

AD-A179 429

THE IMPERATIVES OF TACTICAL LEVEL MAINTENANCE(U) ARMY  
COMMAND AND GENERAL STAFF COLL FORT LEVENWORTH KS  
SCHOOL OF ADVANCED MILITARY STUDIES C A ROCKMELL

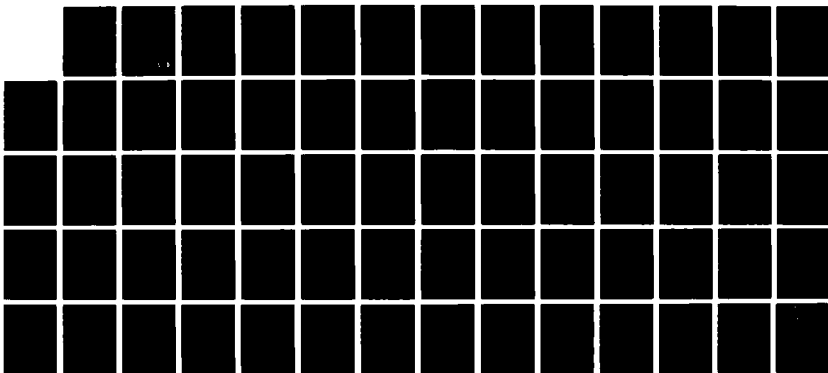
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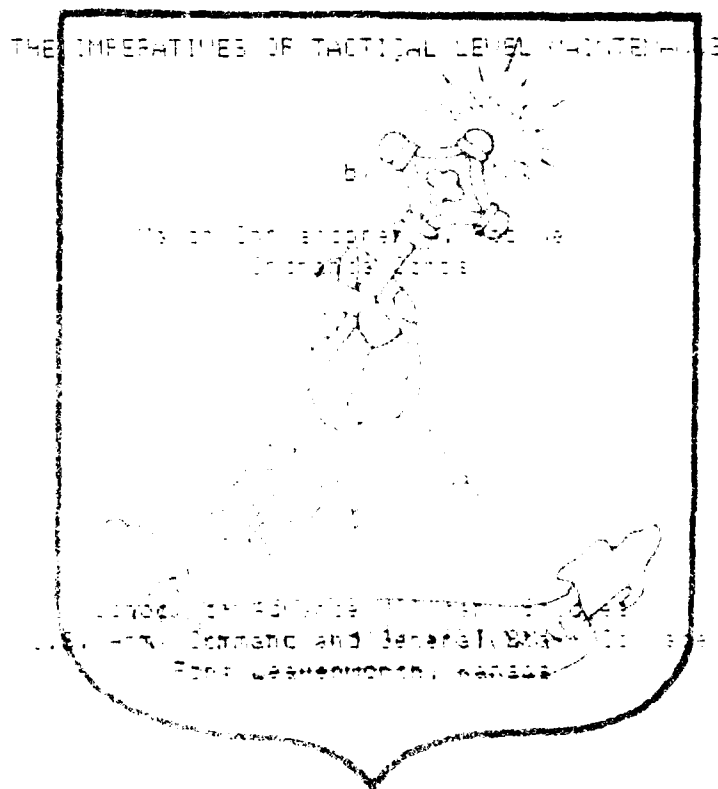
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REPORT DOCUMENTATION PAGE				Form Approved OMB No 0704-0188 Exp. Date: Jun 30, 1986	
1a. REPORT SECURITY CLASSIFICATION <b>UNCLASSIFIED</b>			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S)			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION School of Advanced Military Studies		6b. OFFICE SYMBOL (If applicable) ATZL-SWV	7a. NAME OF MONITORING ORGANIZATION		
6c. ADDRESS (City, State, and ZIP Code) Fort Leavenworth, Kansas 66027-6900			7b. ADDRESS (City, State, and ZIP Code)		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State, and ZIP Code)					
10. SOURCE OF FUNDING NUMBERS			PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.
			WORK UNIT ACCESSION NO.		
11. TITLE (Include Security Classification)  The Imperatives of Tactical Level Maintenance (U)					
12. PERSONAL AUTHOR(S) MAJ Christopher A. Rockwell, USA					
13a. TYPE OF REPORT Monograph		13b. TIME COVERED FROM _____ TO _____		14. DATE OF REPORT (Year, Month, Day) 86/11/24	
15. PAGE COUNT 60					
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)  maintenance      repair logistics          tactical maintenance		
FIELD	GROUP	SUB-GROUP			
19. ABSTRACT (Continue on reverse if necessary and identify by block number)  → This monograph develops what should be the imperatives of tactical level tank-automotive maintenance doctrine. The first section describes the importance of maintenance on the modern battlefield and demonstrates that it is key to the sustainment effort. The second section derives imperatives of tactical level maintenance through the use of historical examples - the Soviet western front in 1944-45 and the Yom Kippur War of 1973. Section Three examines what has changed since the historical examples, mainly the increased lethality and electronization. The section also describes current and emerging doctrine for maintenance operations. Section Four develops the maintenance imperatives of					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a. NAME OF RESPONSIBLE INDIVIDUAL MAJ Christopher A. Rockwell			22b. TELEPHONE (Include Area Code) (913) 682-8311		22c. OFFICE SYMBOL ATZL-SWV

