Machine Gun
071-020-0006	Mount an M60 Machine Gun on an M122 Tripod
071-020-0007	Dismount an M60 Machine Gun from an M122 Tripod
071-020-0008	Mount a Night Vision Sight AN/PVS-2 on an M60 Machine Gun
071-020-0009	Dismount a Night Vision Sight AN/PVS-2 from an M60 Machine Gun
071-022-0001	Maintain a .50 Caliber M2 Machine Gun
071-022-0002	Perform a Function Check on a .50 Caliber M2 Machine Gun
071-022-0003	Operate a .50 Caliber M2 Machine Gun
071-022-0003	Load a .50 Caliber M2 Machine Gun
071-022-0004	Unload a .50 Caliber M2 Machine Gun
071-022-0005	Correct Malfunctions of the .50 Caliber M2 Machine Gun
071-022-0006	Mount a Night Vision Sight AN/TVS-2 on a .50 Caliber M2 Machine Gun
071-022-0007	Dismount a Night Vision Sight AN/TVS-2 from a .50 Caliber M2 Machine Gun
071-022-0008	Mount a Night Vision Sight AN/TVS-5 on a .50 Caliber M2 Machine Gun
071-022-0009	Dismount a Night Vision Sight AN/TVS-5 from a .50 Caliber M2 Machine Gun
071-022-0010	Mount a .50 Caliber M2 Machine Gun on an M3 Tripod
071-022-0011	Dismount a .50 Caliber M2 Machine Gun from an M3 Tripod
071-022-0012	Mount a .50 Caliber M2 Machine Gun on a Vehicle
071-022-0013	Dismount a .50 Caliber M2 Machine Gun from a Vehicle
071-022-0014	Construct a Fighting Position for a .50 Caliber M2 Machine Gun
071-022-0015	Prepare a Range Card for a .50 Caliber M2 Machine Gun
071-024-0001	Load the 25-mm Ammunition Ready Box (HE/HEI-T) on a BFV

071-024-0002	Load the 25-mm Ammunition Ready Box (APDS/APDS-T) on a BFV
071-024-0003	Unload the 25-mm Ammunition Ready Box (HEI-T) on a BFV
071-024-0004	Unload the 25-mm Ammunition Ready Box (APDS-T) on a BFV
071-024-0005	Maintain the 25-mm Automatic Gun on a BFV
071-024-0006	Perform a Function Check on the 25-mm Automatic Gun on a BFV
071-024-0007	Load the 25-mm Automatic Gun on a BFV
071-024-0008	Unload the 25-mm Automatic Gun on a BFV
071-024-0009	Zero the 25-mm Automatic Gun on a BFV
071-026-0001	Load the M240C Coaxial Machine Gun on a BFV
071-026-0002	Unload the M240C Coaxial Machine Gun on a BFV
071-026-0003	Zero the M240C Coaxial Machine Gun on a BFV
071-028-0001	Maintain an M231 Firing Port Weapon
071-028-0002	Perform a Function Check on an M231 Firing Port Weapon
071-028-0003	Install an M231 Firing Port Weapon on an M2 BFV
071-028-0004	Remove an M231 Firing Port Weapon from a M2 BFV
071-028-0005	Load an M231 Firing Port Weapon
071-028-0006	Unload an M231 Firing Port Weapon
071-030-0001	Maintain an MK19 Machine Gun
071-030-0002	Prepare a Range Card for an MK19 Machine Gun
071-030-0003	Zero an MK19 Machine Gun
071-030-0004	Engage Targets with an MK19 Machine Gun
071-030-0005	Load an MK19 Machine Gun
071-030-0006	Unload an MK19 Machine Gun
071-030-0007	Perform a Function Check on an MK19 Machine Gun
071-030-0008	Correct Malfunctions of an MK19 Machine Gun
071-030-0009	Mount an MK19 Machine Gun on a Vehicle
071-030-0010	Dismount an MK19 Machine Gun from a Vehicle
071-030-0011	Mount an MK19 Machine Gun on an M3 Tripod
071-030-0012	Dismount an MK19 Machine Gun from an M3 Tripod
071-030-0013	Construct a Fighting Position for an MK19 Machine Gun
071-030-0015	Select a Fighting Position for an MK19 Machine Gun
071-032-0001	Mount a Night Vision Sight AN/PVS-4 on an M203 Grenade Launcher
071-032-0002	Dismount a Night Vision Sight AN/PVS-4 from an M203 Grenade Launcher
071-032-0006	Construct Field Expedient Firing Aids for an M203 Grenade Launcher
071-034-0001	Load an M243 or M259 Smoke Grenade Launcher
071-034-0002	Unload an M243 or M259 Smoke Grenade Launcher
071-034-0003	Perform Misfire Procedures on an M243 or M259 Smoke Grenade Launcher
071-034-0004	Fire an M243 or M259 Smoke Grenade Launcher
071-034-0005	Load the M257 Smoke Grenade Launcher on a BFV
071-034-0006	Unload the M257 Smoke Grenade Launcher on a BFV
071-034-0007	Maintain an M243 or M259 Smoke Grenade Launcher
071-052-0001	Maintain an M47 Medium Antitank Weapon
071-052-0002	Maintain a Night Vision Sight AN/PVS-5
071-052-0003	Construct a Fighting Position for an M47 Medium Antitank Weapon
071-052-0004	Restore an M47 Medium Antitank Weapon to Carrying Configuration
071-052-0005	Operate a Night Vision Sight AN/TAS-5
071-052-0006	Engage Targets With an M47 Medium Antitank Weapon
071-054-0001	Prepare an M136 Launcher for Firing
071-054-0002	Restore an M136 Launcher to Carrying Configuration
071-054-0003	Perform Misfire Procedures on an M136 Launcher

071-054-0004	Engage Targets with an M136 Launcher
071-056-0001	Load the TOW Launcher on a BFV
071-056-0002	Unload the TOW Launcher on a BFV
071-056-0003	Operate the TOW Launcher on a BFV
071-058-0001	Maintain an M67 Recoilless Rifle
071-058-0002	Perform a Function Check on an M67 Recoilless Rifle
071-058-0003	Load an M67 Recoilless Rifle
071-058-0004	Unload an M67 Recoilless Rifle
071-058-0005	Construct a Fighting Position for an M67 Recoilless Rifle
071-070-0001	Maintain an M202A1 Multishot Rocket Launcher
071-070-0002	Perform a Function Check on an M202A1 Multishot Rocket Launcher
071-070-0003	Load an M202A1 Multishot Rocket Launcher
071-070-0004	Unload an M202A1 Multishot Rocket Launcher
071-070-0005	Perform Misfire Procedures on an M202A1 Multishot Rocket Launcher
071-070-0006	Prepare an M202A1 Multishot Rocket Launcher for Firing
071-070-0007	Restore an M202A1 Multishot Rocket Launcher to Carrying Configuration
071-070-0008	Engage Targets with an M202A1 Multishot Rocket Launcher
071-098-0001	Recover a Mechanical Ambush
071-098-0002	Install a Mechanical Ambush
071-098-0004	Conduct the Breach of a Minefield
071-121-3009	Control Movement Techniques
071-200-0001	Supervise Towing of a Vehicle
071-200-0002	Tow a Tracked Vehicle
071-212-0001	Maintain the Air Cleaner System on an M113 Series Vehicle
071-212-0002	Maintain the Electrical System on an M113 Series Vehicle
071-212-0003	Maintain the Brake System on an M113 Series Vehicle
071-212-0004	Maintain the Cooling System on an M113 Series Vehicle
071-212-0005	Maintain the Engine on an M113 Series Vehicle
071-212-0006	Maintain the Fuel System on an M113 Series Vehicle
071-212-0007	Maintain the Steering System on an M113 Series Vehicle
071-212-0008	Maintain the Transmission System on an M113 Series Vehicle
071-212-0009	Maintain the Heating System on an M113 Series Vehicle
071-212-0010	Maintain the Fire Suppression System on an M113 Series Vehicle
071-212-0011	Maintain the Exhaust System on an M113 Series Vehicle
071-212-0012	Maintain the Bilge System on an M113 Series Vehicle
071-212-0013	Maintain the Hydraulic System on an M113 Series Vehicle
071-212-0014	Maintain the Track and Suspension System on an M113 Series Vehicle
071-212-0015	Maintain the Hull on an M113 Series Vehicle
071-212-0016	Prepare an M113 Series Vehicle for Water Operations
071-212-0017	Maintain and Operate the NBC System on an M113 Series Vehicle
071-212-0019	Operate the M19 Periscope on an M113 Series Vehicle
071-212-0020	Start an M113 Series Vehicle Using Auxiliary Power
071-212-0021	Drive an M113 Series Vehicle
071-216-0001	Maintain the TOW System on a BFV
071-216-0002	Maintain the Smoke Generating System on a BFV
071-216-0003	Maintain the Electrical System on a BFV
071-216-0004	Maintain the Track and Suspension System on a BFV
071-216-0005	Maintain the Fire Suppression System on a BFV
071-216-0007	Maintain the Hull on a BFV
071-216-0008	Maintain the NBC System on a BFV

