Conversion of Selected Military Forces to the Use of Metric Measurment Units.

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ABSTRACT

Conversion of the United States military to the International System of measurement units is in the very early stages. Little formal planning has been done to articulate the management required to complete the conversion of operational Army and Air Force units. For those operational forces tasked to provide continuous combat readiness throughout metrication, management problems associated with the conversion are particularly difficult because of the nature of these assigned missions. This is the case for the 82nd Airborne Division ready brigade force (DRB) and the Military Airlift Command (MAC) strategic airlift system operating the C-141 and C-5A aircraft.

Adequate treatment of metrication management depends upon thorough preplanning and skillful resource allocation. This paper presents a descriptive and a graphic model for management of major events in the changeover process in the DRB and the C-141/C-5A system. It includes major personnel, hardware and interfacing considerations which will be critical to both combat readiness and optimal measurement system conversion.

Investigation shows that metrication of these forces within prescribed readiness constraints is feasible but will require centralized management and highly decentralized execution of many conversion activities. Successful integration of military metrication steps to match the pace of non-military conversion activities and thorough preparation of small unit leaders will be key factors in conducting an optimal conversion program.

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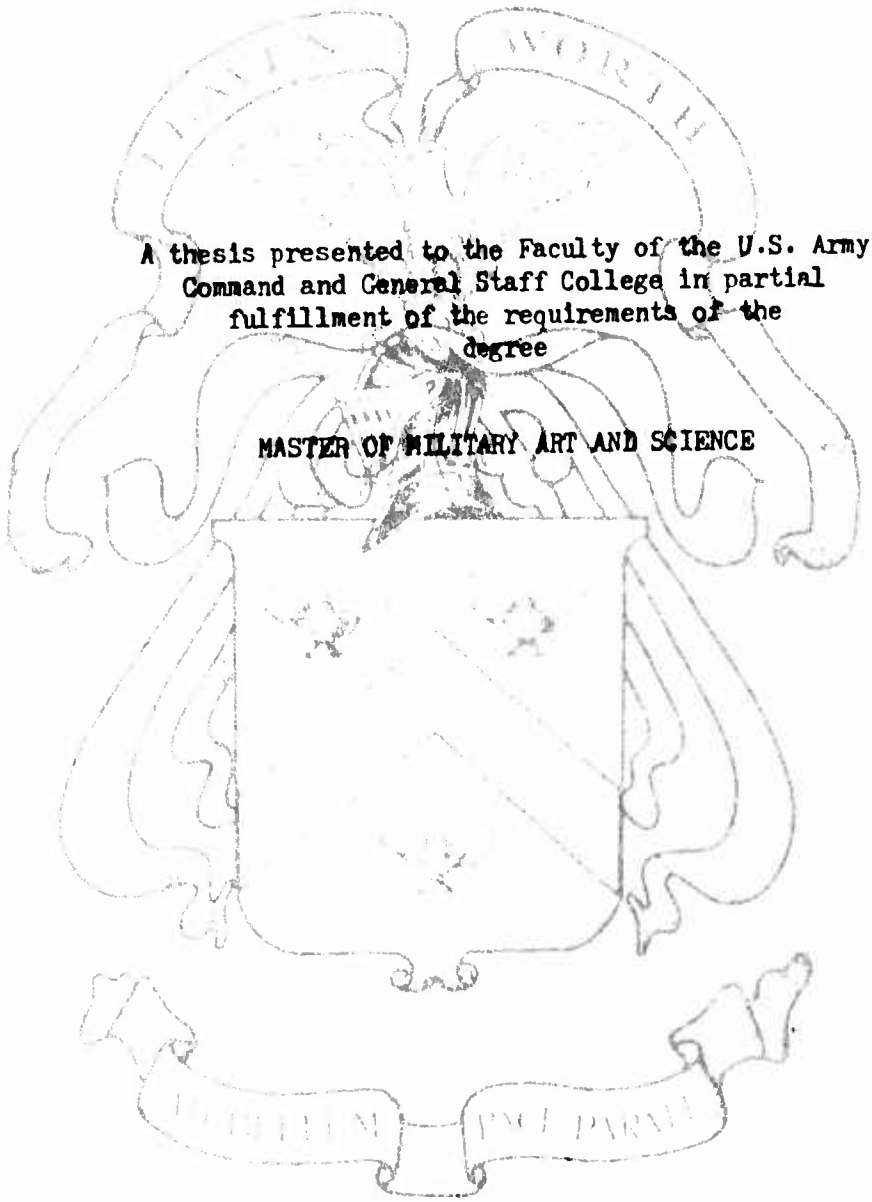

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements of the degree

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MASTER OF MILITARY ART AND SCIENCE

by

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The opinions and conclusions expressed herein are those of the individual student author and do not necessarily represent the views of either the U.S. Army Command and General Staff College or any other governmental agency. (Reference to this study should include the foregoing statement.)

ABSTRACT

Conversion of the United States military to the International System of measurement units is in the very early stages. Little formal planning has been done to articulate the management required to complete the conversion of operational Army and Air Force units. For those operational forces tasked to provide continuous combat readiness throughout metrication, management problems associated with the conversion are particularly difficult because of the nature of these assigned missions. This is the case for the 82nd Airborne Division ready brigade force (DRB) and the Military Airlift Command (MAC) strategic airlift system operating the C-141 and C-5A aircraft.

Aequate treatment of metrication management depends upon thorough preplanning and skillful resource allocation. This paper presents a descriptive and a graphic model for management of major events in the changeover process in the DRB and the C-141/C-5A system. It includes major personnel, hardware and interfacing considerations which will be critical to both combat readiness and optimal measurement system conversion.

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CHAPTER I

INTRODUCTION

Concepts of measurement are basic to all modern societies and most primitive ones. While measurement itself is seldom a subject for general discussion, several segments of the broad topic receive heavy emphasis. For example, much attention is given in the educational process to proficiency in performing arithmetic operations in units such as inches, feet, square yards, dozens, acres, pounds, and bushels. Scientific personnel and industrial organizations devote significant resources to measurements and increasing their precision. This refinement in exactness improves industrial efficiency and refines and expands scientific knowledge.

A pertinent historical dialogue has been recorded on the issue of defining and adopting an optimal system of measurement units. Use of any particular measurement system has an extensive impact on the entire social body. The measurement system becomes as essential part of the expression and language of any people, and may be an asset or a liability as the society strives to meet whatever sociological goals evolve within the cultural framework. Most traditional measurement systems are evolutionary in nature and change only slowly to meet the demands of technological change and new social requirements. The relative capacities of the English and metric systems to meet current needs in the United States are under extensive debate as the nation moves to conversion.

Measurement Systems in the United States

The United States of America now operates in at least three different measurement systems that are often integrated into one another. These are the English system, the metric system, and the International System of Units (SI).[1]

The English sytem was aptly described before the U.S. Senate in September, 1974 as:

> "...three thousand years old, coming about through all kinds of rather crude and amateurish attempts at defining standards, but by guess and by golly and by chance and by muddling, it has become a quite well defined system probably due, as much as anything, to the good efforts of the National Bureau of Standards in the United States, the National Physical Laboratory in England and the British Standards Insitution, all of which, by the way, were formed during the first two years of this century. The inch and the pound are the heart of the greatest industrial effort in the world...".[2]

The English system is widely taught, accepted and used throughout the U.S., with most adult Americans having been raised and educated in this system. In addition, anyone dealing with the nation's commercial business world or industrial sector becomes thoroughly conversant with the system.

Simultaneously, the metric system is widely used in the physical sciences, medicine, and by selected industries. This system has advantages of greater simplicity and manipulative ease than the English system, but suffers from shortcomings described in the folowing summary:

> "The metric system is certainly the junior system, being only 300 years old. It was established and sponsored by that great churchman, statesman, politician Bishop Talleyrand. There were no controls on the system and so it became rather prostituted as time went on. Its system, in fact, is almost as awkward as the English system."[3]

Specifically, Talleyrand's system was based upon the meter, gram and second. In 1873 the centimeter replaced the meter as a base unit.[4] The system "...gives rise to inconveniently small units for some important physical quantities and is limited to mechanical units so does not provide for important quantities such as electrical and thermal units."[5]

In the military a complex integration of these two systems is not uncommon. For example, in field artillery disucssions, a classroom scenario may express range in kilometers, tube size in both millimeters and inches (depending upon the specific piece), round velocities in feet per second, and projectile sizes in pounds. Air Force aerial parachute delivery operations usually require the use of both metric and English systems ground maps, English system weather data, nautical mileage aeronautical charts, English system measurement of drop errors. In such complex situations an individual must be able to reason in more than one measurement system or perform mentally the appropriate mathematical conversions or, as is most often the case, fail to conceptualize the true meanings of the numbers being used.

The third system of measurement is the International System of Units, (SI) or "Le Systeme International d'Unites" as described in ASTM E380-72.[6] "The International System of Units (SI) was defined and given official status by the 11th General Conference of Weights and Measures, 1960.[7] The United States participated in this conference and adopted the standard system which resulted from the conference. Units of convenience such as the liter are metric, but are not defined parts of the SI system.

Characteristics of SI

This system is summarized in a special guidelines for use bulletin

published by the National Bureau of Standards:

> "The SI is constructed from seven base units for independent quantities plus supplementary units for the plane angle and solid angle. (See Table 1) Units for all other quantities are derived from these nine units."[8]

TABLE 1[9]

UNITS WHICH FORM THE BASIS FOR THE SI SYSTEM

Quantity	Name	Symbol
	SI Base Units	
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
ammount of substance	mole	mol
luminous intensity	candela	cd
	SI Supplementary Units	
plane angle	radian	rad
solid angle	steradian	sr

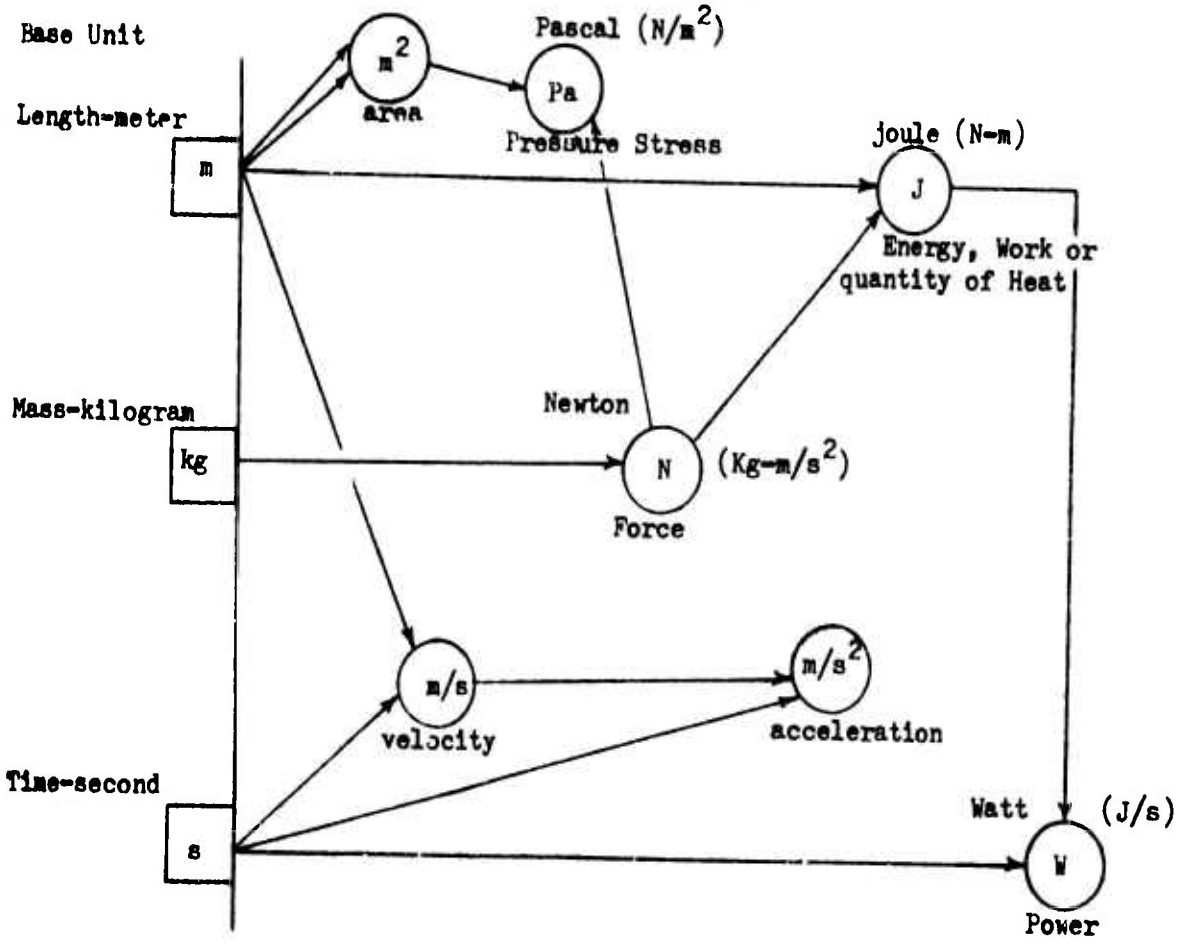
All seven base units except the kilogram are rooted in reproducible physical phenomena. This reproducibility is a particular advantage within the scientific community because the base units can be reproduced anywhere in the world for calibration purposes at a relatively minor cost. This is a specific and unique advantage **in using** the SI system. The one exception, the kilogram, is based on a "cylinder of platinum-iridium alloy kept by the International Bureau of Weights and Measures at Paris. A duplicate in the custody of the National Bureau of standards serves as the mass standard for the United States. This is the only base unit still defined by an artifact."[10] Duplication of

an artifact is only as precise as the equipment used to compare the original to the copy. Therefore, in the case of the kilogram, opponents of conversion to the SI system can correctly argue that the new system is not a particular improvement over the English standards in terms of accuracy of reproducibility.

Derived units are formally defined and given special names in the SI system. Selected derived units are shown in Figure 1 with their relationships to the base units. The examples chosen illustrate the capacity the SI system to satisfy many measurement requirements using a small number of inputs.