Block #19, cont'd.

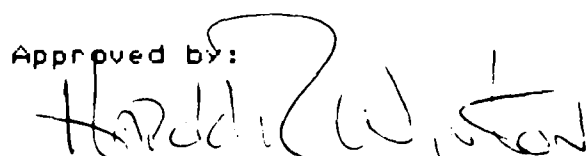
→ AirLand Battle doctrine and reconciles them with the historical examples. The next section addresses the implications of modern battlefield maintenance - command, control and communications, fixing forward and force structure - that the Army must come to grips with if it wants to achieve success in battle. The section also includes the conclusions, which consist of the imperatives of tactical level maintenance. These imperatives are: fix forward; provision of repair parts supply in a responsive manner; provision of recovery and evacuation support in a timely manner; development of effective communications, command and control; 100 % mobility ; and the ability to operate in an NBC environment and at night.

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School of Advanced Military Studies  
Monograph Approval

Name of Student: Major Christopher A. Rockwell  
Title of Monograph: The Imperatives of Tactical Level  
Maintenance

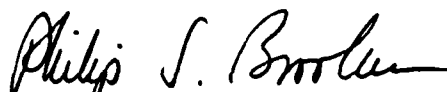
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Accepted this 17th day of December, 1982.



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## ABSTRACT

THE IMPERATIVES OF TACTICAL LEVEL MAINTENANCE by Major Christopher A. Rockwell, USA, 60 pages.

This study determines what the imperatives of tactical level tank-automotive maintenance should be. An examination of two historical examples, a brief examination of the tenets of AirLand Battle doctrine and current and emerging maintenance doctrine, and a determination of the tactical level maintenance requirements of the modern battle are presented in the monograph. The synthesis of these aspects reveals what the imperatives should be.

The two historical examples utilized are the Yom Kippur War in 1973 and the great Soviet offensives on their western front in 1944-45. In both cases, maintenance at the tactical level exhibited similar traits despite the disparity in scope and duration of the operations. An analysis of the maintenance requirements of the current and future battlefields is presented, revealing an intensity, lethality and electronization never before experienced - although approximated in 1973. These requirements are compared to current and emerging doctrine, which stands up well. An implications section addresses issues which the Army must address if it is to secure a responsive maintenance system, mainly force structure, command, control and communications, and electronization.

The conclusions reached are the imperatives of tactical level tank-automotive maintenance. These are: Fix forward; Provide responsive repair parts supply support; Conduct responsive recovery and evacuation operations; Establish and maintain effective command, control and communications capability vertically and laterally; Secure a 100% mobility capability for forward maintenance operations; and Develop the capability to operate in an NBC environment and at night.



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FBI - NEW YORK			
H-1 36			

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## SECTION 1. INTRODUCTION

" I don't know what the hell this logistics  
is . . . but I want some of it."

Adm Ernest J. King, CNO, 1942

If anyone ever needed logistical support - especially maintenance support - it was Admiral King. He got plenty of it and, with a few notable exceptions such as the Arizona, most ships damaged at Pearl Harbor were repaired and returned to service.

Over the last forty-five years, the question whether war is an art or a science has increasingly been answered, 'both'. The scientific aspects have been manifested in the equipment produced as a result of the technological revolution begun in World War II and continuing today. Advancing technology has been translated into more varied, numerous and sophisticated weapons systems and general purpose equipment found in modern military units.