071-216-0009	Maintain the Turret on a BFV
071-216-0010	Maintain the Exhaust System on a BFV
071-216-0011	Maintain the Fuel System on a BFV
071-216-0012	Maintain the Cooling System on a BFV
071-216-0013	Maintain the Heating System on a BFV
071-216-0014	Maintain the Hydraulic System on a BFV
071-216-0016	Maintain the Engine on a BFV
071-216-0017	Maintain the Communications System on a BFV
071-216-0019	Maintain the Bilge System on a BFV
071-311-2001	Perform Operator Maintenance on an M16A1 Rifle, Magazine, and Ammunition
071-311-2003	Load, Reduce a Stoppage, and Clear an M16A1 Rifle
071-311-2004	Zero an M16A1 Rifle
071-311-2006	Construct Field Expedient Firing Aids for an M16A1 or M16A2 Rifle
071-311-2006	Use Limited Visibility Firing Techniques with an M16A1 Rifle
071-311-2007	Engage Targets With an M16A1 or M16A2 Rifle
071-311-2025	Maintain an M16A1 or M16A2 Rifle
071-311-2026	Perform a Function Check on an M16A1 or M16A2 Rifle
071-311-2027	Load an M16A1 or M16A2 Rifle
071-311-2028	Unload an M16A1 or M16A2 Rifle
071-311-2029	Correct Malfunctions of an M16A1 or M16A2 Rifle
071-311-2030	Zero an M16A2 Rifle
071-311-2101	Perform Operator Maintenance on an M203 Grenade Launcher and Ammunition
071-311-2102	Load, Unload, and Clear an M203 Grenade Launcher
071-311-2103	Zero an M203 Grenade Launcher
071-311-2104	Engage Targets With an M203 Grenade Launcher and Apply Immediate Action to Reduce a Stoppage
071-311-2105	Use Limited Visibility Firing Techniques with an M203 Grenade Launcher
071-311-2125	Maintain an M203 Grenade Launcher
071-311-2126	Perform a Function Check on an M203 Grenade Launcher
071-311-2127	Load an M203 Grenade Launcher
071-311-2128	Unload an M203 Grenade Launcher
071-311-2129	Correct Malfunctions of an M203 Grenade Launcher
071-311-2130	Engage Targets With an M203 Grenade Launcher
071-311-3001	Perform Operator Maintenance on a .45 Caliber Pistol
071-311-3002	Engage Targets With a .45 Caliber Pistol
071-311-6001	Perform Operator Maintenance on M231 Firing Port Weapon
071-311-6002	Install/Remove M231 Firing Port Weapon
071-311-6003	Load/Unload and Clear M231 Firing Port Weapon
071-311-6004	Perform Misfire Procedures on M231 Firing Port Weapon
071-311-6005	Engage Targets with M231 Firing Port Weapon
071-312-2322	Mount/Dismount the M60 Machine Gun on the M4 Pedestal Mount
071-312-3001	Load, Reduce a Stoppage, and Clear an M60 Machine Gun
071-312-3002	Fire an M60 Machine Gun
071-312-3003	Lay an M60 Machine Gun Using Field Expedients
071-312-3004	Construct a Fighting Position for an M60 Machine Gun
071-312-3005	Perform Operator Maintenance on an M60 Machine Gun and Ammunition
071-312-3006	Field Zero an M60 Machine Gun
071-312-3007	Prepare a Range Card For an M60 Machine Gun
071-312-3009	Zero the M60 Machine Gun on a 10-meter Range
071-312-3025	Maintain an M60 Machine Gun

071-312-3026	Perform a Function Check on an M60 Machine Gun
071-312-3027	Load an M60 Machine Gun
071-312-3028	Unload an M60 Machine Gun
071-312-3029	Correct Malfunctions of an M60 Machine Gun
071-312-3030	Zero an M60 Machine Gun
071-312-3031	Engage Targets With an M60 Machine Gun
071-312-4001	Perform Operator Maintenance on an M249 Machine Gun and Ammunition
071-312-4002	Load, Reduce a Stoppage, and Clear an M249 Machine Gun
071-312-4003	Field Zero an M249 Machine Gun
071-312-4004	Lay an M249 Machine Gun Using Field Expedients
071-312-4025	Perform Operator Maintenance on an M249 Machine Gun
071-312-4027	Operate an M249 Machine Gun
071-312-4030	Zero an M249 Machine Gun
071-312-4032	Prepare a Range Card for an M249 Machine Gun
071-313-3451	Perform Operator Maintenance on a .50 Caliber M2 Machine Gun
071-313-3452	Zero a .50 Caliber M2 Machine Gun
071-313-3453	Prepare a Range Card for a .50 Caliber M2 Machine Gun
071-313-3454	Engage Targets with a Caliber .50 M2 Machine Gun
071-313-3455	Set Headspace and Timing on a .50 Caliber M2 Machine Gun
071-313-3462	Mount/Dismount a .50 Caliber M2 Machine Gun on a Tracked Vehicle
071-313-4003	Load, Unload & Clear an M240C Machine Gun on a BFV
071-313-4004	Boresight the M240C Coaxial Machine Gun on a BFV
071-313-4006	Correct Malfunctions of the M240C Coaxial Machine Gun on a BFV
071-313-4007	Engage Targets With the M240C Coaxial Machine Gun Using the ISU on a BFV
071-313-4008	Engage Targets With the M240C Coaxial Machine Gun Using the Auxiliary Sight on a BFV
071-314-0001	Boresight the Auxiliary Sight on the BFV
071-314-0002	Load/Unload 25-mm Ready Boxes on an M2/M3 Bradley
071-314-0003	Perform Operator's Maintenance on a 25-mm Automatic Gun
071-314-0006	Load, Unload & Clear 25-mm Automatic Gun on a BFV
071-314-0008	Boresight the 25-mm Automatic Gun on a BFV
071-314-0009	Zero 25-mm Automatic Gun and M240C to the ISU
071-314-0011	Perform Misfire Procedures on the 25-mm Automatic Gun on a BFV
071-314-0012	Engage Targets With the 25-mm Automatic Gun Using the ISU on a BFV
071-314-0013	Engage Targets With the 25-mm Automatic Gun Using the Auxiliary Sight on BFV
071-314-0017	Issue a Fire Command for the M2 BFV
071-314-2003	Prepare a Range Card For an M3 Bradley
071-315-0003	Operate a Night Vision Sight AN/PVS-4
071-315-0008	Engage Targets With an M60 Machine Gun Using a Night Vision Sight AN/PVS-4
071-315-0030	Operate the Night Vision Goggles AN/PVS-5
071-315-0031	Maintain the Night Vision Goggles AN/PVS-5
071-315-0039	Operate M18 Infrared Binoculars
071-315-0056	Engage Targets With a Caliber .50 M2 HB Machine Gun Mounted With an AN/TVS-5 Night Sight
071-315-0090	Maintain a Thermal Viewer AN/PAS-7
071-315-0091	Operate a Thermal Viewer AN/PAS-7
071-315-2301	Perform Operator's Maintenance on an AN/PVS-2
071-315-2302	Conduct Surveillance Using AN/PVS-2
071-315-2303	Mount and Dismount AN/PVS-2 on an M16A1 Rifle