FIGURE 1[11]

DERIVED UNITS WITH SPECIAL NAMES



Despite the flexibility of derived units the exclusive use of the SI system is inadequate. It does not define all the parameters needed to describe the phenomena of modern societies. Therefore, selected units now in existence have been approved by the International Committee of Weights and Measures for continued use. Some are approved for use until a suitable substitute can be defined and adopted. Others are approved for permanent use because definition of a substitute is not anticipated. These include both fundamental and common units of measurement. Fundamental units are those defined in or closely related to phenomena of modern physics. Common units are less closely related to the world of physics, but are conveniently related to the size of the earth, the period of orbit or other well entrenched physical standards. Table 2 contains examples of both fundamental and common units which will continue in use after metrication.

TABLE 2[12]

UNITS APPROVED FOR CONTINUED USE

FUNDAMENTAL UNITS	
elementary charge	Bohr magneton
electron mass	nuclear magneton
proton mass	speed of light
Bohr radius	Planck constant
Comptin wavelength of electron	
COMMON UNITS	
nautical mile	gallon
knot	curie

angstrom	roentgen
standard atmosphere	rad
hectare	barn
day	hour
year	

Proposed Use of the SI System in the United States

Conversion to the SI system of weights and measures in the United States has proceeded along two distinct and somewhat parallel paths. The first path is, historically, one of public policies and debates on the general characteristics of an official U.S. measurement system. Conversion to a single standard system of measurement has been debated since the 18th century. The recent development and relative strengths of the SI system have caused a renewal of such discussion. Most nations of the world have chosen to use the SI system. As late as December, 1975 the United States and a few small non-industrial nations were unique in the matter of having no national policy for eventual adoption of the SI system on at least a voluntary basis.[13]

A bill in the House of Representatives (H. R. 11035) to articulate national SI measurement was defeated in the House on 7 May 1974 by a vote of 153 to 240 despite many expressions from the floor in support of such a policy.[14] In more recent legislative action the House of Representatives and the Senate passed a bill for the adoption of the SI system which President Ford signed into Public Law 94-168 on December 23, 1975. This law articulates "...a national policy of coordinating the increasing use of the metric system in the United States..."[15] The metric system cited

"means the International System of Units as established by the General Conference of Weights and Measures in 1960..."[16] This is the SI system.

The second path is one of subjective educational processes. As more people have been exposed to a wider variety of concepts, material goods, and services in this century, the percentage of people possessing a basic knowledge of SI units and standards has increased. High school physical sciences, the purchase and use of many imported goods including foodstuffs, interaction with the medical community, travel abroad in many countries, and conversion programs of other nations have been some of the elements contributing to an increased general working knowledge of SI measurement. Thus, on at least two levels, a large portion of the population has been increasingly exposed to the functional elements of the SI system.

The Metric Conversion Act of 1975

An understanding of Public Law 94-168 is vital to those managing the adoption of the SI system in any sector. The law provides that "It is therefore declared that the policy of the United States shall be to coordinate and plan the increasing use of the metric system in the United States..."[17] This sets out an unambiguous policy which many parts of both the private and public sectors wanted before they started conversion programs. The law further provides for the establishment of a seventeen member United States Metric Board.[18] The function of this body is to give high level guidance to the total conversion program.[19] The law leaves little doubt that the SI conversion of the United States will eventually occur.

One characteristic common to the public law, pronouncements and publications from the American National Metric Council, and the activities

of other pro-conversion organizations is potentially confusing. Strictly speaking "conversion to metric" could mean conversion to the system developed by Talleyrand in the nineteenth century, rather than to the more carefully defined "System International d'Unites". Although the intended meaning is usually clear, eventually this careless use of terms will increase the potential for confusion.

In spite of the tardiness of formal legislation many economic subsectors in the United States have initiated or completed independent conversions to the use of the SI system.[20] For example, about fifteen years ago, partly as a result of consumer demand, the pharmaceutical industry began to change internal operations and most products to SI units. For the industry the result has been more economical manufacturing, easier personnel training, error reduction, and better standards and records.[21] In addition, many schools have started to teach the SI system. It is believed that SI will be included in instruction in all states by 1978. Such projects are already under way in California, Illinois, New Jersey, Maryland, and New Mexico.[22]

Use of SI within the Department of Defense

The Department of Defense (DoD) has recognized the recent trend for national conversion to the SI system, and has articulated a set of broad policies for DoD participation in the process. The following quotation expresses the basic attitude of the Office of the Secretary of Defense toward SI conversion:

> "Adoption of the metric system will have advantages inherent in a measurement system that is common among nations in addition to its well-known value in mathematical computation. In the military perspective, adoption of the metric system and avail-

> ability of metric standards and modules will enhance interchangeability and interoperability of military equipment and components with our allies, and at the same time facilitate U.S. production of foreign designed equipment and systems and vice versa."[23]

In this same letter specific cautionary guidance was addressed to DoD agencies to preclude them from pioneering in SI conversion. "Generally it is recognized that industry will take the lead in the changeover and the Services and Agencies will follow paying their fair share of the costs."[24]

Understanding Public Law 94-168 is vital for the military manager involved in conversion. Several portions of the law are critical to DoD conversion. First, although there is general talk of a ten year conversion cycle, the law makes no mention of a projected completion date. This complicates the timing of DoD planning and demands great flexibility. Second, the private sector will not be eligible to receive financial aid for conversion under current laws. This will affect DoD procurement policies, especially with small businesses. Third, the voluntary nature of conversion should preclude development of DoD-contractor relationships in which the DoD ends up paying for the bulk of the conversion costs for that firm as a part of a major procurement contract.

The DoD has participated in several studies of metrication, but has not entered into conversion activities with a broad based plan. Detailed planning has not been conducted for the conversion of daily operations, nor have policies been articulated which would lead to decisions on how to accommodate current English standards, materials and weapons presently in the inventory, or the multitude of English/SI interfaces which will be generated by conversion.

Statement of the Problem

The purpose of this paper is to examine a portion of the military conversion process. While both the Army and Air Force now work simultaneously in both systems, neither has the capability to convert completely to the SI system. Neither has organized an ongoing management program to analyze and accommodate the impact of a national conversion program on military operational capability. The paper discusses the impact of conversion on specific elements of existing Army and Air Force forces, specifically the brigade sized ready force of the 82nd Airborne Division (DRB) and the Military Airlift Command C-141 and C-5A fleet.

Military Units and Non-Military Agencies

The Army maintains designated forces in a high state of readiness for rapid global deployment at the direction of the national command authorities. The 82nd Airborne Division is tasked to provide several such force packages including the Division Ready Brigade (DRB). It constitutes the Army portion of the forces in this study. The DRB units, tasked for rapid contingency response, are air transported by the USAF, Military Airlift Command organic strategic airlift assets, the C-141 and C-5A fleets. They constitute the Air Force portion of the forces in this study.

The great value of these forces lies in their responsiveness. Many other military units generate more combat power, but none have the capability of reacting with such a combination of flexibility and speed. Maintaining such responsiveness requires careful preplanning and intensive periodic training. It is likely that the capabilities of these units to perform would be degraded during metrication. New standards for support equipment,

civilian interfaces, operating procedures and mission hardware will have to be carefully introduced into each of the services to prevent operating incompatibilities. This paper identifies a number of points within the 82nd Airborne Division and the MAC C-141/C-5A fleet which are likely to be most affected by an incorrectly administered metrication process. Sequencing of metrication tasks is studied to identify the areas which will need the most managerial attention. Alternative approaches to conversion management are considered.

The impact of private and public agencies which are not a part of the two uniformed services on the metrication of these units will also be significant. For example, action by some government agencies such as the Federal Aviation Administration is just beginning. The FAA controls much of the airspace in which MAC operates this mission. Such external influences are examined in the detail allowed by the current state of conversion planning and knowledge.

Assumptions

Throughout this paper it will be assumed that:

1. The national civilian leadership will direct that the deployment capability of the DRB will be maintained throughout metrication.

2. The nation, led by private industry and national coordinating bodies, will proceed with vigorous conversion to the SI system over the next ten to fifteen years.

3. As a matter of policy the Congress will recognize the long term benefits of metrication. It will allow the short run conversion costs to be paid wherever they fall, and will provide DoD adequate monies to support timely conversion. While cost is an obvious and important

consideration, it will only be discussed here to the extent that it provides a parameter for avoiding the most serious pitfalls of gross overduplication of capability.

Definition of Terms

The following are the intended meanings of specific words and terms used in this paper:

Metric Units: Units defined by the International System of Units based on "Le Systeme International d'Unites (SI)" of the International Bureau of Weights and Measures.[25]

Metrication: Changing to units defined by the International System of Units, or conversion to SI. This paper does not use the term "conversion to metric" to mean metrication.

Hard Conversion: The process of changing a measurement language to nonequivalent SI units which neccessitate physical configuration changes outside those permitted by established measurment tolerances.[26] This process involves changing physical dimensions of existing hardware or building replacement hardware to new dimensions to conform to SI specifications.

Soft Conversion: The process of changing the measurement language to equivalent SI units within acceptable measurement tolerances without changing physical configurations.[27] This process involves changing specification descriptions (numbers) to SI units without requiring a change in the physical dimensions of the hardware under consideration.

Overview of the Thesis

This thesis describes the results of emperical investigations into a specific portion of the SI conversion problems which are pending in the United States. This chapter presents a brief outline of the national metrication program and a statement of the specific military conversion problem addressed. Chapter II presents a review of selected foreign SI system experiences, a historical development of measurement systems in the U.S. and a report on conversion progress in segments of the U.S. private

sector. The DoD preparation for metrication is discussed in some detail. Chapter III describes the principal characteristics of the military units specified for the problem, and relates these characteristics to metrication. Two approaches to conversion for the military manager are suggested. Chapter IV presents modified PERT charts which show the sequencing and timing of critical metrication events and activities. The relationships shown in the PERT charts are developed in detail. Chapter V enumerates specific conversion management conclusions based on the discussion in chapter IV. These should be useful to the miltary manager faced with metrication planning and execution.

FOOTNOTES

1. U.S. Congressional Record, 93rd Cong., 2d Sess., (1974) 120: No. 133, p. S 16059.

2. Ibid.

3. Ibid.

4. Metric Conversion for Australia. Canberra: Australian Government Publishing Service, 1971, p. 3.

5. Ibid.

6. Clements, W. P. Dep SECDEF Memorandum Subj. "Use of the Metric System of Measurement," unpublished, 10 June 1975, p. 3.

7. U.S. Department of Commerce. NBS Guidelines for Use of the Metric System. NBS SP LC1056, Washington: Government Printing Office, 1974, p. 1.

8. Ibid.

9. Ibid., p. 3.

10. U.S. Department of Commerce. Brief History of Measurement Systems. SP 304A, Washington: Government Printing Office, 1974, p. 2.

11. Australia's Metric System. F. flyleaf.

12. U.S. Department of Commerce. NBS Guidelines for Use of the Metric System. op. cit., p. 2.

13. U.S. Congressional Record, 93rd Cong., 2d Sess., (1974) 120: No. 63, p. H3596-H3597.

14. Ibid., p. H3625.

15. Public Law 94-168, preamble.

16. Ibid.

17. Ibid., Sec. 3.

18. Ibid., Sec. 6.

19. Ibid., Sec. 4.

20. U.S. Congressional Record, 93rd Cong., 2d Sess., (1974) 120: No. 108, p. E4896.

21. U.S. Department of Commerce. A Metric America. Washington: Government Printing Office, 1971, p. 41.

22. "Inching Ahead Into the Metric System," U.S. News and World Report. LXXIX:22, December 1, 1975, p. 41.

23. Clements, W. P. o. cit. p. 1.

24. Ibid.

25. Department of Defense. "Guidance for Using Metric Units of Measurement in Preparing Standardization Documents," unpublished guidance, 1 July 1975, p. 4.

26. Ibid.

27. Ibid.

CHAPTER II

HISTORICAL PERSPECTIVES

This chapter provides historical background for the problem to be studied including a commentary on the conversion experiences of several other nations, a summary of recent U.S. metrication legislation, discussion of selected metrication activities in the civilian sector, and an analytical review of DoD metrication programs and policies.

Conversion Experiences of Other Nations

National metrication programs have been completed or are in process in every industrial nation in the world which had previously used the English system except the United States. A selection of observations from these conversion experiences will illustrate some of the pitfalls that may await the United States.

Japan is a classic example of a nation which converted to the metric system (not SI) with insufficient organization and planning. An original commitment to metric usage was made in 1921, well before the SI system was formally identified. At that time three measurement systems were widely used in Japan, namely "...metric, English, and the traditional system based on the "shantu" (11.930 inches) and the 'kan' (8.267 pounds)."[1] The turmoil of World War II prevented changeover during the war, and the subsequent occupation of Japan by the United States reinforced the use of English despite an intensive metric education program.[2] A new legal commitment to the metric system was made in a 1951 law. Conversion was finally completed in all of the major sectors of Japanese society by the 1960's.[3]

Several lessons can be applied from the Japanese experience. First, a significant educational advantage was reaped because of widespread use of metric prior to its official adoption as the single national standard.[4] This advantage reduced the requirement for metric education during the conversion, a situation not fully enjoyed in the United States. Second, the adoption of a national metric standard requires considerable direction from the national government and political system to achieve the desired momentum.[5] Although this conversion characteristic has been recognized by the U. S. Congress, strong administrative action has not resulted. The long record of legislative debate indicates that organization and action by the federal government and the private sector are coming only after the U.S. has become more and more alone in its adherence to the English system. Third, the Japanese experience has shown that a loose structure and a weak promotional effort result in a more costly conversion than would be possible in a more tightly controlled program. This lesson should motivate both the public and private sectors toward a well-coordinated and centrally managed metrication for each sector as the changeover occurs.

Canada's program for conversion to the SI system was aptly described by one U.S. expert as an effort to "...study the problem to death."[6] Although national legislation was passed and an extensive educational effort was conducted, Canada continues the use of English measurement in a remarkably large number of tasks. In the industrial and commercial sectors this may be attributed, at least in part, to Canada's inability to operate as an economic entity independent of the U.S.[7] The high volume of trade with the U.S. as a percentage of Canadian GNP would support this assertion.