These weapons and systems generally have been designed and/or acquired to support military, and in the case of this paper, Army, tactical and operational doctrine. The word 'generally' is used as some newly acquired systems have unforeseen impact. An example of this is the M2 Bradley Fighting Vehicle with its reduction in the size of the infantry squad it carries from eleven to seven, coupled with its substantially increased firepower for the reduced squad.

As these systems have been evolving, so have their needs for a responsive maintenance system. This requirement is the reason for this paper, and leads to the research question which must continually be asked as doctrine and technology advance: What should be the imperatives of tank

automotive maintenance doctrine at the tactical level in order for that doctrine to support the tenets of AirLand Battle (ALB) doctrine?

To answer that question, this paper is divided into five sections. The introduction describes the importance of maintenance on the modern battlefield and defines the tenets of ALB. Section II develops imperatives of tactical level maintenance using historical examples, while Section III examines what has changed on the battlefield since then and describes current and emerging tactical level maintenance doctrine. In Section IV, the paper develops the maintenance imperatives of ALB and determines if they and the historical imperatives coincide. The final section answers the research question, raises several issues for examination by Army tactical and logistical doctrine developers, and suggests several actions that the Army should take. An appendix comprising definitions and explanations of key maintenance concepts and terms to which the reader may wish to refer for assistance in understanding the paper is also provided.

Maintenance is crucial to battlefield success as we integrate more sophisticated equipment into our inventory. Dr. Azriel Lorber of the Center For Strategic Studies at Tel Aviv University believes that all modern armies are undergoing a revolutionary process which is changing the nature of the battlefield. He calls this process "electronization", a descriptive term based on electronics and electro-optics. It also includes such things as disturbance-proof communications systems, night vision devices, passive and active, range finding and target acquisition laser systems, smart munitions, the Position Locator Reference System and printed circuit boards (PCBs).<sup>(1)</sup> Star Wars technology, science fiction fifteen years ago, is beginning to be achieved today.

Although sophisticated systems provide us with enhanced combat capabilities, they also have associated costs - maintenance being one. "The more sophisticated the army, apparently the more vulnerable it is to paralysis and the strains of Clausewitzian 'friction', wherein things that can go wrong will." (2) This is especially true in the case of maintenance; complex equipment necessitates complexity somewhere in the maintenance system.

The Soviets recognize the importance of logistics/maintenance both as a source of strength to support operations, as will be discussed in Section II, and as a valuable target against which to focus offensive operations. Like Napoleon's predilection for manoeuvres sur les derrieres, the Soviets desire to strike targets in our rear areas is emphasized repeatedly in their operational and tactical principles. (3) John English feels that the Soviets will use their electronic warfare capability to disrupt NATO forces (4) , and an ability to generate electromagnetic pulse (EMP) adds to the capability to disrupt electronics systems not only in communications devices but also in electronic components of non-hardened weapons systems and repair parts. (5)

Senior US military officials are well aware of the growing importance of maintenance. Deputy Secretary of Defense William Taft believes that the superior quality of our military personnel, weapons and equipment must offset Soviet numerical superiority. He recognizes, however, that our superiorities are insufficient unless there is a responsive maintenance system, and states that "The most capable and qualitatively superior equipment is virtually worthless if it sits forever in the repair shop... if the men and women assigned to operate it are not qualified...or if we

run out of repair parts just a few days or even hours into a conflict." (6) Assistant Secretary of the Army (IL&FM) Joel Bonner states that "Without a modern, high-technology logistics structure, we will fail." (7) Finally, the Army Chief of Staff states that we must be able to fix forward, that commanders at all levels must be involved in maintenance, and that integration of wartime maintenance training into peacetime tactical training is critical. (8)

What these senior leaders are saying is that in order to win on the modern battlefield, we must be prepared beforehand through command involvement in maintenance from operator through operational levels, realistic, integrated tactical and maintenance training, and provision of rapid, responsive forward maintenance operations.