071-315-2304	Zero an AN/PVS-2 to an M16A1 Rifle
071-315-2305	Engage Targets with M16A1 Rifle Using AN/PVS-2
071-315-2306	Mount and Dismount a Night Vision Sight AN/PVS-4 to an M16A1 Rifle
071-315-2307	Zero a Night Vision Sight AN/PVS-4 to an M16A1 or M16A2 Rifle
071-315-2308	Engage Targets With an M16A1 or M16A2 Rifle Using a Night Vision Sight AN/PVS-4
071-315-2310	Mount and Dismount an AN/PVS-2 on an M60 Machine Gun
071-315-2311	Zero an AN/PVS-2 to an M60 Machine Gun
071-315-2312	Mount and Dismount a Night Vision Sight AN/PVS-4 to an M60 Machine Gun
071-315-2313	Zero a Night Vision Sight AN/PVS-4 to an M60 Machine Gun
071-315-2314	Mount and Dismount a Night Vision Sight AN/TVS-2 to a .50 Caliber M2 Machine Gun
071-315-2315	Zero a Night Vision Sight AN/TVS-2 to a .50 Caliber M2 Machine Gun
071-315-2316	Mount and Dismount a Night Vision Sight AN/TVS-5 to a .50 Caliber M2 Machine Gun
071-315-2317	Zero a Night Vision Sight AN/TVS-5 to a .50 Caliber M2 Machine Gun
071-315-2350	Mount and Dismount a Night Vision Sight AN/PVS-4 to an M203 Grenade Launcher
071-315-2351	Zero a Night Vision Sight AN/PVS-4 to an M203 Grenade Launcher
071-315-2352	Engage Targets with an M203 Grenade Launcher Using a Night Vision Sight AN/PVS-4
071-316-2500	Assemble a TOW Launcher
071-316-2501	Perform Operator Maintenance on a TOW Launcher
071-316-2502	Conduct a System Self-Test and Preoperation Inspection of a TOW Launcher and Encased Missile
071-316-2503	Load, Arm, and Unload an Encased TOW Missile
071-316-2504	Perform Immediate Action For a TOW Missile
071-316-2505	Determine If a Target Can Be Engaged By a TOW Missile
071-316-2508	Conduct Dismount and Remount TOW Operations
071-316-2519	Engage a Target With a TOW
071-316-2523	Install TOW Components and Encased Missiles on an ITV (M901)
071-316-2524	Erect Launcher From a Stow Position
071-316-2526	Stow a Launcher on an ITV (M901)
071-316-2527	Collimate and Operate an AN/TAS-4 Night Sight
071-316-2529	Prepare an ITV (M901) Dual Launcher For Loading
071-316-2530	Load a Dual Launcher With Encased Missile(s) and Return to Stow Position
071-316-2531	Engage a Target With an ITV (M901) Dual Launcher
071-316-2532	Perform Immediate Action For an ITV (M901) Dual Launcher Misfire
071-316-2534	Operate M243 Smoke Grenade Launcher on an ITV (M901)
071-316-2535	Conduct Preoperational Checks on an ITV (M901) (Turret)
071-316-2536	Operate the ITV (M901) Dual Launcher Using Emeregency Action Procedures
071-316-2540	Mount, Stow, and Dismount an M60 Machine Gun on an ITV (M901)
071-316-2550	Occupy a TOW Firing Position
071-316-2903	Place an AN/TVS-4 Night Observation Device Into Operation
071-316-3002	Perform Misfire Procedures on the TOW System on a BFV
071-316-3005	Boresight a TOW Launcher on a BFV
071-316-3006	Engage Targets With the TOW System on a BFV
071-316-3009	Load/Unload a TOW Launcher on an M2/M3 Bradley
071-316-3015	Remove a Misfired TOW Missile From the TOW Launcher on a BFV
071-316-4000	Assemble a TOW 2 Launcher

071-316-4001	Conduct a System Check-Out and Preoperation Inspection of a TOW 2 Launcher and Encased Missile
071-316-4002	Perform Operator Maintenance on a TOW 2 Launcher
071-316-4003	Perform Immediate Action For a TOW 2 Misfire
071-316-4005	Engage a Target With a TOW 2
071-316-4050	Conduct Preoperationa Check on an ITV (M901A1) (Turret)(TOW 2)
071-316-4051	Conduct a System Check-Out Procedure on an ITV TOW 2 (M901A1)
071-316-4053	Enage a Target With an ITV TOW 2 (M901A1) Dual Launcher
071-316-4055	Conduct Dismount and Remount TOW 2 Operations (M901A1)
071-317-0000	Prepare an Antiarmor Range Card
071-317-3301	Conduct a Preoperation Inspection and Perform Operator Maintenance on a Dragon Tracker and Round
071-317-3302	Prepare an M47 Medium Antitank Weapon For Firing
071-317-3303	Determine if a Target is Engageable by a Dragon
071-317-3304	Demonstrate Correct Dragon Firing Position
071-317-3306	Perform Misfire Procedures on an M47 Medium Antitank Weapon
071-317-3307	Construct a Fighting Position (Dragon/90-mm RCLR)
071-317-3324	Select a Fighting Position for an M47 Medium Antitank Weapon
071-318-2201	Prepare an M72A2 Law For Firing
071-318-2202	Engage Targets With an M72A2 Law
071-318-2203	Apply Immediate Action to Correct a Malfunction on an M72A2 Law
071-318-2205	Control the Employment of a Squad's M72A2 Laws
071-318-2210	Prepare an M72A2 Law For Firing
071-318-2211	Restore an M72A2 Law to Carrying Configuration
071-319-3151	Perform Operator Maintenance on an M67 Recoilless Rifle
071-319-3152	Boresight an M67 Recoilless Rifle
071-319-3153	Load, Unload, and Clear an M67 Recoilless Rifle
071-319-3155	Engage Targets with an M67 Recoilless Rifle
071-324-1008	Perform PMCS on the Hull of an M2/3 Bradley
071-324-2003	Prepare a Range Card for a M2 BFV
071-324-3052	Direct Fire and Maneuver of a Dismount Team Against an Enemy Position
071-324-4002	Load, Unload, & Stow Smoke Grenades for the M257 Smoke Grenade Launcher on an M2/M3 Bradley
071-324-4003	Fire the M257 Smoke Grenade Launcher on a BFV
071-324-4004	Perform Misfire Procedures on the M257 Smoke Grenade Launcher on a BFV
071-324-6001	Drive a BFV
071-324-6003	Shut Down the Driver's Station on an M2/M3 Bradley to include Crew Area
071-324-6004	Operate the Turret on a BFV
071-324-6004	Shut Down the Turret on a BFV
071-324-6007	Break/Join Track on an M2/M3 Bradley
071-324-6019	Operate an M2/M3 Bradley in Water
071-324-6021	Tow/Tow Start an M2/M3 Bradley
071-324-6022	Extinguish a Fire on a BFV
071-324-6025	Start a BFV Using Auxiliary Power
071-324-6026	Operate the NBC System on an M2A1/M3A1 BFV
071-324-6031	Start/Stop the Engine on an M2/M3 Bradley
071-324-6033	Drive an M2/M3 Bradley Using Night Vision Equipment
071-325-4401	Perform Safety Checks on Hand Grenades
071-325-4402	Engage Enemy Targets With Hand Grenades
071-325-4405	Identify and Employ Hand Grenades