While Japan and Canada suffered conversion difficulties, Australia

seems to have achieved a more effective approach. Australian national policies appear to have optimized a solution to their conversion problems. The national program balances suboptimizations in calculating lead times for conversion, sequencing of conversion steps, selection of time phasing, accompanying educational effort and other programs.[8] Metrication should be completed by the 1980's at minimum cost and with relative ease, although the Australian experience still merits a word of qualification. Trade patterns, the industrial base, economic autarky, size and other influences make Australia's conversion problems vastly different from those of the United States. An optimal outcome was more likely for Australia than for the more complex and larger case of the United States.

U.S. Historical Background and Legislative Activity

Standards of measurement have been an issue within the government and among special interest groups in the private sector since independence. Consequently debate over measurement systems and, specifically, over conversion of the U.S. to the metric system is treated in a substantial body of literature. In 1790 a debate was conducted in the United States, Great Britain and France which addressed a major overhaul of the respective national systems of weights and measures.[9] Agreement could have yielded an especially timely and unique standardization of measurement systems because it took place shortly after Talleyrand's exposition of the metric system. Unfortunately the three nations failed to act in concert and lost this unique opportunity for the infant United States. Including this first debate, the United States has experienced a total of at least five distinct historical phases during which the issue of a common international metric measurement system has been a recurring theme.[10] The two phases

one procedural and the other substantive. The procedural objection, a valid one, was simply that the bill was introduced to the floor of the House under parliamentary rules allowing only twenty minutes for debate. This led to a hurried, and rather incomplete discussion of the bill on the floor before a vote was called. The substantive objection was the lack of clarity on certain facets of the proposal. Small businesses forced into SI conversion might have been eligible for federal aid under the then existing laws. This possibility was raised in debate, but was not clarified by amendment to H.R.11035. Therefore, the bill failed partly because it was an ambiguous legislative effort.

Additional debate over H.R.11035 was directed at the total cost of conversion. The large variance in cost figures debated showed that the legislators did not have accurate cost information available. This seems to have had an impact on the 1975 conversion bill which became Public Law 94-168. The law makes no provision for federal reimbursement to those adversely, and perhaps unfairly, forced into capital investments solely because of metrication. This excludes the possibility of directly subsidizing the private sector, particularly the small business community. The legislators were also careful and explicit in defining the "voluntary" nature of the conversion.[13] In essence, the law establishes a national policy without making it a mandatory policy. It is framed so that in time the private sector should find an economic advantage in conforming to the national policy. This partly explains why there is no legal time limit for the conversion period. The American legislative approach to metrication may lead to unique changeover experiences for this nation since the market place will be the most important force driving us toward the SI system.

Metrication in the Civilian Sector

The clearing house in the United States for information and coordination on metrication is the American National Metric Council (ANMC). The ANMC is a nonprofit organization constituted for action as "a coordinating, planning and information center for all organized elements of U.S. society involved with conversion to the International Metric System.[14] As such a body the ANMC was asked by the DoD Metrication Panel to assist in the formulation of of a DoD/Industry Metrication Orientation Workshop, This Workshop was held at the Redstone Arsenal on 9-12 July 1974. There were a total of 127 participants; 41 Army, 33 Air Force, 12 Navy, 17 DSA, one GSA, one Department of Commerce, one University, one Marine Corps and 20 from industry.[15] A formal document listing the results, conclusions and recommendations of the conference was not published. Subsequent formal interaction between the DoD and the ANMC has been limited. This is understandable because some of the conversion sectors of great concern to the DoD were only recently organized within the ANMC. For example, aerospace is one of the seven DoD sectors defined by the DoD Metrication Panel. Yet, the aerospace sector of the ANMC did not hold its first organizational meeting until 11-12 November 1975 in Washington, D.C.[16] This meeting did not discuss and resolve the substantive issues of a sequence of metrication events. Rather, it was an initial step to bring together the components of the sector for the first time. Eventually they will be required to modify aerospace operations and products as a result of conversion to the SI system.[17] The most substantive outcome of this meeting was to establish the dominant role of the Federal Aviation Administration in organizing the actors concerned with utilization of American airspace during metrication and under new SI standards.[18]

Today the aerospace industry operates an English/metric (SI) interface frequently in international cargo transportation. Usually this occurs when SI specification cargo is generated in foreign countries and is imported into the United States aboard aircraft built and operated in the English system. Such cargo handling operates from a few fixed, high volume ports and can be controlled through a set of metric/English, English/metric conversion steps at each affected terminal. Thus, metric or SI cargo might enter a cargo handling facility such as that at Frankfurt, be sorted, weighed and palletized for loading aboard a Lufthansa owned, Boeing built, English system 747F aircraft. From that point it would typically be handled on English system conveyors, pallets, loaders and aircraft until discharge at John F. Kennedy International in New York.[19] The entire situation is quite unlike the case to be faced within the DoD. The latter has many additional variables in equipment, operating locations, and other characteristics.

American aerospace manufacturers are moving very slowly toward SI. Currently, "A few aerospace systems within corporations (Gruman, Hughes Aircraft, and Rockwell) are now being designed and fabricated using SI metric units as the primary dimensional system.[20] This reluctance to convert is prudent and a logical position for this industry.[21] The relatively poor profit record of airline companies in recent years makes them reluctant to demand new equipment. The aerospace manufacturers have, consequently, not been able to solve the cash flow problems inherent in the changeover, and are not in a position to absorb the conversion costs.

In civilian sectors other than aerospace the pressure for SI conversion has been quite varied. For example, the automotive industry is a leader

among heavy industries moving toward conversion.[22] Both General Motors and Ford see early conversion as having significant profit benefits, and they have resolved the short term cash flow problems associated with metrication.[23] The pace of automotive metrication affects military metrication in two primary ways. It works directly when the military is cast as a customer for the SI standard automotive products. In this role the military user is faced with operating many SI standard items of equipment. Second, an industry this large acts as a catalyst for other military procurement processes. The early conversion of the automotive industry will increase the demand for machine tools built to SI standards. This will accelerate a fundamental change in the market serviced by the tooling and machinery industry. SI conversion is generally favored within the tooling and machinery industry.[24] This industry can supply SI system products more cheaply to all customers, including the military, as the economies of scale created by the automotive industry are realized.

On the other hand various labor union officials voice opposition to the entire metrication prgram. There seems to be no identifiable center of resistance to conversion, but there are many expressions of concern for the economic burden of the individual craftsmen faced with the expense of replacing all of their tools with comparable SI standard equipment.

U.S. Metric Study Interim Report: Department of Defense

One volume of the U.S. Metric Study Interim Report, National Bureau of Standards Special Publication 345-9, "Department of Defense" deals exclusively with the metrication of the Department of Defense. The document was a thorough and authoriative discussion of the costs and benefits

of the conversion of the DoD to the SI system in 1968. Much of the document remains useful in 1976. For instance, it outlines a number of major DoD activities which will encounter great problems during metrication such as shipbuilding. It does not, however, suggest specific solutions to these problems.

The study estimated the total DoD metrication cost to be 18.1 billion dollars to be spent over a thirty year period.[25] Major assumptions were required to arrive at this cost estimate. At least two of the assumptions in this case have been rendered invalid by historical changes. First, it was assumed that "Congress will have acted to adopt the SI system of weights and measures by July 1972."[26] Congress did not do so and inflation has had obvious consequences. Second, it was presumed that the "existing force structure with numbers and types of weapons systems as of the FY 70 Budget, will be assumed constant for the study with metric weapons and equipement replacing inch-pound as these end their useful lives."[27] The force structure has both decreased and substantially changed in character and items of equipment since 1970. The cost calculations in the study are probably inadequate due to these difficulties.

An example from the Air Force portion illustrates further difficulties in using the DoD portion of the 1968 study. The Air Force input addresses budgetary considerations as follows:

> "The major financial impacts of converting to metric measurement will involve additive costs associated with the areas of design, development, procurement and support of new weapons systems, publication of technical data, training of personnel, and storage generated by metrication. Such additive costs were computed or estimated by appropriate Air Force organization."[28]

Colonel M. R. Lee provided input to the 1968 study for Military Airlift

Command while assigned to MAC Headquarters as a staff officer in the early 1970's. The MAC portion of the study estimated a conversion cost for the command of $878,935.[29] Colonel Lee's personal recollection of this staff action is that MAC primarily addressed retraining costs in the analysis.[30] These training cost figures eventually became part of the 1968 report because better data did not exist. It is clear that the MAC analysis did not use concepts, procedures or hardware now operational in the force.

Other potential and real world operational incompatibilities are now being identified. Functional interfaces with other agencies which are essential to MAC operations remain to be addressed for the first time. For example, the problems of converting the computer systems in use today did not exist when the 1968 study was conducted.[31] These illustrations of the shortcomings of the DoD portion of the document are alarming. They show that the 1968 study probably cannot accurately forecast costs or the conversion difficulties of a total metrication program initiated in 1976 or at any later time. Still, the U.S. Metric Study Interim Report is considered to be the most complete and authoritative metrication analysis done for the case of the United States. It is the best broad spectrum factual analysis in print and is used extensively by members of the Congress and most SI conversion planners.[32]

Current DoD Metrication Planning

Mr. Ron Kunihiro, general engineer for the DoD Material Specifications and Standards Office, stated that planning for metrication has only recently received serious emphasis from senior civilian and uniformed DoD officials.[33] Copies of the initial metrication guidance from the Deputy Secretary of

Defense, with cover letters from the Joint Staff Director of Logistics and the Vice Chief of Staff, USAF may be found at Appendix A. Initial channels for high level coordination within some DoD activities have been established.

A DoD Metrication Panel was convened for the first time in 12 February 1974.[34] The panel was chaired at the Assistant Secretary of Defense level and charged as follows: "The Metrication Panel will develop a General DoD Plan for the orderly conversion of specifications and standards to the metric units of measurement."[35]

The panel is responsible for broadly based activities to "determine what kind of policies are needed, the kind of training needed, a broadly based time schedule, etc."[36] The Panel prepared such a study plan on 24-26 April 1974 and briefed it to the Defense Materials Specification and Standards Board on 9 May 1974.[37] This document divides all DoD inventory items into seven major categories for SI conversion treatment: Automotive, Armaments, Building and Construction, Aerospace, Electronics, Ships, and Common Items.[38] There is no evidence that daily operational usage or mission execution while in the changeover process have been studied by the panel. Their major emphasis was on acquisition of DoD hardware. However, Dr. Ryerson, a USAF Panel representative, did sound a clear note of caution in his closing remarks:

> "I must emphasize my impression of the seriousness of the impact of conversion on the Department of Defense. Directives issued by the Department of Defense to its components should be formulated with the utmost care after long and serious deliberation based upon the most dispassionate evaluation of its mission and responsibilities to the taxpayer. While many aspects of conversion are indeed trivial, we cannot afford the least adverse impact on our defense preparedness."[39]

Dr. Ryerson's point is clear, and the hesitancy of leadership at high levels

has led to a situation in which there are many cases of inadequate organization, planning and guidance for the pending conversion. Contrary to some military thinking, metrication cannot be completed in a few simple management steps which may be taken at the convenience of the unit commanders at wing or divisional level. The need for extensive coordination and planning is not obvious and is, therefore, too often unrecognized.

Examples of Superior DoD Preparation for Metrication

In some areas within the DoD excellent preparation has been made for an eventual total conversion to the SI system. In the Air Force the impact of metrication on maintenance tasks and the tasks performed by mechanics have been thoroughly researched. The fairly consistant experimental data available show that personnel involved in mechanical tasks are readily trained to operate in both the SI and the English systems with acceptable error rates.[40] This research data has direct application to training programs and maintenance planning which will be implemented as a part of conversion.

In a second field, meterology, there have been a number of ongoing efforts to convert all data collection and integration to the SI system. The staff meteorologist usually translates SI weather information into the English system only when there is a requirement to interface with a user who must have the information in the English system.[41] Meteorology is particularly well suited for early metrication action, because much of the scientific data and all of the international dissemination processes have historically used the metric system. For the types of data gathered in meteorology, metric and SI units are essentially synonymous. Despite the historic disposition toward the SI system and the relatively narrow types

of data collected in the science, a number of technical incompatibilities exist and are subjects of lively and unresolved debate among meteorologists.[42] Even so, meteorology, the study of maintenance tasks and a few minor activities are far ahead of the balance of the services in conversion to the SI system.

Generalized DoD Summary

For that portion of the military establishment below the policy decision level the problem which dominates metrication will be neither command guidance and attention nor education. Both of these requirements will be met from external sources. Instead, the crux of the problem will be force management while the conversion is in progress. Thorough and careful planning of the sequence of conversion events is the only alternative to higher than necessary costs and considerable confusion. Such planning must consider a wide spectrum of tradeoffs to be made in hardware, safety, mission readiness, procurement of new weapons and support systems, and a host of other areas. The remaining chapters examine some of the considerations which are important for that portion of the Army and Air Force defined in the problem statement. However, incomplete it may be, it is a starting point for a process which will eventually consume a significant portion of the military planning effort and resource base throughout the conversion process.

FOOTNOTES

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4. Ibid., p. 120.

5. Ibid.

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11. Ibid., p. 260.

12. Ibid., p. 252-253.

13. Public Law 94-168, 94th Cong., H.R.8674, 23 December 1975, Sec. 3.

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16. Daniels, Sam, op. cit.

17. Elefritz, LTC Joseph, HQ USAF (LGYE), personal interview, December 1975.

18. Ibid.

19. Watkins, Harold D. "747F Broadens Marketing Opportunities" Aviation Week and Spcae Technology. 97:8, 21 August 1972, p. 29-31. and "747F Boosts Lufthansa Cargo Results" Aviation Week and Space Technology. 97:7, 14 August 1972, p. 32-34.

20. Carmody, LTC Robert W., Metric Conversion Impact Upon Department of Defense Material Acquisition Managers, op. cit., p. 19.

21. Ibid., p. 18.

22. Ibid., p. 17.

23. Ibid., p. 19.

24. Ibid.

25. U.S. Department of Commerce. Department of Defense. NBS SP 345-9, Washington: Government Printing Office, 1971, p. 2.