The role of maintenance in battle is easy to define, yet like any other concept is more difficult to execute. My belief is that maintenance consists of two complementary actions - one preventive and the other corrective. The preventive aspect consists of actions taken by operators, crews, and the chain of command to keep equipment in such a condition that it can fulfill its intended mission. In combat, these actions will be conducted whenever time permits. A critical dimension of this aspect is the active involvement by commanders at all levels to ensure these actions occur. Perhaps more important is the peacetime inculcation by the chain of command into its supervisors and operators of the necessity to perform preventive maintenance (PM) to ensure the reliable performance of their equipment in battle. Lives and mission accomplishment depend on it.

The corrective aspect is infinitely more complex. It involves the identification of maintenance faults, the recovery and/or evacuation of

equipment, if necessary, to a repair site, determination of repair requirements, to include necessary repair parts, tools and diagnostic equipment, the scheduling and conduct of repairs, and the return of equipment to the user or the supply system. Whereas operators and crews are generally associated with at most a few pieces of equipment, maintenance organizations at all levels are responsible for hundreds or thousands of items/systems. This results in the requirement for a management system for the maintenance process and leadership for maintenance units.

As there are equipments and maintenance personnel at all levels of command, all commanders are involved in the maintenance process. It is their people and equipment that accomplish the missions they assign, thus they have a vested interest in the conduct of preventive and corrective maintenance.

A further consideration in the role of corrective maintenance is the fact that replacement items of equipment are limited. Certain pieces of equipment are more important to the conduct of the battle than others, and equipment vulnerabilities vary. Important, vulnerable systems such as combat and tactical vehicles are the ones that are the most difficult to replace. They are expensive and in demand by all units in combat - demand exceeding supply. As the US industrial base is incapable, without an extended lead time, of producing these systems at a rate that exceeds losses as projected by FM 101-10-1 for a mid to high intensity conflict, the primary battlefield source of supply becomes the maintenance system. (9) The role of maintenance, therefore, is to assist in the provision of the physical means of conducting the battle.

While the conduct of maintenance is a system, a system in and of itself has little meaning unless it operates within some type of framework. The framework our maintenance system operates in is ALB doctrine. ALB is the name the Army has given to its operational and tactical doctrine. This doctrine is based on a number of battlefield imperatives which are characterized by four tenets. (10)

Initiative, the first tenet, expresses the requirement to make the enemy respond to our actions. At all levels, individuals and leaders take the necessary actions within the intent of the higher commander to set the terms of the action. Initiative implies an aggressive pursuit of offensive action, with risk taking accepted in order to take advantage of opportunities. (11)

Agility, the second tenet, requires us to be able to act and react faster than the enemy - a prerequisite for seizing and retaining the initiative. Individuals and units must be agile - quick thinking, quick acting and quick moving, always with a purpose, and able to cut through the friction of battle. (12)

Depth concerns our ability to act through time and space with whatever resources are available to us. This concept embodies the use of space to conduct operations - forward, rearward and vertically; and the use of time to plan, giving subordinates time to plan as well, and to execute and monitor execution. Momentum and elasticity are crucial and are obtained/retained through the efficient use of all available resources. Commanders see and use the entire battlefield, protecting their assets, using their forces - committed and reserve - wisely, and exploiting opportunities boldly. (13)

The final tenet is synchronization. This concept goes beyond the coordination of activities, although this is a part of the concept. It pertains to the effects that all available resources are able to produce, focused precisely at a specific place and time. On the battlefield, it is maximizing combat power potential. The concept also implies the ability to respond rapidly by executing well rehearsed actions and operating independently. Finally, it involves economy of force, application of all resources available, anticipation, knowledge of friendly and enemy requirements and capabilities, and mastery of time-space relationships. (14)

## SECTION 2. HISTORICAL EXAMPLES AND IMPERATIVES

The period 1944 to 1945 on the German eastern front was one which saw the halt of German eastward expansion, the marshalling of Soviet military strength, and the Soviet transition from defensive to offensive operations. Operations such as Bagration in the summer of 1944 and the Vistula-Oder Operation in the winter of 1944-1945 culminated in the capture of Berlin in the spring of 1945.