071-325-4406	Install/Recover a Mechanical Ambush
071-325-4407	Employ Hand Grenades
071-325-4412	Install and Fire/Recover an M18A1 Claymore Mine
071-325-4413	Install an M18A1 Claymore Mine with Trip Wires
071-325-4414	Disarm an M18A1 Claymore Mine with Trip Wires
071-325-4425	Employ an M18A1 Claymore Mine
071-325-4426	Recover an M18A1 Claymore Mine
071-325-4450	Perform Self-Extraction from a Minefield and Probe for Mines
071-326-0500	Move a Casualty from the Immediate Battle Area
071-326-0501	Move As a Member of a Fire Team
071-326-0502	Move Under Direct Fire
071-326-0503	Move Over, Through, or Around Obstacles
071-326-0510	React to Indirect Fire
071-326-0511	React to Flares
071-326-0512	Estimate Range
071-326-0513	Select Temporary Fighting Positions
071-326-0515	Select a Movement Route Using a Map
071-326-0520	Establish a Hot Loop with TA-1/PT Telephone
071-326-0541	Perform Movement Techniques During Military Operations on Urbanized Terrain
071-326-0542	Enter a Building During MOUT
071-326-0543	Organize a Squad for an Attack on a Building
071-326-0547	Organize a Platoon for an Attack on a Building
071-326-0550	Prepare Positions for Individual and Crew Served Weapons During MOUT
071-326-0551	Prepare Building(s) for a Platoon Defensive Position
071-326-0556	Clear a Building
071-326-0557	Select Hasty Firing Positions During MOUT
071-326-0572	Conduct Defensive MOUT Operations with a M2 BFV Platoon
071-326-0573	Control Movement Through Urban Terrain with a M2 BFV Platoon
071-326-0600	Use Visual Signals to Control Movement (Dismounted)
071-326-0608	Use Visual Signalling Techniques While Mounted
071-326-1001	Supervise the Construction and Negotiation of a Slack-Rope Retrievable Bridge (One-Rope)
071-326-1026	Rappel From a Hovering UH-1 Helicopter
071-326-1028	Rappel From a Hovering UH-60 Helicopter
071-326-3000	Supervise Combat Loading of Personnel and Equipment on a Vehicle
071-326-3001	Direct a Driver Over a Terrain Route
071-326-3002	React to Indirect Fire While Mounted
071-326-3004	Control Occupation of a Bounding Position
071-326-3006	Conduct the Maneuver of a Mechanized (M113) Squad
071-326-3007	Determine Movement Techniques for a Mechanized Infantry Platoon
071-326-3008	Control Platoon APCs in the Defense
071-326-3011	Drive a Tracked Vehicle Using Terrain for Cover and Concealment
071-326-3012	React to Enemy Direct Fire while Mounted on an M2 BFV
071-326-3013	Conduct Tactical Road March
071-326-3048	Conduct an Ambush
071-326-3049	Conduct Troop Leading Procedures For an Operation
071-326-3054	Direct Dismount Team Fires in the Defense
071-326-3055	Ensure OPSEC of a BFV Squad
071-326-3056	Direct Dismount of a M2 BFV
071-326-3057	Supervise Combat Loading of M2 BFV Personnel and Equipment

071-326-3060	Consolidate and Reorganize a BFV Squad
071-326-3604	Conduct a Disengagement with a M2 BFV Platoon
071-326-5501	Control Rate and Distribution of Fire
071-326-5502	Issue a Fragmentary Order
071-326-5503	Issue a Warning Order
071-326-5505	Prepare and Issue an Oral Operation Order
071-326-5509	Consolidate and Reorganize Squad-Sized Element Following Enemy Contact (Offense)
071-326-5510	Consolidate and Reorganize Squad-Sized Element Following Enemy Contact (Defense)
071-326-5511	Consolidate and Reorganize Platoon Sized Element Following Enemy Contact (Defense)
071-326-5512	Consolidate and Reorganize Platoon Sized Element Following Enemy Contact (Offense)
071-326-5515	Organize Platoon for Night Defense
071-326-5605	Control Fire Team Movement
071-326-5606	Select Overwatch Positions
071-326-5610	Implement Infantry Squad Movement Techniques When Not In Contact With the Enemy
071-326-5611	Direct the Fire and Maneuver of an Infantry Squad Against an Enemy Position
071-326-5625	Prepare and Issue an Oral Platoon Operation Order (OPORD) for an Offensive Mission
071-326-5626	Prepare and Issue an Oral Operation Order (OPORD)
071-326-5630	Conduct Movement Techniques By a Platoon
071-326-5635	Direct Fire and Maneuver of a Platoon Against an Enemy Position
071-326-5701	Supervise the Preparation of a Squad-Size Element's Defensive Position
071-326-5703	Construct an Individual Fighting Position
071-326-5704	Supervise Construction of a Fighting Position
071-326-5705	Establish an Observation Post
071-326-5710	Designate Fighting Positions for Squad Members (Less Crew-Served Weapons)
071-326-5711	Designate Alternate and Supplementary Fighting Positions for Squad Members
071-326-5720	Prepare a Squad-Sized Element's Defensive Sector Sketch
071-326-5725	Direct Squad-Sized Element's Fire in the Defense
071-326-5750	Prepare and Issue an Oral Platoon Operation Order for a Defensive Mission
071-326-5761	Designate Primary, Alternate, and Supplementary Fighting Positions For Key Weapons
071-326-5770	Prepare a Platoon Sector Sketch
071-326-5775	Coordinate with Adjacent Platoon-Sized Elements
071-326-5780	Direct Platoon-Sized Elements Fires in the Defense
071-326-5801	Organize an Antiarmor Ambush
071-326-5802	Conduct an Antiarmor Ambush
071-326-5803	Organize an Antiarmor Ambush with an M2 BFV Squad
071-326-5804	Conduct an Antiarmor Ambush with a M2 BFV Squad
071-326-5805	Plan and Conduct a Route Reconnaissance
071-326-5806	Plan and Conduct an Area Reconnaissance
071-326-5807	Plan and Conduct a Screening Mission
071-326-5808	Plan and Conduct a Zone Reconnaissance
071-326-5811	Conduct a Passage of Lines
071-326-5832	Conduct a Disengagement of a Platoon While Under Enemy Pressure
071-326-5832	Plan a Withdrawal Under Enemy Pressure