26. Ibid., p. 43.

27. Ibid.

28. Ibid., p. 67.

29. Ibid., p. 71.

30. Lee, Colonel M. R., Directorate of Plans, HQ Military Airlift Command, personal interview, November 1975.

31. Ibid.

32. Kunihiro, Ron, op. cit.

33. Kunihiro, Ron, op. cit.

34. Ryerson, J.L., op. cit., p. 8.

35. Ibid., p. 4.

36. Ibid.

37. Ibid.

38. Ibid.

39. Ibid., p. 12.

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CHAPTER III

METRICATION MANAGEMENT IN CERTAIN MILITARY UNITS

The DoD's metrication initiatives have evolved primarily about the seven sectors defined by the DoD Metrication Panel: automotive, armament, building and construction, aerospace, electronics, ships and common items. This approach has limited uitility in the conversion of the 82nd Airborne Division and the MAC strategic airlift fleet. The requirement for continuous operational readiness and the broad mix of personnel and equipment in these units make conversion management a new problem. In these cases portions of all aspects of conversion must be integrated on a continuing basis into a single, intensively managed process. This chapter describes characteristics of the 82nd Airborne Division and the MAC C-141/C-5A fleet which are pertinent to metrication. It then introduces two views of metrication designed specifically to give perspective to the small unit leader assigned in either organization during conversion.

Division Ready Brigade (DRB): 82nd Airborne Division

As a part of its total mission"the 82nd Airborne Division maintains the capability of employing as its rapid reaction force a company team, battalion task force, brigade or division force package."[1] For metrication analysis the brigade slice (DRB) has been selected as the most useful sized unit. Although not capable of operating independently for long periods, the DRB contains an ideal balance of immediate deployment responsiveness and combat fighting power. From the standard alert posture the DRB is tasked to have all personnel and equipment airborne and en route to a designated destination no more than twenty-six hours after initial notification.[2] The

DRB is prepared to deploy for airdrop or airland and, upon arrival, to conduct independent operations for periods of up to thirty days.[3] The force contains appropriate slices of combat, combat support, and combat service support elements. A detailed description of the DRB force structure may be found in Appendix B.

When it deploys, the DRB is tailored for the specific mission assigned. For this reason the size of the brigade slice with tailored augmentation may vary from slightly over 3500 to more than 5000 personnel. The essential points are that the brigade fights around a core composed of three combat infantry battalions, and that the capability for independent operations for thirty days mandates an appropriate slice from all supporting arms.[4] The force is characterized by unit and individual equipment typical of other line units, except that size and quantity of large equipment such as artillery pieces or helicopters must be restricted for airlift and airdrop operations.

The force usually has 828 wheeled and tracked vehicles, depending upon the specific force elements included in the DRB at any given time. The largest single items are the D5A bulldozer, the grader and other engineering equipment.[5] All equipment except for certain helicopters found in the cavalry platoon can be moved by C-141. The helicopters require the outsize capability of the C-5A, although the outsized cargo organic to the entire force can be moved in one C-5A mission. In summary, the DRB force contains about 4100 personnel and a wide variety of individual and unit equipment, all air transportable and most of it air droppable.

Military Airlift Command: C-141, C-5A Strategic Airlift Fleet

Military Airlift Command has available assets of some 250 C-141's and 65 C-5A aircraft. These numbers vary slightly as individual aircraft are detached from the MAC fleet from time to time for use in special projects and activities. The fleet is assigned to Military Airlift Wings at six Air Force bases, three on the eastern and three on the western U.S. seaboards. For any given DRB deployment, aircraft and crews would be available and could be drawn from all of these stations to Fort Bragg to support air movement.

Aside from the one C-5A sortie which is required by the outsized cavalry squadron helicopters, a widely varied mix of C-141/C-5A aircraft resources could complete a deployment operation. If only one C-5A sortie was allocated approximately 296 C-141 sorties would be required for a DRB movement. Although exclusive use of the C-5A is possible, in a deployment, sole use of this aircraft would be a poor resource allocation. Because it is limited to seventy-three passengers on any flight, use of only the C-5A would result in the rapid closure of assigned DRB equipment at the destination with a distinct lag in the arrival of personnel.

Both these aircraft were designed and test flown in the 1960's, the C-141 as predecessor to the C-5A. Both were built by Lockheed Aircraft Company to English specifications and standards. With the exception of the liquid oxygen quantity guage (measured in liters of O_2) the aircraft have English system instrumentation and are designed to be flown in an English measurement standard Air Route Traffic Control System. They are configured to carry cargo measured and weighed in the English system. Associated maintenance and ground handling equipment are built to a common set of English standards. A complex matrix of ground support equipment has been

produced in large quantities and distributed throughout the non-Communist world to enhance the global flexibility of U.S. airlift posture.

MAC Wings at the six CONUS home stations follow roughly the same organizational pattern. Flight crews are assigned to distinct Military Airlift Squadrons (MAS). These squadrons have very limited organic support. Unlike most organizational patterns, the maintenance, aircraft, much training management, personnel, and almost all other non-flying services are centralized and assigned at Wing or base level. The chain of command to the aircrews is entirely distinct from that to almost all supporting elements. This will complicate the coordination of any metrication program.

The logic of this type of organizational structure becomes more apparent, however, when it is realized that MAC operational missions and much training is accomplished away from the home station for the aircraft and crew. All except major maintenance can be done at many points within an elaborate en-route support structure stationed throughout the world.

Successful use of this strategic airlift fleet to deploy an army force requires the orchestration of the full spectrum of MAC airlift assets and other, more diverse, and independent actors. People separated by great geographic distances will be routinely required to function together. Because of this the international flight environment is highly structured. It usually includes interaction between MAC, private industries, other U.S. government agencies and the governments and air traffic regulating bodies of foreign powers.

Metrication Planning for Conversion of these Units

Although different in mission, equipment and organization, the MAC

strategic airlift fleet and the 82nd DRB share certain characteristics which present challenges to the metrication process. The remainder of this chapter will detail such characteristics and then discuss the conversion process from the viewpoint of the small unit commander/leader within the two units. Both the C-141/C-5A fleet and the DRB will be required to operate at a high state of readiness throughout the conversion to the SI system. This assumption in the study highlights the military importance of the units. It means that both organizations must accommodate metrication within the framework of the overriding readiness responsibilities.

Second, both organizations have essential organic equipment which cuts across the categories defined by the DoD Metrication Panel. For this reason, neither can anticipate that SI standard equipment will be ordered from procurement sources and phased into operation over a short ard easily controlled time period. Within the DRB replacement of much automotive equipment could be completed early in the conversion because of the leadership of the major automotive manufactuers in metrication. On the other hand certain critical equipment is very costly and has a long service life. Items such as bulldozers, graders and helicopters now in use may continue in the inventory until the end of the ten to fifteen year conversion cycle estimated by the planners. Within the MAC fleet the basic airframes have a remaining life expectancy of more than fifteen years, however, the support systems and the equipment of the other agencies required for the total airlift system will, in most cases require a much earlier replacement. Replacement of any piece of equipment with a hard conversion SI equivalent has great potential for disruption of the entire system, because of the highly structured nature of the airlift complex and because of the geographic dispersal characteristics.

Third, both units receive personnel resources from a central human resource management and assignment system within their respective services. The inexperienced unputs into both officer and enlisted ranks are relatively young. As conversion progresses most of these junior personnel will have had prior experience with the SI system within the context of the larger society. This means that both organizations will be required to adjust metrication training to meet the needs of people possessing widely varying SI backgrounds. Inronically, they may eventually be required to formulate measurement orientation training for some of these yound people preparatory to operation of English equipment still in service twenty or more years from now.

Fourth, the DRB and the C-141/C-5A fleet are bound by the need to operate together in the planning and deployment of the ground forces by air. Neither can initiate a metrication program without considering the impact of new equipment, procedures and directives on the sister services. The deployment mission requires that the two organizations interact continuously in planning, exercises and in actual operations. Isolation of one from the other is anacceptable.

The Conversion Process and the Small Unit Commander/Leader

Successful mission accomplishment is a direct result of the efforts of the platoon or company commander in the DRB and the aircraft commander or flight commander in the MAC squadron. The imposition of metrication requirements at this operating level may be impatiently received as an addition to an already large workload. The next several sections of this thesis are written to relate the broad based approach in chapter IV to the perspective of those who are actually performing most of the functional tasks.

Small unit leaders and members will either accept or resist metrication based on individual experience and the perspectives and attitudes of peers and immediate superiors. Although little can be done to change the past of the squad or flight members, thorough preparation of the small unit leaders should help direct the work group toward positive acceptance of the conversion process. This, in turn, could yield an improved metrication program at all levels. The next two sections described two views of conversion potentially useful to the small unit leader or commander. They show two ways in which the junior officer or NCO could handle conversion to the SI system; a useful perspective, some management techniques, and conscious development of primary leadership duties unrelated to the metrication process.

The Interface Perspective

The first way that the junior officer or NCO could profitably view metrication is as a set of interfaces defined in measurement systems which do not match. This means that the leader is faced with a variety of tasks, some defined in English and some defined in the SI system, presented in a context in which they are not interchangeable, and required to function together for accomplishment of the unit's mission. These interfaces can be subdivided into three parts; person-person, person-machine, and machine-machine. Of equal importance, these subdivisions give the leader or manager an organizational framework within which to define conversion problems and bring resources to bear to overcome them.

The person-person interface is the most subtle, most abstract, and the most difficult to manage. Identification of the SI system and English system knowledge levels and the manipulative proficiency of unit members should be the first step in assessing this interface. Conversion education will be a

major factor in timely interface management. The leader will be required to define the knowledge level of each member and compare it to the minimum standard required for the operation of his particular equipment. The leader must either select prepared programs of training for each subordinate, or revise the training materials available to fit the needs of his people. He can expect a wide variance in the training required of his people and must be prepared to offer several levels of training based upon their previous knowledge.

He must keep the training program as simple as possible and still meet the conversion requirements. Training people to a simpler measurement system loses appeal and credibility as soon as the charts and papers explaining the system become more complicated than the old system. A variety of devices can help the leader in this effort. The Australian Army used a highly effective newsletter program. Published on as "as required" basis, it was written simply, maintained a high interest level in the target audience and accomplished the desired results.

Most importantly, the leader must maintain open lines of communication within his unit on the conversion problem. Experience in the automated data processing field has shown that upward communication provides useful ideas for program improvement and permits subordinates to express their feelings about inadequacies in the new system. Communication will be a primary tool in overcoming behavioral and psychological resistance to the change to the SI measurement system.

The person-machine interface necessarily overlaps into both of the other two sets. However, the small unit leader will face decisions unique to this interface. Depending upon the availability of SI standard equipment, he must

decide how to manage the training of his people in SI hardware use. The relative ease of training a select cadre must be balanced against broad capability requirements, expected equipment delivery schedules and other factors. The character of the specific equipment is important. Automotive equipment such as trucks or jeeps will be much commoner in either DRB or MAC units than bench test calibration devices. There is utility in training many people to operate the motor vehicles and little return in teaching many to operate specialized test equipment.

The machine-machine interface is beyond the control of most small unit leaders. It is largely governed by the procurement process which introduces new military hardware into the inventory. There is a limited opportunity for the Air Force wing or Army division commander to influence the machine-machine interface by consolidating SI standard resources within one portion of his command. Such a procedure could be applied to most ground vehicles such as jeeps or trucks. Initially the consolidation of all SI system vehicles in one battalion or squadron will localize training and maintenance requirements. The small unit leader can best prepare for the new machine-machine interface by gathering as much advance information about the new equipment as practical and communicating it to his subordinates. He can anticipate adjustments or modifications to English equipment on hand which will create acceptable interfaces with the new SI system materials. He should recognize that many of the actions to prepare the personnel of his unit will be most effective if the training coincides with the arrival of SI standard components. In a sense, the pace of arrival of SI machines to his unit is a standard to which his other metrication actions must conform.

The interface perspective offers a framework within which basic

leadership actions can be planned and internal timing can be formulated in the small unit. The most important contribution of the viewpoint is adequate development of the sense of conversion perspective in the junior leader. It should help him to understand the types of problems inherent in conversion and the priority which conversion actions should assume in light of other duties. If these considerations are developed in the junior leadership and communicated to the subordinate ranks, the resulting unity of effort will make the actual metrication relatively easy.

The Critical Task and Command Emphasis Perspective

A second perspective or approach is dictated by the junior leader's understanding of what is important to his mission, or what he thinks his superiors believe to be important. It may be developed through directives and instruction, or it may develop informally. In either event, some attitudes characteristic of this perspective will be developed unconsciously in almost all small unit leaders. Although less desireable than the interface approach, this perspective does permit the junior leaders to develop and employ an understanding of what metrication effects are considered by senior officers as critical to the entire DRB or MAC wing. The management areas most important to mission accomplishment are brought out, and the junior leader is able to place corresponding emphasis within his command.

Examples of such important areas might include; definition of goals and priorities, operational readiness, high morale, safety standards, and maintenance record. Metrication impacts, usually in an adverse manner, on all of these areas. The essence of conversion management in this perspective lies in a conscious decision to allow some critical areas to be degraded during conversion, while protecting others from adverse effects. For

example, in a MAC unit it is likely that maintenance and readiness would be degraded during conversion, but it is unlikely that the aircraft commanders would accept a serious compromise in standards of safety.

The leader using this approach may judge accurately the desires of his superiors and the standards or management areas which they wish to protect. He will be less likely, however, to understand the total metrication impact and will not be well equipped to communicate the program to his subordinates. It is less likely that he will be positively geared toward metrication as a program with real long-term benefits for the society as a whole and for his specific unit. Without a formal program of planning and training for junior leaders, this perspective has a high probability of occurrence.

Preparation of the platoon, company and flight level units for metrication is critical to the compatibility of continual operational readiness and any conversion activities. The attitudes, communications skills and knowledge of the SI system among junior leaders will dramatically influence the nature and success of metrication. An organized, formal preparation of people in junior leadership positions will be useful in minimizing conversion turmoil and the degradation of mission readiness.

Understanding the perspectives and likely actions at the lowest levels within the force structure is vital to development of an adequate metrication program. This chapter has highlighted some important characteristics of the DRB and the C-141/C-5A fleet. It has then developed two of the many possible approaches to a metrication program which are likely to be found at company or flight level and below. Development of a positive program of junior officer and NCO leadership in conversion to the SI system could contribute dramatically to the overall process. The next chapter uses

these considerations in building a scheme of metrication which works from DoD level into the various functional supporting efforts within the DRB and the MAC structure supporting the C-141/C-5A fleet.