The Soviets had lost huge quantities of combat and tactical vehicles in the early years of the war because of inadequate doctrine and the lack of an effective repair system. Lack of mobility, inadequate stocks of repair parts and major assemblies, and an inadequate maintenance structure led to such typical events as the 2d Tank Army losing 226 of 448 tanks on a 200 kilometer (km) road march, and the existence of only 20 operational tanks in the four tank corps of the Southwestern Front in February of 1943. (1)

By January, 1944, it is estimated that the Soviets had 5500 tanks to 5400 for the Germans opposing them. (2) This ratio of approximately one to one was to change greatly in favor of the Soviets as the end of the war approached. Soviet tank losses in the last eighteen months of the war continued to be great - up to 50% of a unit's strength in the first three days of a battle - because of combat damage and maintenance failure. (3) During the last great offensives, however, vehicle repair rates by maintenance units rose from 12,000 per month in 1944 to 17,000 per month in 1945. (4)

The Soviets achieved such tremendous repair rates through the restructuring of their maintenance system. Tank and mechanized units were allocated repair and salvage capability to ensure battleworthiness throughout the course of their operations. (5) Units were charged with carrying out routine repairs and not allowing combat vehicles to fall more than 10 km behind the formation. Corps repair facilities were not located more than 20 km from the front lines and army repair units no further back than 30 km. (6) The army also organized army repair-recovery groups (AREG) which supported subordinate echelons with recovery and repair assistance, as well as an armored equipment dump which provided Class III (in this case combat vehicles) to combat units. (7) The Soviets also emphasized preventive and organizational maintenance whenever the tactical situation permitted. (8)

A significant improvement in capability was provided with the formation in later 1943 and in 1944 of three mobile tank-assembly repair plants (PTARZ) and the formation shortly thereafter of mobile tank repair plants (PTRZ). These organizations consisted of a large number of various shops



with machine tools and other equipment, test stations, laboratories and power plants, and were placed on motor vehicle chassis and trailers. (9) This capability permitted repair and overhaul of tank engines and transmissions in the PTARZ and complete tank overhaul in the PTRZ in the field, normally 100-150 km behind combat units but often only 20 km to their rear. These units could tear down quickly (18-20 hours) and set up quickly (24-28 hours). During the war, PTARZ #7 repaired 3,000 tank engines, over 7,000 tank transmissions and about 10,000 major assemblies for other combat and tactical vehicles. (10)

The reasons the Soviets were so successful are numerous. Of primary importance was their ability to push maintenance capability forward. Within 30 km of the front lines, which today would be in a US brigade or division rear area, you could find from general support to depot level maintenance capability. This permitted rapid turn-around and sustainment of combat operations. Hand in hand with this was the concept of maintenance unit mobility, which permitted responsive maintenance during offensive operations. The Soviets also emphasized battlefield recovery. Possession of the battlefield enabled them not only to recover battle-damaged equipment and evacuate it to repair facilities, but also to deny the enemy the same opportunity. The seizing and holding of the initiative greatly enhanced maintenance operations. Finally, the Soviets recognized the need to conduct maintenance whenever the tactical situation permitted.

All of these lessons are applicable today. Mobile maintenance fosters agility, and the performance of maintenance at all levels enhances depth and contributes to initiative. The Soviets recognized that their success hinged on rapid recovery and repair of inoperative equipment.

Leaping forward twenty-eight years, the Yom Kippur War in 1973 presented us with the most recent view of a mid-intensity conflict.

Israel was attacked in the Sinai by the Egyptians and on the Golan Heights by the Syrians on October 6th. Achieving strategic surprise in the west, the Egyptians quickly crossed the Suez Canal at numerous locations and pushed tens of thousands of infantrymen across. By the end of the second day, they had pushed six to ten miles inland. (11) On the Golan, "eight hundred Syrian tanks and 25,000 mechanized infantry advanced across terrain in parade ground fashion." (12) The actual numbers of combat vehicles involved varies from source to source, but overall it appears that the Israelis had about 2,100 tanks (M60s, Centurions, M48s, M51 Shermans and between 300-400 T54s/55s captured during the 1967 war and rebuilt) (13) while the Arabs had between 3,500 and 5,000 tanks, mainly T54s and T55s. (14) Thousands of APCs, self-propelled artillery pieces and cargo trucks were also involved, as were modern anti-tank and anti-aircraft systems.