071-326-5833	Plan a Withdrawal Not Under Enemy Pressure
071-326-5902	Prepare an M2 BFV Squad Defensive Position
071-326-5904	Prepare an M2 BFV Platoon Defensive Position
071-326-5905	Direct M2 BFV Platoon Fires in the Defense
071-326-5907	Ensure OPSEC of a BFV Platoon
071-326-5908	Employ an M2 BFV Platoon on BP
071-326-5910	Control Dismounted BFV Platoon Formations
071-326-5911	Control Mounted BFV Platoon Formations
071-326-5912	Direct the Fire and Maneuver of a BFV Platoon
071-326-5913	Employ an M2 BFV Platoon in the Aerial Defense Role
071-326-5914	Consolidate and Reorganize a BFV Platoon
071-326-5915	Plan a Movement to Contact with the M2 BFV Platoon
071-326-5917	Conduct a Mounted Assault with a M2 BFV Platoon
071-326-5918	Conduct a Dismounted Assault with a M2 BFV Platoon
071-326-5920	Control a Dismount Team Movement
071-326-5921	Move as a Member of a Dismount Team
071-328-5301	Inspect Personnel/Equipment
071-328-5302	Supervise Maintenance on Individual and TOE Equipment
071-328-5303	Practice Preventive Medicine
071-329-1000	Identify Topographic Symbols, Colors, and Use Marginal Information
071-329-1001	Identify Terrain Features on a Map
071-329-1002	Determine the Grid Coordinates of a Point on a Military Map Using the Military Grid Reference System
071-329-1003	Determine a Magnetic Azimuth Using a Compass
071-329-1004	Determine the Elevation of a Point on the Ground Using a Map
071-329-1005	Determine a Location on the Ground By Terrain Association
071-329-1006	Navigate From One Point on the Ground to Another While Dismounted
071-329-1007	Determine Distance While Moving Between Two Points on the Ground
071-329-1008	Measure Distance on a Map
071-329-1009	Convert Azimuths (Magnetic or Grid)
071-329-1011	Orient a Map Using a Lensatic Compass
071-329-1012	Orient a Map to the Ground By Map-Terrain Association
071-329-1014	Locate an Unknown Point on a Map or on the Ground By Intersection
071-329-1015	Locate an Unknown Point on a Map or on the Ground By Resection
071-329-1018	Determine Direction Using Field Expedient Methods
071-329-1019	Use a Map Overlay
071-329-1021	Determine a Target by Grid Coordinates
071-329-1030	Navigate From One Point on the Ground to Another While Mounted
071-329-1031	Determine Azimuths Using a Protractor and Compute Back Azimuths
071-330-3009	Perform PMCS on the Turret of an M2/M2A1, M3/M3A1 Bradley
071-331-0001	Move As a Member of a Patrol
071-331-0002	Conduct a Local Security Patrol
071-331-0003	Plan a Patrol
071-331-0011	Prepare Individual Equipment For Patrol
071-331-0012	Select, Occupy, and Operate a Patrol Base
071-331-0013	Lead a Reconnaissance Patrol
071-331-0014	Lead a Raid
071-331-0015	Lead an Ambush
071-331-0571	Secure a Building with a M2 BFV Squad
071-331-0801	Use Challenge and Password

071-331-0802	Process Enemy Personnel and Equipment
071-331-0803	Collect/Report Information (SALUTE)
071-331-0804	Conduct Day and Night Surveillance Without the Aid of Electronic Devices
071-331-0808	Identify Threat Weapons and Equipment
071-331-0809	Emplace/Recover Field Expedient Warning Devices
071-331-0810	Emplace/Recover Pyrotechnic Early Warning Devices
071-331-0815	Practice Noise, Light, and Litter Discipline
071-331-0820	Analyze Terrain Using the Five Military Aspects of Terrain
071-331-0852	Clear a Field of Fire
071-331-1000	Prepare the Platoon Early Warning System AN/TRS-2 for Operation
071-331-1001	Perfom Pre-Mission Checks on the Platoon Early Warning System AN/TRS-2
071-331-1002	Monitor the Platoon Early Warning System AN/TRS-2
071-331-1003	Installation Planning and Installation of Platoon Early Warning System AN/TRS-2
071-332-5000	Prepare an Operations Overlay
071-332-5001	Prepare, Assemble, and Distribute an Operation Plan/Operation Order/Annex
071-332-5002	Prepare a Fragmentary Order
071-332-5004	Prepare a Battalion Warning Order
071-332-5020	Post an S3 Workbook
071-332-5021	Prepare/Update Enemy/Friendly Situation Map
071-332-5022	Prepare Situation Report (SITREP)
071-332-5030	Prepare Road Movement Graph
071-332-5031	Prepare a Road Movement Table
071-332-5034	Extract Information from a Route Reconnaissance Report
071-332-5036	Prepare Strip Map
071-332-5041	Request Preplanned Close Air Support
071-332-5050	Monitor Operations/Movements of Subordinate Units
071-332-5051	Post a Daily Staff Journal
071-332-5052	Supervise Establishment/Displacement of Tactical Operations Center (TOC)
071-333-6500	Drive a Tracked Vehicle (M113A1 or M901)
071-333-6503	Operate Light Controls and M19 Infrared Periscope on a Tracked Vehicle
071-333-6508	Perform Operator's Maintenance on a Tracked Vehicle
071-333-6512	Negotiate Obstacles in an M113A1
071-333-6515	Remove/Install Track Shoe(s) on a Tracked Vehicle
071-333-6516	Stop the Engine of an M113A1
071-333-6517	Start the Engine of an M113A1
071-333-6518	Troubleshoot an M113A1
071-333-6519	Extinguish a Fire on a Tracked Vehicle (M113A1 or M901)
071-333-6523	Self-Recover an M113A1
071-333-6550	Escape From a Tracked Vehicle
071-334-4001	Guide a Helicopter to a Landing Point
071-334-4002	Establish a Helicopter Landing Point
071-400-0001	Adjust Aerial Fire Support
071-400-0003	Prepare Personnel and Equipment for Air Assault
071-410-0001	Perform Self-Extraction from a Minefield
071-410-0002	React to Direct Fire While Mounted
071-410-0007	Prepare an M2 BFV Rifle Team Sector Sketch
071-410-0008	Prepare a BFV for Fording
071-410-0009	Supervise Preparation of a BFV for Water Operations
071-410-0010	Conduct a Leader's Reconnaissance
071-410-0011	Conduct a Tactical Road March

071-410-0012	Supervise Occupation of an Assembly Area
071-410-0013	Prepare a Situation Report
071-410-0015	Direct Dismount from an M113 Vehicle
071-410-0016	Conduct Occupation of an Overwatch Position
071-410-0019	Control Organic Fires
071-410-0020	Plan for Use of Supporting Fires
071-420-0001	Consolidate a Platoon Following Enemy Contact While In the Offense
071-420-0002	Reorganize a Platoon Following Enemy Contact While In the Offense
071-420-0003	Consolidate a Squad Following Enemy Contact While In the Offense
071-420-0004	Reorganize a Squad Following Enemy Contact While In the Defense
071-420-0005	Conduct the Maneuver of a Platoon
071-420-0007	Conduct the Maneuver of an M2 BFV Rifle Team
071-420-0010	Conduct a Mounted Assault by an M2 BFV Platoon
071-420-0013	Conduct a Movement to Contact by an M2 BFV Platoon
071-430-0002	Conduct a Defense by a Squad
071-430-0003	Consolidate a Squad Following Enemy Contact While in the Defense
071-430-0004	Reorganize a Squad Following Enemy Contact While in the Defense
071-430-0006	Conduct a Defense by a Platoon
071-430-0007	Consolidate a Platoon Following Enemy Contact While in the Defense
071-430-0008	Reorganize a Platoon Following Enemy Contact While in the Defense
071-430-0017	Conduct a Defense by a M2 BFV Platoon
071-430-0024	Conduct a Defense by a M2 BFV Squad
071-440-0003	Conduct an Attack on a Building by a Squad During MOUT
071-440-0006	Conduct a Defense by a Squad During MOUT
071-440-0019	Conduct a defense by a M2 BFV Platoon During MOUT
071-440-0022	Conduct an Attack by an M2 BFV Platoon During MOUT
071-450-0005	Conduct a Screen by a Platoon
071-450-0011	Conduct an Antiarmor Area Ambush by an M2 BFV Platoon
071-450-0014	Conduct a Point Antiarmor Ambush by a Squad
071-450-0017	Conduct a Raid
071-450-0024	Conduct an Area Ambush by an M2 BFV Platoon
071-450-0027	Conduct a Relief
071-450-0030	Conduct a Passage of Lines
071-450-0035	Conduct an Area Ambush by a Platoon
071-450-0036	Conduct an Antiarmor Ambush by a Platoon
071-450-0037	Supervise Employment of Smoke
071-450-0038	Construct Field Expedient Flame Weapons
071-510-0001	Determine Azimuths Using a Protractor
071-510-0002	Compute Back Azimuths
071-600-0001	Destroy Supplies and Equipment
071-600-0005	Enforce Preventive Medicine
071-600-0006	Cross-Load Key Equipment and Personnel
071-600-0010	Supervise the Receipt of Supplies
071-620-0001	Plan for Decontamination Operations
071-620-0002	Employ NBC Defense Teams
071-710-0001	Maintain a Night Vision Sight AN/PVS-4
071-710-0002	Operate the Driver's Night Viewer AN/VVS-2 on a BFV
071-710-0003	Maintain the Driver's Night Viewer AN/VVS-2 (V3) on a BFV
071-710-0004	Supervise Use of Night Vision Devices
071-710-0006	Plan Use of Night Vision Devices