FOOTNOTES

1. 82nd Abn Div Reg 525-4, p. 1-1.
2. Ibid., p. 7-9.
3. Ibid., p. 8-17.
4. Ibid., p. 8-17, 8-19.
5. Ibid., p. 8-19, 8-20.

CHAPTER IV

SYSTEMIZING AN APPROACH TO THE CONVERSION PROCESS

This chapter presents a systematic view of metrication management in operational forces. Selected broad topics are discussed for the DoD, the Military Airlift Command, and the 82nd Airborne Division. A graphic portrayal of metrication is presented in Figure 2 through Figure 7. These diagrams are flow charts which use elements of conventional performance evaluation and review (PERT) methodology to show the major events and activities of conversion. The balance of the chapter discusses the activities and sequencing of relationships illustrated in them.

This type of approach has inherent limits which should be recognized at the outset. Specifically, the solutions presented here are a first iteration for this organizational framework of metrication management, and they are not the only ones likely to succeed in the real world. Second, these general solutions are useful for perspective and for gross planning, but lack the precision necessary for the unique circumstances of a planner tasked to organize conversion within any specific unit. They should, however, be useful for generating ideas applicable to specific metrication planning.

General Discussion of Conversion Management

Metrication of operational DoD activities will be highly visible to military and civilian commanders and selected staff members because of conversion's impact on mission readiness. This fact will dictate that commanders control the flow of conversion inputs from external agencies and form a buffer between internal operations and the outside world. They will be the initiating authorities for introduction and sequencing of metrication

activities within their units. For example, initiatives directing subordinate commanders to start specified conversion activities will occur only after deciding that appropriate portions of the private sector have achieved a reasonable proficiency in the use of the SI system and are able to support the expected military requirements. This evaluation is critical to success and is a matter of subjective judgement. It should be held at a high DoD level. The DoD will begin to convert operational units only after assuring that adequate support has been marshalled or assured in all areas.

The military force commanders at all levels subordinate to the DoD will convert to the SI system within tight constraints on readiness, funds, training facilities and assigned personnel. This will lead to a peculiar management structure in which control of most activities is centralized at high levels and the execution of tasks is decentralized to the lowest levels. It is important that military commanders provide enough options within this structure for subordinates to convert to the SI system in a fashion tailored for the particular needs of each individual unit. At the same time there is some danger in creating too many options for the small unit commander. This could lead to confusion and waste in the conversion process. The great organizational distance between management directives and the supervision of activities at the worker level highlights the need for open channels of formal and informal communication within the uniformed chain of command.

The services can expect to identify joint doctrine and joint planning changes both before operational units begin to convert and during the entire metrication. Early revision of joint manuals and directives will be essential to an orderly allocation of conversion activities, however, continuing

revisions will be required throughout the cycle as new equipment and procedures are subjected to joint training exercises or actual employment. These revisions will be controlled at no lower than major air command level for MAC and no lower than division level for the 82nd DRB.

Explanation of the Diagraming Technique

Figures 2 through 7 use elements of conventional PERT techniques to show metrication events. Figures 2 through 4 show the flow of metrication during the first few years of the conversion process. They illustrate general metrication management by the DoD (Figure 2), the operational metrication process in the Army's DRB (Figure 3), and the conversion of the C-141/C-5A airlift system (Figure 4). These identical processes are illustrated for a later time period in Figure 5 through Figure 7. Changes over time in metrication management show as differences between the two sets of diagrams. They reflect a general increase in public and military knowledge of the SI system and the learning curve of the conversion process. They identify some expected refinements as conversion progresses.

The rectangular boxes represent events or completed actions and the connecting arrows show metrication activities. Quantiative information assigning activity times is part of PERT analysis, however, for this case lack of emperical data makes assignment of time impossible. Additionally, unlike most PERT cases, some activities will be ongoing and repetitive throughout the conversion cycle. Critical paths cannot be identified, but managers should be able to identify those activities most likely to be critical paths based on the information which is presented.

FIGURE 2: EARLY METRICATION AT DOD LEVEL

- - - - - Communication and Coordination
_____ Chain of Command

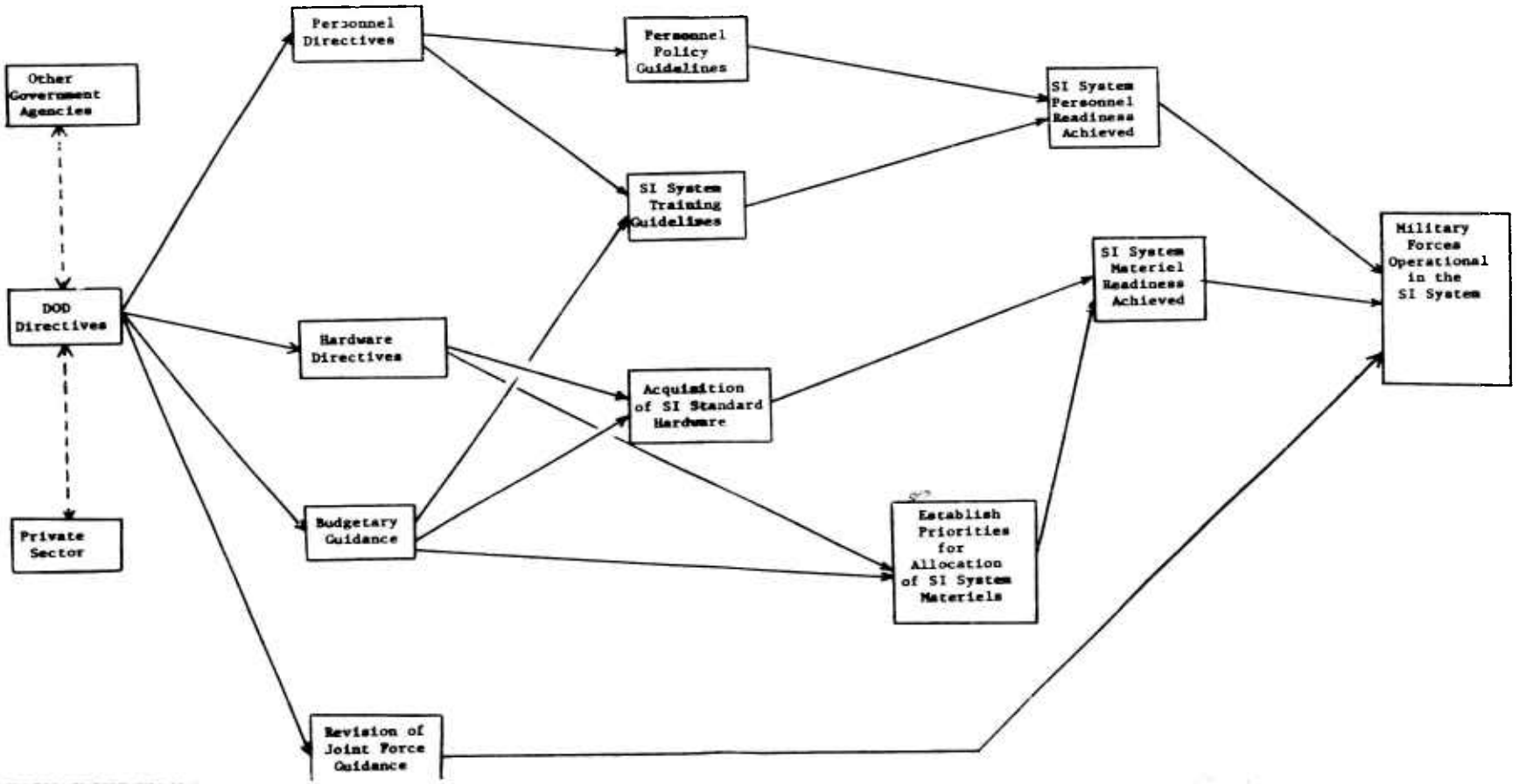
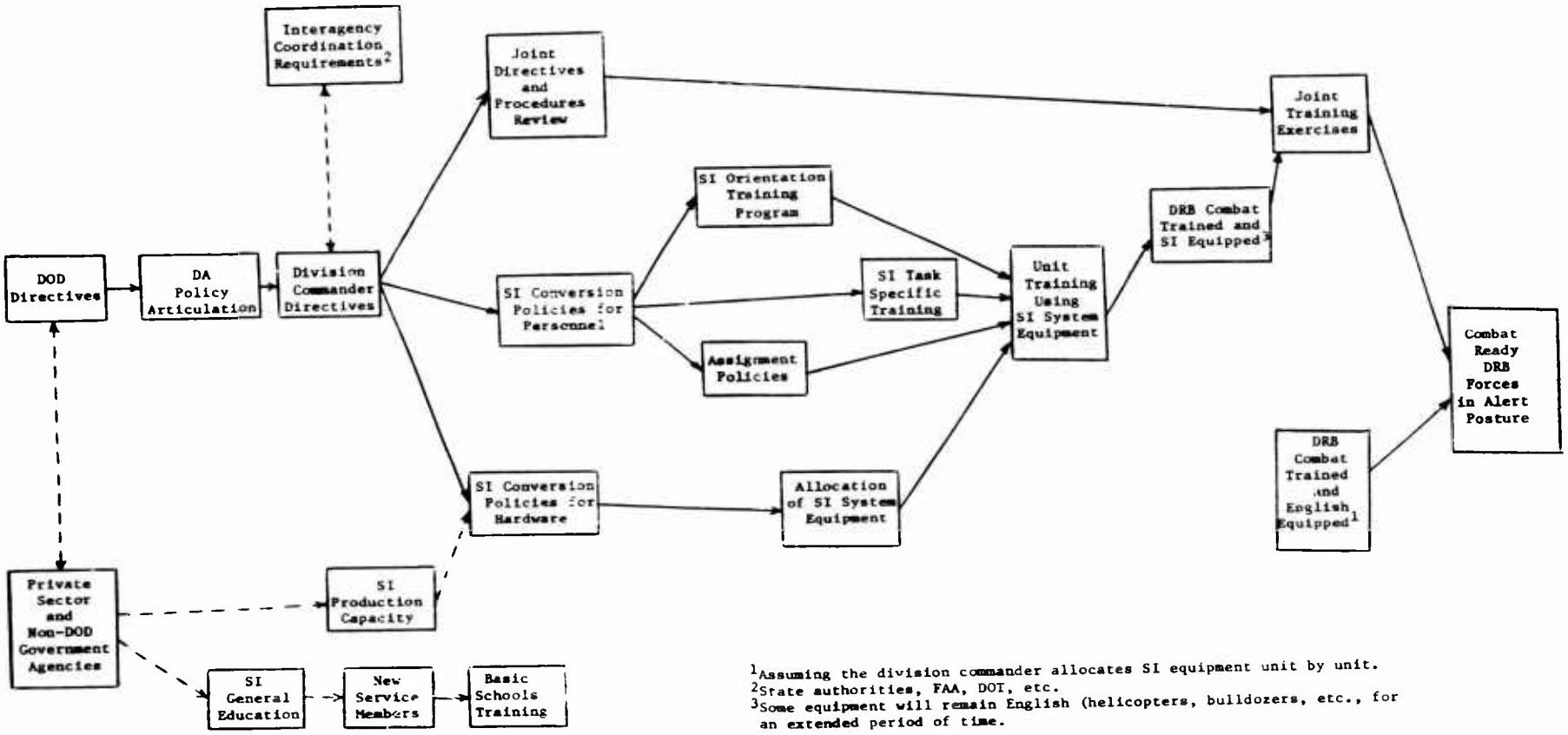


FIGURE 3: EARLY METRICATION IN THE 82ND DRB'S

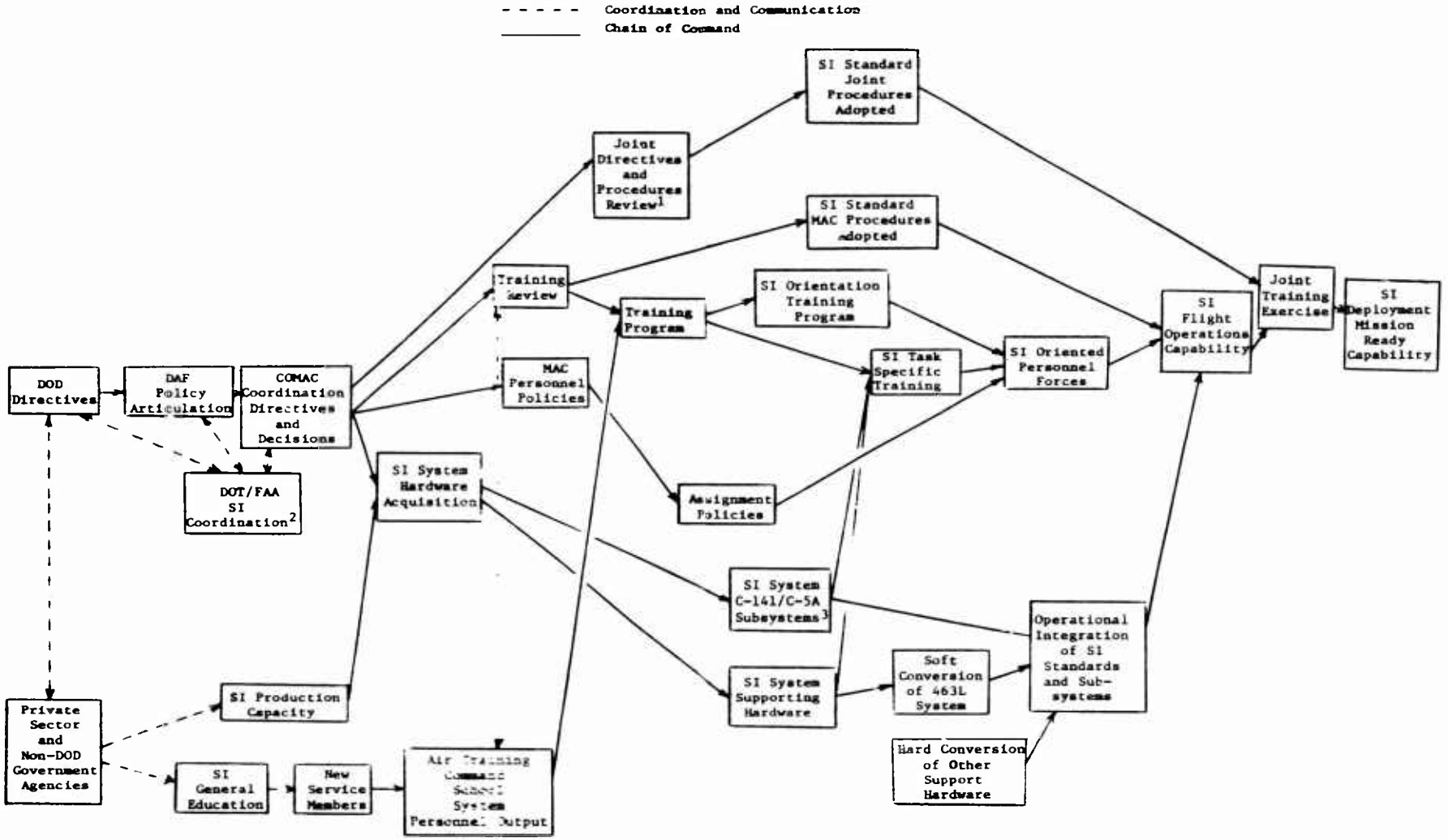
- - - - - Coordination and Communication

——— Chain of Command



[1]Assuming the division commander allocates SI equipment unit by unit.
[2]State authorities, FAA, DOT, etc.
[3]Some equipment will remain English (helicopters, bulldozers, etc., for an extended period of time.