071-720-0006	Conduct Operation of a Patrol Base
071-720-0009	Conduct a Local Security Patrol
071-720-0012	Conduct a Zone Reconnaissance By a Platoon
071-720-0015	Conduct an Area Reconnaissance By a Platoon
071-720-0017	Conduct a Route Reconnaissance by a Platoon
071-730-0001	Emplace Pyrotechnic Early Warning Devices
071-730-0002	Recover Pyrotechnic Early Warning Devices
071-730-0005	Plan Employment of Field Expedient and Pyrotechnic Early Warning Devices
071-730-0006	Enforce Operations Security
071-730-0007	Supervise Employment of Field Expedient and Pyrotechnic Early Warning Devices
071-730-0008	Emplace Field Expedient Early Warning Devices
071-810-0001	Maintain an AN/PRC-126 Radio
071-810-0002	Operate an AN/PRC-126 Radio
071-810-0003	Construct a Field Expedient Antenna
071-810-0004	Maintain Intercommunications Set AN/VIC-1 on a Tracked Vehicle
071-820-0001	Operate Telephone Set TA-1/PT
071-820-0002	Install Telephone set TA-1/PT
071-820-0004	Recover Communications Wire Lines
071-900-0001	Prepare an Operation Plan
071-900-0002	Safeguard Classified Material and Documents
071-900-0003	Prepare a Battalion Operation Order
071-900-0004	Supervise Establishment of a Tactical Operations Center
071-900-0005	Supervise Displacement of a Tactical Operations Center
071-930-0001	Supervise Engineer Support
071-940-0001	Supervise the Distribution of Supplies
171-132-1001	Perform Emergency Evacuation Procedures on the M3 Bradley
171-132-1002	Stow Amunition and Equipment on an M3 Bradley
171-132-1003	Abandon and Destroy an M3 Bradley
171-132-1004	Install/Remove an M240C Coaxial Machine Gun on an M2/M3 BFV

Occupy Assembly Area Tasks for IUSS

051-191-1361	Camouflage Yourself and Your Individual Equipment
051-191-1362	Camouflage Equipment
071-311-2025	Maintain an M16A1/M16A2 Rifle
071-311-2029	Correct Malfunctions of an M16A1/M16A2 Rifle
071-311-2129	Correct Malfunctions of an M203 Grenade Launcher
071-312-3029	Correct Malfunctions of an M60 Machine Gun
071-326-0513	Select Temporary Fighting Positions
071-326-5703	Construct Individual Fighting Positions
071-329-1000	Identify Topographic Symbols, Colors, and Use Marginal Information
071-329-1001	Identify Terrain Features on a Map
071-329-1002	Determine the Grid Coordinates of a Point on a Military Map Using the Military Grid Reference System
071-331-0801	Use Challenge and Password
071-331-0815	Practice Noise, Light, and Litter Discipline
113-571-1016	Send a Radio Message
071-052-0003	Construct a Fighting Position for an M47 Medium Antitank Weapon

071-311-2006	Construct Field Expedient Firing Aids for an M16A1/M16A2 Rifle
071-311-2125	Maintain an M203 Grenade Launcher
071-312-3004	Construct a Fighting Position for an M60 Machine Gun
071-312-3025	Maintain an M60 Machine Gun
071-312-3003	Lay an M60 Machine Gun Using Field Expedients
071-312-4004	Lay an M249 Machine Gun Using Field Expedients
071-312-4025	Perform Operator Maintenance on an M249 Machine Gun
071-312-3007	Prepare a Range Card for an M60 Machine Gun
071-315-0003	Operate a Night Vision Sight AN/PVS-4
071-315-0030	Operate Night Vision Goggles AN/PVS-5
071-317-0000	Prepare an Antiarmor Range Card
071-328-5303	Practice Preventive Medicine
071-730-0008	Employ Field Expedient Early Warning Devices
113-588-1087	Install a Hot Loop
113-600-2007	Operate Telephone Set TA-312/PT
031-503-2008	Use and Maintain the M8A1 Chemical Agent Alarm
071-032-0006	Construct Field Expedient Firing Aids for an M203 Grenade Launcher
071-326-5503	Issue a Warning Order
071-710-0004	Supervise Use of Night Vision Devices
113-573-4003	Encode and Decode Messages Using KTC 600E Tactical Operation Code
113-573-4006	Use the KTC 1400D Numerical Cipher/Authentication System
113-573-8006	Use Automated CEOI
071-317-3324	Select Fighting Position for an M47 Medium Antitank Weapon
071-326-3049	Conduct Troop Leading Procedures for an Operation
071-326-5505	Issue an Oral Operations Order
071-410-0010	Conduct a Leader's Reconnaissance
071-730-0005	Plan Employment of Field Expedient and Pyrotechnic Early warning Devices
071-326-5761	Designate Primary, Alternate, and Supplementary Firing Positions
071-410-0012	Supervise Occupation of an Assembly Area
071-410-0020	Plan for Use of Supporting Fires
071-312-3026	Perform Function Check on an M60 Machine Gun
071-326-5775	Coordinate with an Adjacent Platoon
071-052-0001	Maintain an M47 Medium Antitank Weapon
071-052-0002	Maintain a Night Vision Sight, AN/PVS-5
071-311-2026	Perform a Function Check on an M16A1/M16A2 Rifle
071-312-4032	Prepare a Range Card for an M249 Machine Gun
071-317-3301	Conduct a Preoperations Inspection and Perform Operator Maintenance on a Dragon Tracker and Round
071-317-3307	Construct a Fighting Position (Dragon)
071-325-4425	Employ an M18A1 Claymore Mine
071-325-4426	Recover an M18A1 Claymore Mine
071-326-0520	Establish a Hot Loop with TA-1/PT Telephone
071-326-5502	Issue a Fragmentary Order
071-326-5625	Prepare and Issue an Oral Platoon Operation Order for an Offensive Mission
071-326-5701	Supervise the Preparation of a Squad-size Element's Defensive Position
071-326-5704	Supervise Construction of a Fighting Position
071-326-5705	Establish an Observation Post
071-326-5710	Designate Fighting Positions for Squad Members (Less Crew-Served Weapons)
071-326-5711	Designate Alternate and Supplementary Fighting Positions for Squad Members
071-326-5720	Prepare a Squad-Sized Element's Defensive Sector Sketch

071-326-5770	Prepare a Platoon Sector Sketch
071-326-5775	Coordinate with Adjacent Platoon-Sized Elements
071-326-5806	Plan and Conduct an Area Reconnaissance
071-328-5301	Inspect Personnel/Equipment
071-328-5302	Supervise Maintenance on Individual and TOE Equipment
071-331-0002	Conduct a Local Security Patrol
071-331-0001	Move as a Member of a Patrol
071-331-0003	Plan a Patrol
071-331-0011	Prepare Individual Equipment for Patrol
071-331-0804	Conduct Day and Night Surveillance Without the Aid of Electronic Devices
071-331-0820	Analyze Terrain
071-331-0852	Clear a Field of Fire
071-600-0005	Enforce Preventive Medicine
071-600-0010	Supervise the Receipt of Supplies
071-730-0006	Enforce Operations Security
071-820-0001	Operate Telephone Set TA-1/PT
071-820-0004	Recover Communication Wire Lines
171-121-1007	Perform Duties of a Road Guide
441-091-1101	Perform Search and Scan Procedures
441-091-1040	Visually Identify Threat Aircraft
441-091-1102	Engage Hostile Aircraft with Small Arms
031-503-1001	Maintain your M17 Series Mask with Hood
031-503-1003	Store your M17 Series Mask with Hood in Carrier
031-503-4002	Plan and Supervise Positioning of M8A1 Alarm System
113-587-2044	Operate Radio Set AN/PRC-77 or AN/PRC-25
113-587-3001	Perform Operator's Maintenance on Radio Set AN/PRC-77 or AN/PRC-25

6.0 Glossary

Aerobic: Requiring the presence of oxygen.

Alveolar air: The air present in the pulmonary alveoli that participates in gas exchange with the blood in the pulmonary capillaries.

Alveoli: The air sacs of the lungs in which most of the gas exchange occurs.

Anaerobic: Occurring in the absence of oxygen.

Anoxia: A deficiency of oxygen in the blood or tissues (hyposia).

Basal Metabolism: The energy expenditure of the body under conditions of complete rest.

Calorie: The amount of heat required to raise the temperature of 1 kilogram of water 1° C.

Cardiac Cycle: The sequence of events in the heart-volume and pressure changes and valve actions-during one complete period of contraction and relaxation.

Cardiac Output: The volume of blood pumped by each ventricle of the heart in 1 minute.

Dead Space: The combined volume of all the air passages in which no gas exchange occurs.

Dyspnea: Labored breathing associated with unpleasant sensation of breathlessness.

Ergometer: An apparatus for measuring the amount of work performed by a subject. The bicycle ergometer is a stationary bicycle in which the rear wheel is replaced by a heavy flywheel against which the subject performs work.

External Work: Movement of external objects by the contraction of skeletal muscles.

Fatigue: A diminished capacity for work caused by previous work. The term is also applied to accompanying subjective sensations.

Glycolysis: The breakdown of glucose to lactic acid.

Homeokinesis: Maintenance of steady state in the organism at elevated levels of metabolism.

Homeostasis: The normal constancy of the internal environment of the body.

Hyperpnea: Increased minute volume of breathing.

Isometric Contraction: A contraction in which a muscle is unable to shorten, the total tension developed eventually being dissipated as heat. No movement is produced and no work is performed.

Isotonic Contraction: A contraction in which a muscle shortens against a load, resulting in movement and the performance of work.

Kilocalorie per hour: Equals .1163 watts.

Kilocalorie per minute: Equals 6.978 watts = 6.978 joules per second..

Mechanical Advantage: The ratio of the length of the weight arm to that of the power arm in a lever. This determines the amount of load that can be moved by the application of a given amount of force.

Mechanical efficiency: The proportion of the energy requirement of an act that is converted into mechanical work. The mechanical efficiency of the human body ranges from 15 to 30%, according to the type of activity.

Metabolic Rate: The total energy expenditure of the body per unit of time.

Metabolism: The chemical reactions that occur in living tissues; the term is often confined to the oxidation's that are the ultimate source of biological energy.

Metabolite: One of the intermediate or final products in the metabolic breakdown of foodstuffs in the body.

Meter-kilogram: A unit of energy or work in a meter-kilogram-second gravitational system, equal to the work done by a kilogram-force when the point at which the force is applied is displaced 1 meter in the direction of the force; equal to 9.8 joules.

Normal Load: A light or moderate load of work in which the oxygen intake is adequate to supply the needs of the body.

Overload: A heavy work load in which the oxygen intake is inadequate to meet the requirement.

Oxygen Debt: The amount of oxygen required in the postexercise recovery period to reverse the anaerobic reactions of the exercise period. Quantitatively, the difference between the oxygen requirement of a task and the oxygen intake during performance of the task.

Phasic Contraction: A contraction of a muscle or group of muscles that results in movement.

Postural Contraction: A contraction of a muscle or group of muscle that results in no movement but serves to maintain a posture or attitude.

Power: The rate of performing work (force * distance/time) or the rate of expending energy. The preferred unit of power is the Watt.

Prestart: Conditioned response to exercise resulting in elevation of body processes prior to activity.

Reflex: An involuntary motor response resulting from stimulation of sensory receptors.

Respiration: The sum total of the processes involved in the exchange of gases between an organism and its environment.

Starling's Law: The stroke volume of the heart is proportional to its diastolic volume. This results from the fact that the force of muscle contraction is increased by stretching of the muscle fibers.

Watt: The unit of power in the meter-kilogram-second system of units, equal to 1 joule per second. 1 watt = 1 joule per second = 0.1433 kilocalories per minute = 8.6 kilocalories per hour.

Work: The product of a force and the distance through which the force is applied for example, if a 1-pound weight is lifted a distance of 1 foot, the work performed is one-foot pound.

Work Cycle: A sequence of tasks, operations and processes, or pattern of manual motions, elements and activities repeated for each unit of work.

Work Load: The intensity of work, usually expressed in terms of foot-pounds or kilogram-meters of work per minute; sometimes the work load is expressed in terms of the oxygen requirement per minute.

DISTRIBUTION LIST

External Distribution

Commander
U.S. Army Armament Research,
Development and Engineering Center
ATTN: SMCAR-ASA-S (MS. Chu),
Picatinny Arsenal, NJ 07806-5000

Commander,
U.S. Army Medical R&D Command
ATTN: SGRD-PLC (MAJ Leu)
Ft. Detrick, MD 21701-5012

Commander
TRAC-WSMR
AATN: ATRC-WAC (Mr. J. Galloway)
White Sands Missile Range, NM
88002-5002

Commander
TRAC-WSMR
ATTN: ATRC-WEB (Dr. Parish)
White Sands Missile Range, NM
88002-5002

Commander
U.S. Army Research Institute of
Environmental Medicine
ATTN: SGRD-UE-ZB (LTC G. Lindsay)
Natick, MA 01760

Commander
U.S. Army Research Institute of
Environmental Medicine
ATTN: SGRD-UE-EMB (Mr. Matthew)
Natick, MA 01760

Commander
U.S. Army Special Operations Command
ATTN: AOFI-CDA (CPT Andrew Yee)
Ft Bragg, NC 28307-5200

Commander
U.S. Army Simulation Training and
Instrumentation Command
ATTN: AMSTI-EC (Mr. L. Curless)
12350 Research Parkway
Orlando, FL 22826

Commander
U.S. Army CECOM
ATTN: AMSEL-RD-NV-LPD
(Mr. C. Bradford)
10215 Burbeck Rd.
Ft. Belvoir, VA 22050-5806

Commander
HQ TRADOC
ATTN: ATCD-SE (Mr. Stefaniw)
Ft. Monroe, VA 23651

Director
U.S. Army Training and Doctrine Command
Analysis Center
ATTN: ATRC-ZD (Mr. Bauman)
Ft. Leavenworth, KS 66027-5200

Commander
ESC/AUJM ATTN: 1LT. Bill Adair
20 Schilling Circle
Hanscom AFB, MA 01731-2816