FIGURE 4: EARLY METRICATION OF THE C-141/C-5A STRATEGIC AIRLIFT SYSTEM



[1]Commenced as soon as feasible and continuously revised.
[2]Cargo standards, passenger certification, etc.
[3]To be installed on the aircraft.

FIGURE 5: LATE METRICATION AT DOD LEVEL

- - - - - Coordination and Communication
——— Chain of Command

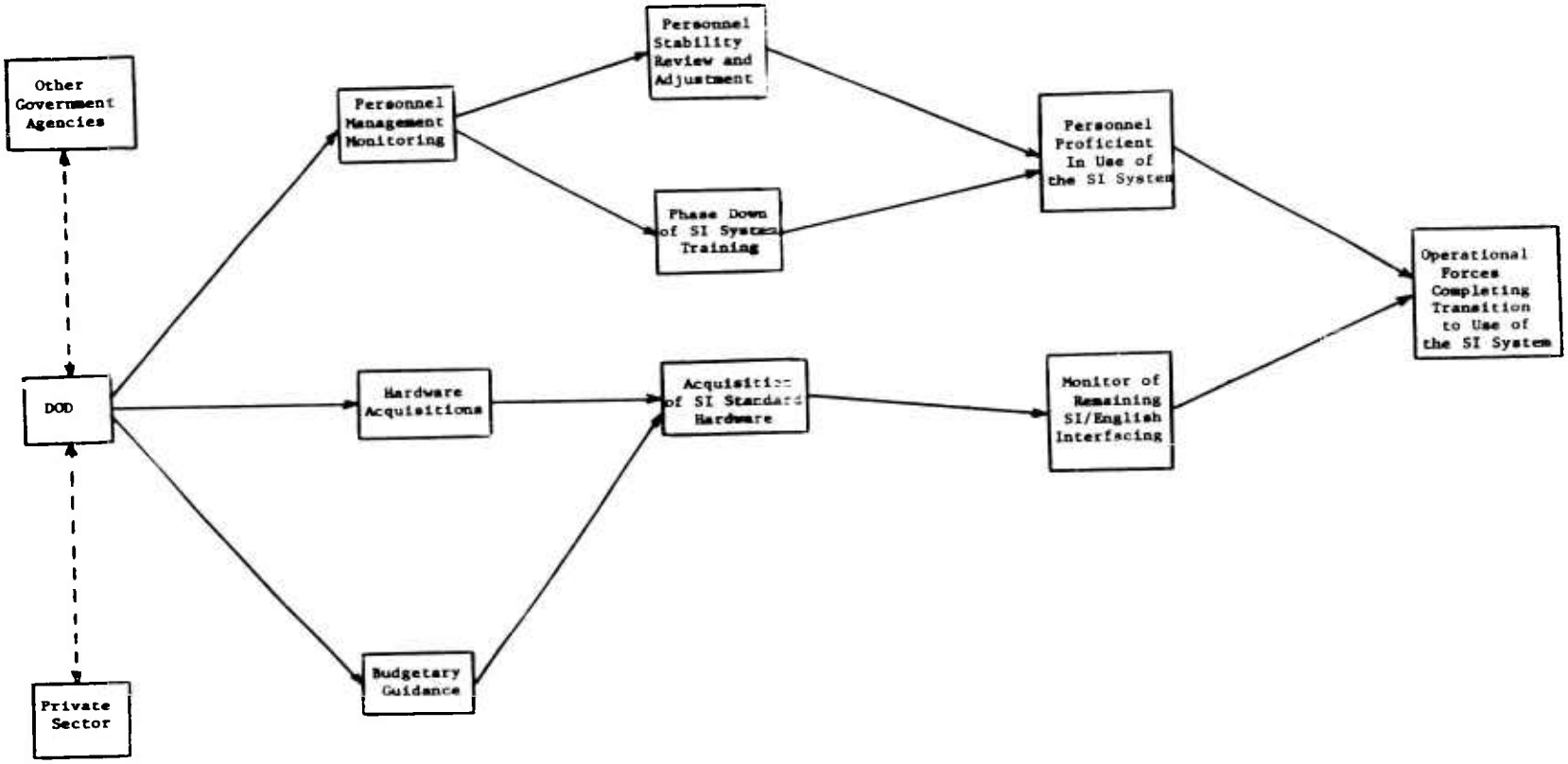


FIGURE 6: LATE METRICATION IN THE 82ND DRB'S

- - - - - Coordination and Communication
_____ Chain of Command

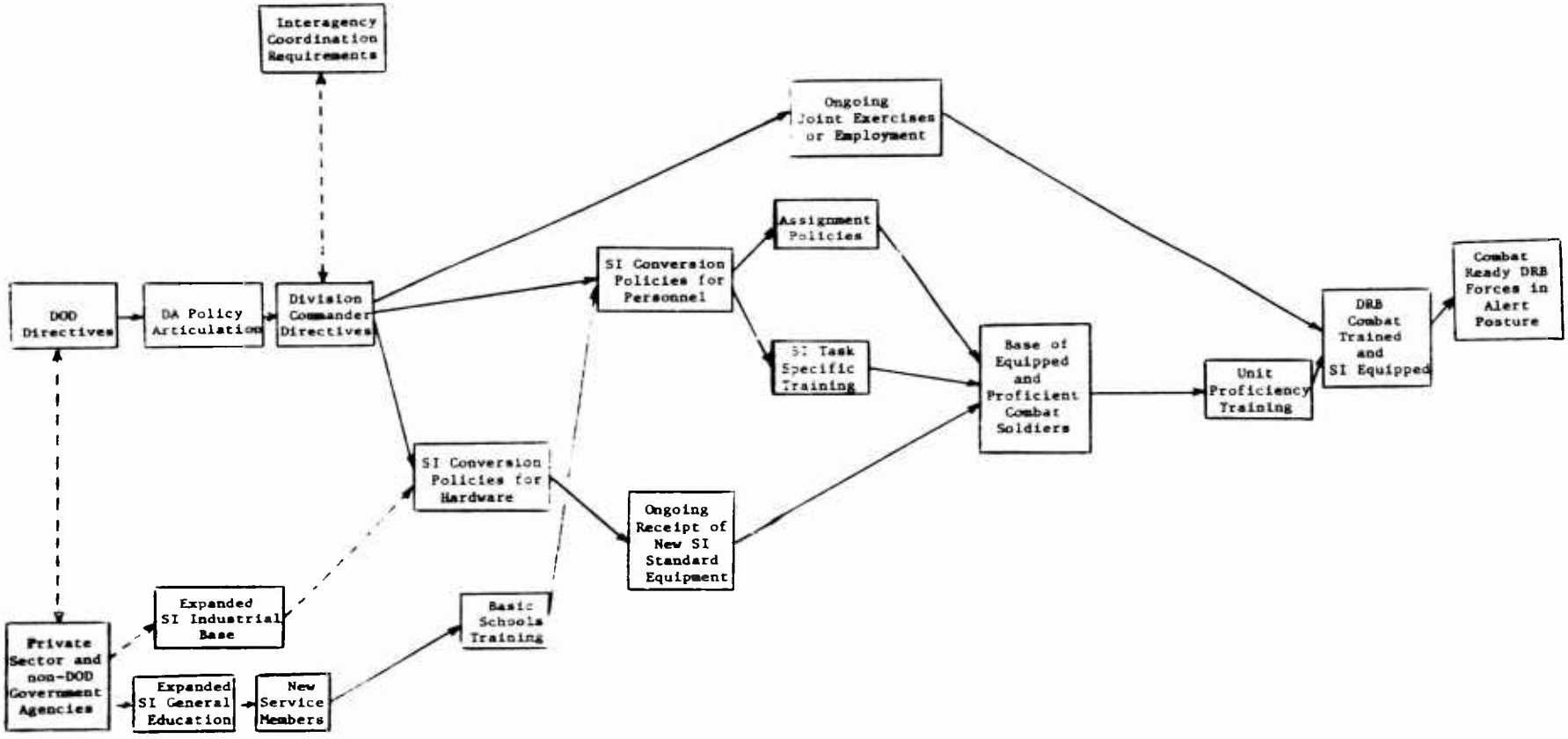
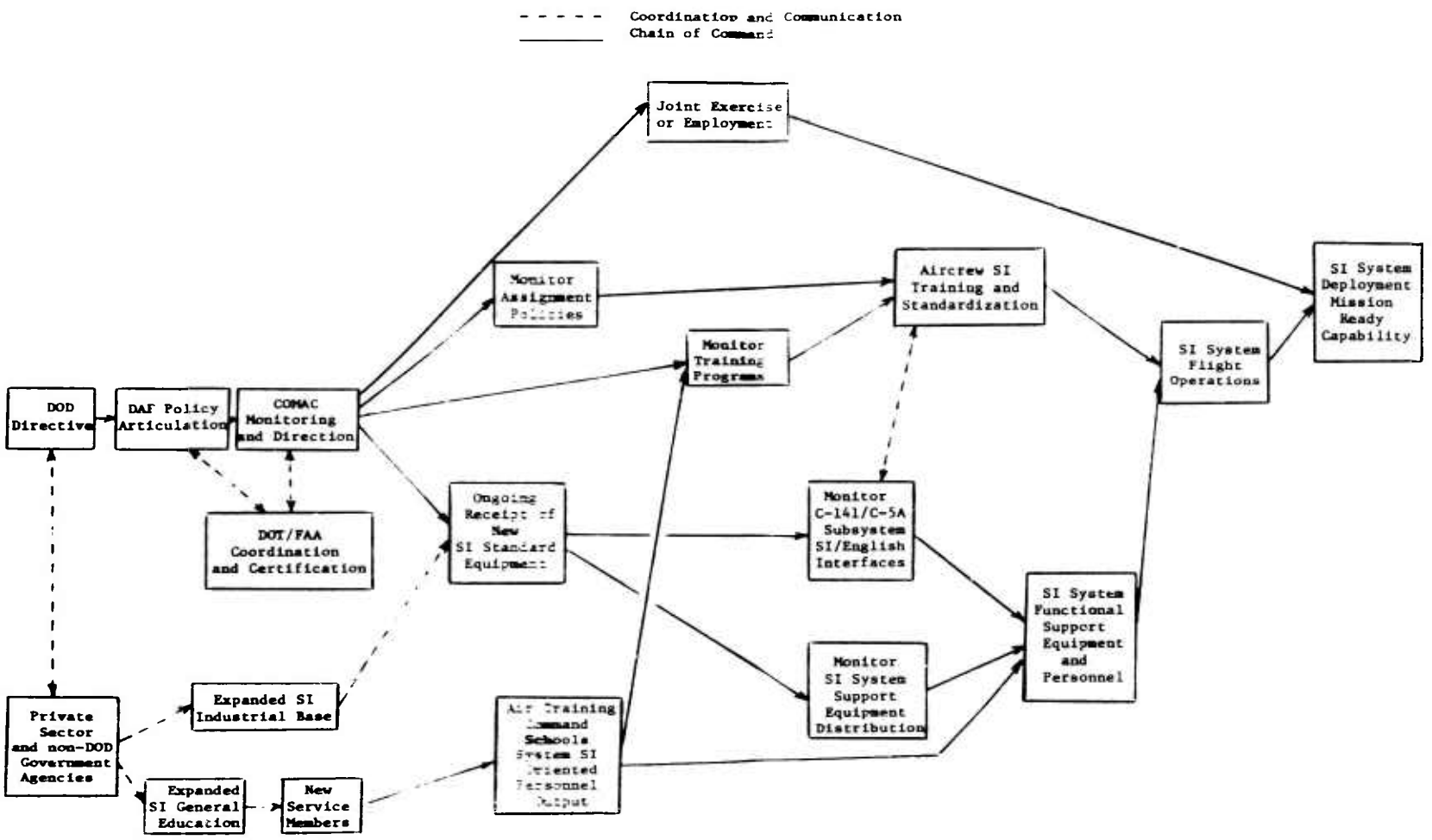


FIGURE 7: LATE METRICATION OF THE C-141/C-5A STRATEGIC AIRLIFT SYSTEM



Metrication Management at DoD Level

The role of the DoD in conversion to the SI system is that of a large scale director. The department should become involved in execution as little as possible except for normal budgetary processes and interfacing with non-DoD actors. The DoD should direct revisions of joint manuals, procedures and doctrine where appropriate. Subordinates should be tasked to implement broad programs and should have the flexibility to tailor these programs to unique needs. Figure 2 shows the DoD issuing broad policy guidance in three primary areas; the budget, materiel and personnel actions. Discussion of these three areas and supplemental actions will complete the analysis of direct DoD impact on the subject forces.

This paper assumed that adequate funds will be made available by the Congress for conversion. The DoD may find that this is not the real world case and should be prepared to adjust the speed of conversion according to the funds voted annually. The budget, in a direct sense, drives hardware acquisition which, in turn, drives personnel requirements. The DoD should have adequate budgetary flexibility for metrication management within the current administrative framework. No changes are recommended which have management implications.

DoD materiel actions are broken into two subcategories. First, the DoD must direct broad based, but in many cases quite detailed, revisions of material specifications and standards. Some of this work is being carried on now by the Defense Material Specifications and Standards Office, a staff agency within the DoD.[1] Working with industry, this office is defining DoD standards for thousands of raw and finished materials for application to testing procedures, procurement and a host of other uses.[2]

Such activity is a prerequisite to developing DoD descriptions of standards using SI units, but has little immediate impact of the conversion of operational fighting units.

Second, acquisition of all SI system hardware will be under broad DoD controls which directly impact on the fighting units. When acquisition is part of the introduction of major new weapons systems, use of SI standards will not raise problems vastly different from those encountered in introducing new weapons built to English standards. In either case, interfacing with existing Table of Organization and Equipment (TO&E) hardware will produce approximately the same problems. Whether English or SI, the new weapons can be monitored within the present administrative DoD framework.

Replacement of portions of existing major systems with hard conversion SI system equivalents generates new problems at the DoD level. Apportionment and allocation priorities must be set for all services. For example, if several division sized units are to be reequipped, operational readiness standards for these units may require revision. This type of decision will influence the timing of the 82nd Airborne DRB's receipt of SI standard replacement hardware. The priority assigned the 82nd will dictate the state of the metrication learning curve and the mission readiness degradation to be expected. If the 82nd is the first operational division to receive SI standard vehicles, a relatively long training period with the new equipment should be anticipated. If a high premium is placed on the readiness of the 82nd, the DoD should probably assign a corresondingly low priority for issuance of SI standard equipment.

Training requirements should be expected to decrease over time as shown in Figure 5 because both new recruits and more senior service members

will become progressively more immersed in the national conversion environment. Policies and objectives should be well established. The DoD role in defining and refining various training programs should decrease correspondingly.

The DoD should also plan to issue guidance on personnel policies during the changeover period. Such guidance should be general enough to allow the services and subordinates to tailor programs to meet unique and specific needs. However, the directives should explicitly define the limits of military investment in such personnel policy adjustments.

The DoD should direct those policies which may be feasible for reducing personnel turbulence and transfers in selected units undergoing metrication. Such a step would increase mission readiness and decrease the cost of the conversion cycle, but it can probably be applied to only a few selected units.

DoD Relations with the Private Sector and other Government Agencies

Much of the metrication coordination required with the private sector and with other government agencies should be retained at DoD level. This is especially true of interactions with large industrial firms and major agencies of the federal government. DoD management of these interactions will provide coordination to the separate services in the move to conversion.

Figure 5 shows the DoD role in conversion during the final few years of the cycle. Close laision with non-DoD actors should continue because DoD conversion will be strongly influenced by the speed of non-DoD metrication. Timely and adequate revision and certification of DoD SI system

standards and specifications should result.

Metrication Management in the Military Airlift Command

Within the C-141/C-5A airlift system much of the metrication management should be held at the Headquarters, MAC level. This is necessary to prevent a divergence of policies and procedures within the six geographically separated military airlift wings at which the fleet is based. A large number of enroute military airlift support squadrons and other semi-independent, geographically separated supporting activities are an additional part of the system. They must be centrally directed to achieve adequately standardized metrication proficiency. For this reason Figures 3 and 6 show initiatives flowing from the Commander, Military Airlift Command (COMAC) directly to the various types of activities. Subordinate commanders at wing, squadron and lower levels will be a part of the chain of command responding to the centralized management of the conversion.

COMAC should be the directing and controlling authority for the pace of MAC conversion; personnel training and SI system hardware allocation and use. He will also provide primary laision with non-MAC agencies. He will, for example, play a key role in negotiating matters of aircrew training and aircraft subsystem modification and certification with the Federal Aviation Administration. He will be required to approve MAC contributions to the updating of policies and regulations governing joint operations. He will coordinate MAC requirements and capabilities in revision of Department of Transportation standards for the movement of hazardous and dangerous cargo. In short, he will be the focal point of all of the highly centralized MAC metrication management efforts.

MAC Personnel Policies

COMAC should implement new command-wide personnel management standards as required to conform to DoD guidance. For metrication MAC personnel policies can be divided into two primary areas; personnel training programs and personnel assignment policies. Together these programs comprise the single most challenging portion of MAC conversion management.

Training for conversion should be tailored to MAC requirements and to the prior knowledge and proficiency of the members of the command. SI system orientation training may have to be conducted MAC-wide early in the conversion process as shown in Figure 4, but can probably be eliminated later in the program. Over time the requirements for specific training needed to do particular tasks will decrease as a function of pre-military exposure to the SI system and preparation within the Air Training Command schools system. These relationships are shown in Figure 7.

Training which is specific to particular jobs or tasks such as ground power supply maintenance, flight instrument repair, aircrew navigator and almost all other functions will require modification to accommodate the SI system. However, this type of training revision is a normal part of ongoing MAC training formulation and should not require organizational changes. The training syllabus material for most instruction is written or controlled at MAC Headquarters, and integration of SI system requirements will not be an unusual problem for the training staff agency.

As special training requirements are identified which must be fulfilled in operating MAC units they can use existing facilities which now provide recurring ground training at each major MAC base. Successful completion of such local training will be key to establishing a positive attitude toward

the SI system among working airmen. For this reason thorough preparation and relevant instruction should be mphasized in such programs. The training must fit the needs of the trainees, be interesting and stimulating, portray the benefits of the SI system, and meet the needs of the Air Force. It should make visible and useful the open channels of communication on metrication matters within the chain of command. Whenever possible training should incorporate the use of new SI standard equipment.

Personnel assignment policies should be revised where necessary to conform to DoD policies and fit Air Force requirements. The specific case of the MAC aircrew assignment structure and allocation procedures provides a useful illustration. Individual assignment actions are driven, in great part, by the specific aircraft type in which the individual crew member becomes qualified when first assigned to MAC. Normally the pilot, navigator and flight engineer assigned initially to the C-141 can expect to remain in that aircraft so long as he is a member of the command.[3] The same holds true if he leaves the command and returns for a subsequent tour. While there are exceptions to this policy, especially when a new aircraft is introduced into the aircraft inventory, the basic thrust remains in force and generates training cost savings and other benefits as a result. This same policy is not applied to personnel filling loadmaster position in the MAC fleet.[4] A loadmaster is considered assignable to any transport type aircraft regardless of his previous aircraft experience.[5] This is based on the assumption that loadmaster functions in all transport aircraft are essentially interchangeable.[6] During metrication this policy should be changed. It is unlikely that all transport aircraft will be converted to use of the Si system and procedures simultaneously, and loadmasters will not perform the

common tasks which are assumed today. The variety of duties and, importantly, the penalties possible for major mistakes, will be so great that assignments for this crew position should be the same as for the pilots, navigators and flight engineers.[7]

Assignment of support personnel does not appear to be as complex as the case for aircrews and should demand less rigid control. There are some specalized exceptions. Still, the entire spectrum of assignment policies should be scrutinized for feasible adjustments to increase stability and make metrication less costly.

MAC SI System Hardware Acquisition

The introduction of new SI system hardware and the modifications to existing equipment which must interface with SI measurement become extremely complex management problems. COMAC should expect that the C-141 and C-5A aircraft will remain in use after all other parts of the airlift system have been replaced by SI system equivalents. This means that the aircraft will require significant and expensive modifications to electronic and instrument systems to perform in an SI standard flight environment. This, in turn, will generate requirements for unique maintenance and test equipment and other components. Therefore the program for aircraft modifications and the acquisition of new components should be closely coordinated with the United States Metric Board and the agencies responsible for the various flight environments; the Federal Aviation Administration (FAA) and the International Civil Aviation Organization (ICAO). New standards for the flight environment have not been identified by these organizations, and promise to be highly complex. ICAO changes must be negotiated and approved at the international level

before implementation. Although an important factor for MAC operations, a study of these standards is beyond the scope of this thesis. Coordination responsibility for MAC on such matters should be held at the COMAC level.

The second portion of the MAC hardware discussion includes all equipment except for aircraft, and can be called mission support equipment. This category is, in turn, subdivided into two subordinate categories, the 463L materials handling system and all other support equipment. The 463L system contains both aircraft mounted and ground based components. It is designed to handle all air transportable cargo and is essentially common to the entire strategic and tactical airlift fleets. Its functions are to provide for the ground handling, securing, loading, and off-loading of all types of cargo. Because this equipment is so widely used it seems prudent to engage in only a soft conversion of these components until a new generation of transport aircraft are procurred which will justify either hard conversion modifications or an entirely new cargo handling system. Therefore, it will be most practical to refrain from extensive 463L modifications. The interfaces between the 463L system and the various English aircraft are too numerous and too complex to permit hard conversion in the former.

Other mission support equipment could be modified more freely to meet SI system specifications. Flight line maintenance equipment such as trucks, tractors, power carts, air carts, hydraulic mules and shop equipment are all integral to the airlift wing and the other support systems. These could be extensively modified and still interface with the C-141/C-5A fleet.

As SI standard support equipment enters the inventory it should be distributed throughout the airlift system. The mobile nature of most system components will eventually cause dispersion whether it is intended or not.

although there is a penalty for dual English/SI operation of support equipment at all bases, research indicates that free mixing will not generate difficulties among maintenance personnel. Returns for allowing dispersal accrue in terms like simplicity of control and mobility of operational capability.

Joint Procedures and Standards

COMAC should direct periodic reviews of the Air Force portion of joint training guidelines in conjunction with similar Army reviews initiated at intervals during the metrication cycle. Procedures applicable only to MAC members should be revised prior to teaching SI system standards or introducing hardware, and should be implemented in conjunction with initial metrication orientation. This should require MAC members to use the SI system in routine training procedures in the instructional environment and contribute to effective development of proficiency.

Procedures and directives which govern operations in which both services are directly involved require wider concurrence and more elaborate training. Airdrop operations of both troops and equipment, for example, are a highly complex part of the MAC/DRB mission. Conversion of governing directives to SI standards could occur early, but publication of the revisions should be withheld until both the Army and the Air Force have separately trained with the SI system. An exercise after such SI system training using all types of units on a large scale joint problem would assure that MAC and the 82nd Airborne Division standards provide for adequate operational control and mission readiness.

The assignment of DRB duties is rotated among the 82nd's brigades, and MAC resources for an actual deployment can be drawn from all MAC wings.

These facts make it impractical to train selected portions of either force in the use of the SI system. Once introduced, SI standards for joint operations should become the only standards as soon as practical in both services. Although Figure 3 shows a separate English equipped DRB within the division, this unit should plan to use SI system joint procedures. Interfacing between English and SI should be accomplished within the DRB. Such policies place a premium on thorough knowledge of the SI system and a positive approach to conversion among lower echelon leaders. Training and leadership should be planned and constructed to encourage acceptance of the SI system among all ranks.

Summary of Military Airlift Command

The MAC system is presently constituted to accept new ideas and equipment. The metrication program can succeed in operational MAC units provided that: (1) timely coordination with non-MAC agencies is accomplished, (2) training programs emphasize the benefits to be accrued from use of the SI system, (3) small unit commanders are prepared for the conversion and (4) open channels are maintained to communicate conversion difficulties with the chain of command.

Metrication Management in the 82nd Airborne Division and the DRB's

The 82nd Airborne Division is characterized by a more localized base of operations than the C-141/C-5A MAC fleet. All major elements of the division are assigned at Ft. Bragg. For this reason the Commander, 82nd Airborne Division should have more latitude in conversion management than the approximate MAC counterparts. Although subjects to DA policies for personnel and hardware, he should anticipate retaining great flexibility in

implementing such directives. For this reason control of the three most basic areas; personnel, hardware and interfacing will present different challenges to him than to Air Force leaders. He should be in a position to generate independent training programs, personnel policies and hardware allocation plans within the division. Holding much of the Army expertise in large scale parachute delivery operations, he should have a strong influence on the revision of all airborne directives and procedures.

82nd Airborne Division Personnel Policies

The rotation of DRB responsibilities among assigned units mandates particular personnel policies for both assignment and training. Like MAC the 82nd Airborne Division's subordinate units could realize improved metrication and increased combat readiness in direct proportion to decreased assignment turbulence. Normally Army training is more decentralized into subordinate, closely knit units than in the MAC case. Therefore, in the Army environment, metrication orientation could best be accomplished on a unit by unit decentralized basis. Most personnel will require approximately the same types of SI system orientation that was described for the Air Force case. The difference is that the training needs and instruction design would be controlled at division level which is lower than the MAC Headquarters level. Figures 3 and 6 show the orientation training requirements to be diminishing over time for the same reasons that the requirements changed for MAC.

Certain types of units will require far less preparation to use the SI system. Artillery and infantry combat units currently function primarily in metric units which integrate directly into the SI system.

82nd Airborne Division Hardware Conversion and Specific Task Training

Training to perform specific tasks in the SI system will be influenced by the way SI standard hardware is allocated within the division. The commander could opt to allocate SI hardware equally among subordinate units, creating a division in which most organizations would have both English and SI system hardware. This will result in maintenance duplication and will seriously degrade mission capability. Aerial delivery and combat committment of units lacking internal standardization of like items is unacceptable and dangerous.

An alternative approach available to the division commander is to designate specific units to receive SI system hardware until TO & E specifications are met. This alternative yields minimum mixing of English and SI measurement standards for any DRB in the alert posture. It would also minimize training waste. In either case, training for specific SI system tasks should begin only after SI hardware has been received within the using unit. Soldiers who need to know the SI system to use their equipment will see clearly the need for SI system training and will develop proficiency in the system at a relatively rapid rate.

Alternative two should provide a maximum opportunity for junior supervisors and commanders to show initiative and skill in training and leadership. If these junior leaders are properly motivated and understand the conversion cycle a highly efficient and economical conversion should result.

82nd Airborne Division Interfacing

Specialized equipment of limited issue within the DRB's of the division will probably mandate a degree of English/SI system interfacing in the oper-

ations area until late in the conversion cycle. Helicopters, road graders, bulldozers and other engineering equipment are likely candidates fro this role. They should have little impact on the overall SI system conversion. The aerial delivery characteristics required of the division keep the DRB's free from many large items of equipment which might otherwise remain in service beyond the initial conversion cycle.