Commander
U.S. Special Operations Command
ATTN: SOJ5-C (LTC Smith)
7701 Tampa Point Blvd
MacDill Air Force Base, FL 33621-5323

Commandant, U.S. Army Infantry School
ATTN: ATSH-WC (COL Canada)
Ft. Benning, GA 31905

Commandant, U.S. Army Infantry School
ATTN: ATSH-DWS (Mr. Chervenak)
Ft. Benning, GA 31905

Commandant, U.S. Army Infantry School
ATTN: ATSH-OTY-I (Mr. D. Reiss)
Ft. Benning, GA 31905

Director
U.S. Army Materiel Systems Analysis Activity
ATTN: AMXSY-J (Mr. LaGrange)
Aberdeen Proving Grounds, MD 21005-5071

Director
U.S. Army Materiel Systems Analysis Activity
ATTN: AMXSY-GI (Mr. Butler)
Aberdeen Proving Grounds, MD 21005-5071

Director
U.S. Army Materiel Systems Analysis Activity
ATTN: AMXSY-GI (Mr. Butler)
Aberdeen Proving Grounds, MD 21005-5071

Director
U.S. Army Materiel Systems Analysis Activity
ATTN: AMXSY-CR (Mr. M. Carothers)
Aberdeen Proving Grounds, MD 21005-5071

Director
U.S. Army Materiel Systems Analysis Activity
ATTN: AMXSY-CG (Mr. Tom Mallony)
Aberdeen Proving Grounds, MD 21005-5071

Director
U.S. Army Research Laboratory
ATTN: AMSRL-HR-SPD (Ms. Thein)
Aberdeen Proving Ground, MD 21005-5001

Director
U.S. Army Research Laboratory
ATTN: AMSRL-HR-SPD (Mr. Paicopolis)
Aberdeen Proving Ground, MD 21005-5001

Director
U.S. Army Research Laboratory
ATTN: AMSRL-SL-VL-I (Mr. Neades)
Aberdeen Proving Grounds, MD 21005-5066

Director
U.S. Army Research Laboratory
ATTN: AMSRL-SL (Mr. D. Bassett)
Aberdeen Proving Grounds, MD 21005-5066

Director
U.S. Army Research Laboratory
ATTN: AMSRL-SL-VL-I (MS. Juarascio)
Aberdeen Proving Grounds, MD 21005-5066

Director
U.S. Army Research Laboratory
ATTN: AMSRL-TW-WA (Mr. A. Baran)
Aberdeen Proving Grounds, MD 21005-5066

Director
U.S. Army Research Laboratory
ATTN: AMSRL-SL-NS (Mr. D. Farenwald/Mr. T. Mallory)
Aberdeen Proving Grounds, MD 21010-5423

Director
U.S. Army Research Laboratory
ATTN: AMSRL-SL-EP (CPT Washceck, Mr. C. Zella)
White Sands Missile Range, NM 88002-5513

Director
Walter Reed Army Institute of Research
ATTN: SGRD-UWH (COL Hursh)
Washington, DC 20307-5100

Director
Walter Reed Army Institute of Research
ATTN: SGRD-UWH (Dr. Hegge)
Washington, DC 20307-5100

Director, Army Research Institute-
STRICOM Orlando Field Unit
ATTN: PERI-IF (Dr. Goldberg)
Orlando, FL 32826-3276

Director, Army Research Institute-
STRICOM Orlando Field Unit
ATTN: PERI-IF (Dr. Knerr)
Orlando, FL 32826-3276

Program Manager, Soldier
ATTN: AMCPM-CIE (Mr. Marrio Velez)
14050 Dawson Beach Road
Woodbridge, VA 22191

TRADOC System Manager-Soldier
U.S. Army Infantry School
ATTN: ATSH-TS (CPT Jones)
Ft. Benning, GA 31905

U.S. Army Aero Medical Research
Laboratory
ATTN SGRD-UAS-VS (Dr. R. Wiley)
P.O. Box 577
Ft Rucker, AL 36362-5292

U.S. Army Foreign Science and Technology
Center
ATTN: IAFSTC-RCH (Ms. V. Dibbern)
220 7th Street N.E.
Charlottesville, VA 22901-5395

U.S. Army Foreign Science and Technology
Center
ATTN: IAFSTC-RCH (Ms. K. Narducci)
220 7th Street N.E.
Charlottesville, VA 22901-5395

US Army Medical Dept. Center & School
Director of Combat & Doctrine
Developments
ATTN: HSMC-FCM (Benjamin Gibson)
Ft Sam Houston, TX 78234-6100

U.S. Army, Office of the Assistant Secretary
(RDA)
ATTN: SARD-TT (Mr. Yuhas)
Pentagon Rm 3E479
Washington, D.C. 20310-0103

U.S. Army Model and Simulation
Management Office
ATTN: SFUS-MIS
(MS. Lana Eubanks McGlynn,)
Crystal Square 2 Suite 808
1725 Jefferson Davis Highway
Arlington, VA 22202

Institute for Defense Analyses
ATTN: Mr. Schultz
1801 N. Beauregard Street
Alexandria, VA 22311

Institute for Defense Analyses
ATTN: Mr. Christenson
1801 N. Beauregard Street
Alexandria, VA 22311

Special Assistant, Biomedical Technology
Advanced Research Projects Agency
3701 N. Fairfax Dr.
Arlington, VA 22203

Director
Defense Modeling and Simulation Office
1901 N. Beauregard St., Suite 504
Alexandria, VA 22311

U.S. Army Topographic Engineering Center
ATTN: CETEC-TL-ST (Mr. R. Marth)
Ft. Belvoir, VA 22060-5546

Commander
U.S. Army CECOM
ATTN: AMSEL-RD-C2-PS (Mr. Flatt)
Ft Monmouth, NJ 07703-5203

Commander
U.S. Army CECOM
ATTN: AMSEL-RD-ST-CE-M
(Mr. B. Sudnikovich)
Ft Monmouth, NJ 07703-5202

Naval Training Systems Center
ATTN: Code 242 (Mr. G. Haga)
12350 Research Parkway
Orlando, FL 32826-3224

Dr. Arnold Warshawsky
Lawrence Livermore National Laboratory
Military Applications
P.O. Box 808, L-83
Livermore, CA 94550

Dr. Ralph Toms
Lawrence Livermore National Laboratory
Conflict Simulation Laboratory
P.O. Box 808, L-315
Livermore, CA 94550

Office, Chief of Staff, Army, Louisiana
Maneuvers Task Force
ATTN DACS-LM (LTC. J. Geddes)
Ft. Monroe, VA 23651

US Marine Corps Systems Command,
Combat Clothing and Equipment
ATTN: SSCGP (Mr. M. Everly)
Quantico, VA 22134-5080

Commanding General, MCRDAC
ATTN: Amphibious Warfare Technology
Directorate (MAJ F. Wysocki)
Quantico, VA 22134-5080

HQ, USSOCOMS
ATTN: SOJ3-RM (Mr. J. Cox)
7701 Tampa Point Blvd
MacDill AFB, FL 33621-5323

U.S. Military Academy
Wargaming Lab
Operations Research Center
ATTN: CPT Sue Romans
West Point, NY 10996

Internal Distribution

ATD/T
ATD/E&A
Director, SURD
SURD/SISD (Barbara Fossey)
SURD/SISD (Deidre Rapacz)
Director, MOBD
MOBD/TPO (Keith Schroeder)
Director, S&TD
Director, ASCD
ASCD/ACD/CDB (Dr. D. Paul Leitch)
GEN II Office
Mr. Snow
Mr. O'Brien
JTS Rep, U.S. Marine Corps Liaison Officer
JTS Rep, U.S. Navy Liaison Officer
JTS Rep, U.S. Air Force Liaison Officer