Joint Training Exercises

Joint exercises to test the proficiency of soldiers and airmen and to exercise the SI system hardware should be scheduled as soon as DRB or MAC units acquire significant capability using SI system equipment. If the two services do not convert simultaneously adjustments to planning and to joint operating procedures should be recognized at this time. Special adjustments may be required for the period of the conversion cycle. After conversion of both services additional joint exercises will be useful in refining directives and procedures for the use of the Forces.

Summary of the 82nd Airborne Division

Metrication within the 82nd Airborne Division should be more decentralized than the MAC conversion. Heavy dependence on thoroughly indoctrinated and prepared junior subordinates will probably yield the most efficient conversion. Unlike MAC, mixing English and SI standard equipment throughout the division should not be done. Specific task training should be accomplished in conjunction with the receipt of a full TO & E issue of SI standard hardware.

FOOTNOTES

1. Kunihiro, Ron op. cit.

2. Ibid.

3. Kerr, Major Joseph W., Personnel Officer, Headquarters, Military Airlift Command, personal interview, 24 October 1975.

4. Ibid.

5. Ibid.

6. Ibid.

7. Ibid.

CHAPTER V

SUMMARY AND CONCLUSIONS

This study presents solutions to some problems and identifies a large number of new difficulties inherent in the metrication process. Conversion to the SI measurement system has been directed within the DoD and will be a subject of growing interest for commanders, planners and managers. The metrication cycle will affect some facet of every military duty. Many additional problems will unfold as the conversion gains momentum.

Proper timing of conversion events is critical to effective metrication management. This should be a responsibility of high level commanders. Varying requirements for personnel training and orientation will exist throughout conversion. Efficient metrication requires intensive management of the personnel resource base and modifications to some personnel policies which are acceptable in the current environment. The following conclusions are specific to the MAC C-141/C-5A strategic airlift fleet and a DRB constituted from the 82nd Airborne Division.

1. Metrication of the designated Air Force and Army forces can be accomplished within the mission readiness constraints given provided that the conversion is conducted within the national program and provided that adequate funds are allocated to support it.

2. The last hardware to be replaced by SI equivalents will be the MAC C-141 and C-5A airframes.

3. Significant SI/English hardware interfaces will exist so long as the C-141 and C-5A remain in the inventory.

4. Conversion of the MAC forces should be characterized by central-

ized management and direction coupled with highly decentralized execution of training and employment of SI system hardware.

5. Allocation of new SI standard equipment in the MAC forces can best be managed if it is equally distributed among all applicable operating units.

6. The 82nd Airborne Division commanding officer will have greater conversion management freedom than his MAC counterpart.

7. Allocation of new SI standard equipment within the division will best meet operational needs if SI system hardware and English hardware are segregated into different units to the extent that this is feasible.

8. Metrication training and orientation within the division should be delegated to the junior leaders and commanders of subordinate operating units.

9. Specific task training within the division will be best accomplished in conjunction with receipt and initial employment of the applicable SI system hardware.

10. Joint training exercises are mandatory to test manuals and directives which are revised to accommodate the SI system and to assure the continuance of mission readiness throughout the conversion cycle.

APPENDIXES

APPENDIX A
Metrication Directives

MEMORANDUM FOR: Secretaries of the Military Departments
Chairman, Joint Chiefs of Staff
Director, Defense Research and Engineering
Assistant Secretaries of Defense
Directors of Plans Agencies

SUBJECT: Use of the Metric System of Measurement

The Department of Defense participated in a U.S. metric study by the Department of Commerce which resulted in a recommendation to the Congress in July 1971 that the United States change to the international metric system. Although Congress has not completed action on a metric conversion act, it has recognized that increased use of the metric system in the U.S. is inevitable. Many Defense-related industries have already started conversion to the metric system.

Adoption of the metric system will have advantages inherent in a measurement system that is common among nations in addition to its well-known value in mathematical computation. In the military perspective, adoption of the metric system and availability of metric standards and modules will enhance interchangeability and interoperability of military equipment and components with our allies, and at the same time facilitate U.S. production of foreign designed systems and equipment and vice versa.

It is considered to be in the best interest of the DoD to pursue an interim policy with respect to the changeover, pending enactment of legislation. Generally, it is recognized that industry will take the lead in the changeover and the Services and Agencies will follow paying their fair share of the costs. However, procurement actions will not normally bear the burden of contractor conversion programs for machine tools and equipment calibrated in customary units; rather, such transition to the metric system will take place through normal attrition. Transition to metric usage will be evolutionary; that is, involving principally new systems and facilities, and will not normally include the redesign and modification of existing systems in the inventory.

Accordingly, the following interim policies are established:

1. The Department of Defense will use the international metric system in all of its activities consistent with operational, economical, technical, and sfety considerations.

2. Effective immediately, the international metric system will be considered in the procurement of all supplies and services and particularly in the design of new material. It will be used when determined to be in the best interest of the Department of Defense. In general, the metric system will be considered for the following:

a. Material which has potential for significant foreign sales or joint production programs.

b. Where there is a specific military need such as for material to be used jointly with NATO and other allied nations.

c. Areas where industry has made significant progress in metric conversion and production facilities are available.

d. Areas where defense industry preparedness or defense production readiness may be enhanced.

e. Other areas which offer definite economic, operational, or other advantage.

3. Existing designs dimensioned in U.S. customary (inch-pound) units will be converted to metric units only if determined to be necessary or advantageous. Normally, the system of measurement in which an item is originally designed will be retained for the life of the item.

4. Materiel components, parts, subassemblies, and semi-fabricated materials which are of commercial design will be specified in metric units only when economically available and technically adequate or when it has been determined that the significant elements of a higher order metric system or subsystem are also to be metric. Bulk materials will be specified and accepted in metric units when it is expedient or economic to do so.

5. Defense Systems Acquisition Review Council (DSARC) reviews which take place after 31 December 1975 (and associated Development Concept Papers) will include comments regarding the use of metric units of measurement or reasons for their nonuse.

6. Technical reports, studies, and position papers issued after 31 December 1975 will include metric units of measurement in addition to or in lieu of U.S. customary units.

7. Programming and budgeting actions will include resources required to support the DoD effort in converting to use of metric units. Use of the metric system will be identified and planned so that costs can be included in the budget cycle on an orderly basis.

8. The International System of Units (SI) described in ASTM E380 , (ANSI Z210.1 - 1973), or successor documents listed in the DoD Index of Specifications and Standards, will be the metric system used by the DoD.

9. Representatives of the Department of Defense will participate in the development of national and international standards using the metric system, to the extent indicated by DoD interest. NATO and other international metric standards will be used to the maximum practical extent. However, if a U.S. standard is established with greater definition and restriction than a prevailing international standard, the U.S. standard will apply.

10. Emphasis will be placed on conversion or development, using metric units, of specifications, standards, and other general purpose technical data, to keep pace with the conversion in the private sector. When the item in question is a military item without a commercial counterpart, the Preparing Activity will assume a leadership role in development of the applicable metric document as the need arises.

11. Services and Agencies are encouraged to purchase new equipment that will allow direct measurement in terms of SI units.

12. Training in metric practices and usage will be provided to those personnel whose duties require such knowledge.

13. Use of dual dimensions (i.e., both metric and U.S. customary dimensions) on drawings will be avoided unless it is determined in specific instances that such usage will be beneficial. However, the use of tables to translate dimensions from one system of measurement to the other is acceptable.

It is expected that these policies will be modified or augmented in a permanent DoD issuance as futher experience is gained. I will look to the Assistant Secretary of Defense (Installations and Logistics) to take such action as may be required to assure an effective and economical transition, in coordination with the DDR&E and with the advice of the Defense Materiel Specifications and Standards Board.

(Signed)
W. P. Clements Jr.

MJCS-299-75
29 August 1975

MEMORANDUM FOR: Commander in Chief, Aerospace Defense Command
Commander in Chief, Atlantic
US Commander in Chief, Europe
Commander in Chief, Pacific
Commander in Chief, US Readiness Command
Commander in Chief, US Southern Command
Commander in Chief, Strategic Sir Command

Subject: Use of the Metric System of Measurement

1. The attached memorandum from the Deputy Secretary of Defense, which provides policy guidance for the introduction and use of the metric system within agencies of the Department of Defense, is furnished for your information. The movement toward increased use of metric units to replace customary measurement units has economic and operational advantages, many of which will be experienced at overseas locations. A DoD directive based upon the attached is being staffed and should be published in approximately 90 days.

2. The resolution of problems stemming from the interface of inch-pound and metric units will be a conintuing task. Some of the problems to be faced may be: psychological resistance to change among personnel trained only in customary units; possible requirements for dual stockage or dual manufacturing to support weapon systems in some instances; and continued inventories of long-life items designed under the obsolete system. These problems, although significant, may be minimized by proper planning and monitoring.

3. The military advantages of metrication are those inherent in using a simpler measurement system, and the increasing compatibility that can be achieved between US and foreign equipment.

4. You are encouraged to begin use of the international metric system in all activities consistent with the guidance provided in the Appendix. Proper planning and monitoring are essential to insure flexibility in using both systems during the transition period to avoid adverse impacts on operational equipment and systems will be addressed when planning is completed for military-wide operational conversion to the use of the metric measurement system.

For the Joint Chiefs of Staff:

Maurice F. Casey
Lieutenant General, USAF
Director for Logistics
The Joint Staff

Reply to
Attn of: CC

Subject: Use of Metric Units of Measurement

To: ALMAJCOM/CC

1. Most of the major nations have converted or are converting to the use of metric units of measurement. Phasing of this action varies, but the decisions have been made, plans have been developed and implementation has been initiated. The United States is the lone major power which has not completed legislation on application of the metric system.

2. Although there is no official legislation, many segments of industry are designing and producing their new products in metric units of measurement to stay competitive in world markets. Decisions are being made on a corporation by corporation basis based on their evaluation of the economics involved with the introduction of new products. Within several years some of these metric items will be offered to the Air Force as cost effective off-the-shelf hardware.

3. The Secretary of Defense has rocognized the trends within industry and has disseminated interim metric policy guidance pending the enactment of national legislation and promulgation of a Department of Defense Directive. This policy, enclosed as Attachment 1, will be used within the Air Force for development of guidance in appropriate functional area directives and for internal planning at all levels of management.

4. Questions regarding interpretation of this policy should be directed to AF/LGYE.

(Signed)
William V. McBride, General, USAF
Vice Chief of Staff

APPENDIX B[1]
DRB Major Equipment Items

DRB PERSONNEL AND EQUIPMENT SUMMARY

Includes the following units:
Bde HQ, Three Inf Bn's FABn, Engr Co, Cav Plt, Weather Det, Bde TACP, MP Det, 82nd MI Det, FASCP, CCT, 358th ASA Det, BAME, FAST,

Total Personnel: 3499

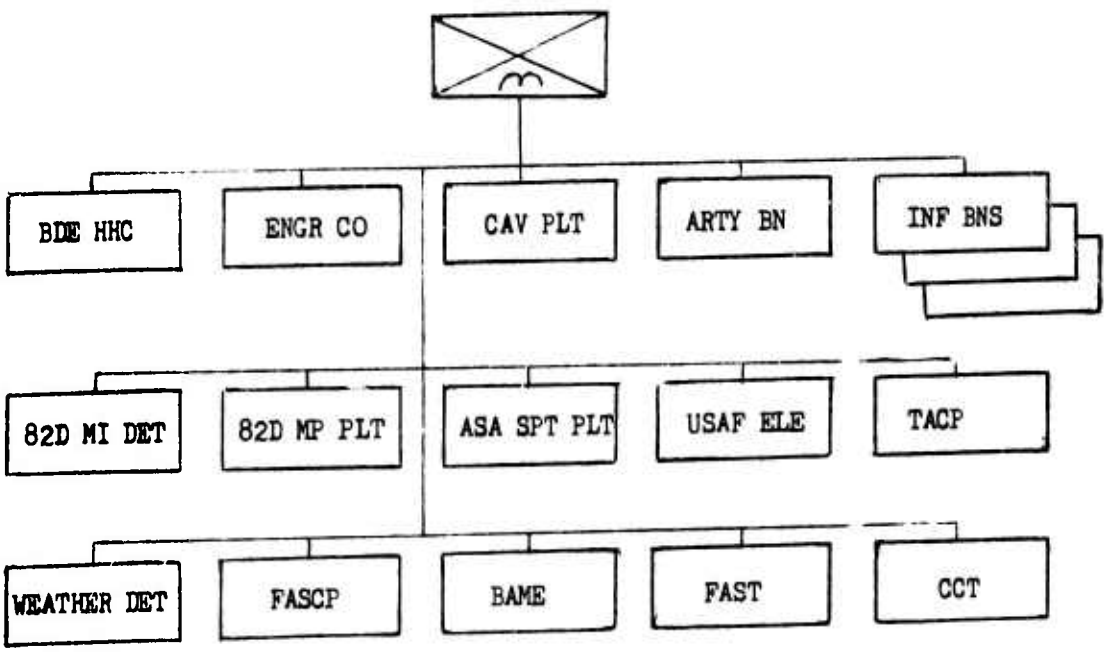
Total Equipment: 833

Subdivided as Follows:

1/4T Trk (19ea TOW)	187
1/4T Trk (106 RR)	20
1-1/4T Trk (M715)	1
1/4T Tlr	134
1-1/4T Trk M561	158
1-1/4T Trk M792	21
3/4T Tlr	83
3/4T Trk	21
1/2T Trk M274	83
2-1/2T Trk	21
1-1/2T Tlr	4
1-1/2T Tlr (Water)	20
2-1/2T Trk Dump	6
5T Trk Dump	6
5T Wrecker	1
105mm Howitzer	18
OH-58	7
AH-1G	2
UH-1H	2
6000lb Forklift	3
AN/GSM (Shop van)	7
Cont X-4 (Fiberglass)	6
AN/MPQ 4 Radar	1
Water Purification Set	2
1½T Tlr	1
Back Hoe	1
Elec Tool Tlr	3
4T Bolster Tlr	3
500 Gal Bladder	2
1/4T Trk (MK 107)	3

1/4T Tlr W/AN-MRC127 MTT	2
D5A Dozer	1
Scoop loader	1
Grader	1
Tool Set AC Maint	1

DIVISION READY BRIGADE (DRB)



1. Extracted from the 82nd Airborne Readiness SOP., Division Regulation 525-4, 25 July 1975, p. 8-19, 8-20, 8-17.

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