The war was extremely intense. On the Sinai front, by evening of the 7th, only 90 of 250 Israeli tanks initially deployed were operable. (15) On the Golan, by the end of the war - which lasted three weeks - the 7th Armored Brigade was left with only 7 operable tanks out of 80 authorized. (16) The Arabs lost over 2,500 tanks and thousands of armored vehicles and guns. The Israelis lost over half of their tank strength, yet the vast majority were returned to action. (17)

It was the maintenance system, plus American resupply, that kept the Israelis in the fight. On the Sinai front alone, 2,700 tanks were repaired and returned to the battle during the first ten days. (18) This means that, on average, each tank was repaired approximately three times. How was

this done? Before the smoke of battle had cleared, maintenance teams were repairing what they could on site. If it was beyond their capability to repair, it was classified and evacuated. Like-vehicle evacuation was used wherever possible to tow disabled vehicles to the nearest road, where a transporter would haul them to a forward repair facility. This facility was located far enough forward that we would consider it part of the battlefield. At these forward facilities, approximately two thirds of all damaged or worn out items were repaired and returned to action. (19) The Israelis worked 22- hour days.

Cannibalization was used extensively, especially as the war wore on. Repair teams in the division area frequently swapped "the components of two or more tanks - gun from one, turret from another, chassis from a third - often within a stone's throw of combat." (20) Gun tubes were switched out on the firing line - even swapping 175mm tubes for 203mm tubes - in three hours.

Anticipating engine losses because of severe sand, dust and heat, the Israelis stockpiled engines and track forward. Prior to the conflict, they also computed repair parts supply requirements for each type of tactical unit. These items were selected from stocks and pushed forward immediately to the rear of that formation. Contact teams would pick up the parts needed here for immediate repairs. Major secondary items such as engines and transmissions also went forward, but in limited numbers, most remaining 50-60 miles behind the front lines. (21)

The reasons for the Israeli success were both physical and moral. On the physical side, they were well trained and organized. They had preplanned Class IX (repair parts), prestocked critical items, and pushed them forward

in battle. Their battlefield recovery and repair system was extremely responsive; they were on site quickly, repairing as far forward as possible. All maintenance assets and echelons of repair were located within 100 km of the front lines, although 67% of the repairs were done forward. Cannibalization was used effectively. On the moral side, the maintenance personnel were highly motivated, hard working and ingenious.

General (Ret.) Henry Miley, former commander of Army Materiel Command, attributes their success to "Careful preplanning, superb discipline, long practice and training, and, perhaps most of all, a level of motivation almost unbelievable to the average American." (22)

As with the case of the Soviets in WWII, these lessons are especially applicable to the US Army today. Although we may not be able to generate as high a level of motivation - unless we are fighting for the continued survival of our country - combat and the desire to win have always been strong motivators of the American soldier, and, I believe, always will be. The Israelis demonstrated the importance of preplanning, prestocking and pushing forward Class IX and major assemblies. They also fixed as far forward as possible. Finally, their training enabled them to work effectively for long hours. This modern, intense conflict provided us with a great opportunity to observe the criticality of an effective maintenance system. In a three week period, Israel lost more tanks than the US produces in a year.(23) With loss rates this high, our maintenance system must be prepared to respond quickly, as it will be the main source of supply.

A comparison of the two historical examples reveals a number of imperatives. In both cases, the approach to maintenance turns out to be basically the same.

Until the latter stages of the war, the Soviets' primary source of supply of equipment was the return of repaired items through the maintenance system. The Israelis, who had no combat vehicle production capability and were greatly outnumbered, also depended on their repair capability, with their tanks, for example, being repaired a number of times. The first imperative, therefore, is that the maintenance system must be prepared to serve as the primary source of Class III resupply. This requires a tremendous preplanning effort both in organization and for provision of Class IX.

The second historical imperative is that of the necessity to conduct battlefield recovery and evacuation quickly and efficiently. The possessor of the battlefield has the advantage in this area, therefore when its title is in doubt, speed in operations is crucial. Both historical cases demonstrate the requirement for using every means available, especially like-vehicle recovery. This imperative ties in directly with the first imperative as in many cases the item must be taken to a maintenance site for repair.

Third, the ability to push maintenance capability forward is absolutely critical. In Soviet sectors one could, at times, find every level of maintenance capability from unit to depot within ten to thirty kilometers of the front lines. The Israelis used numerous contact teams and routs and conducted major repairs in locations barely protected from enemy direct fire. This forward capability reduced turn around time, thus increasing available combat power. Pushing capability forward dealt with more than just where it was done, it also concerned the level of capability. Forward capability added to the ability to conduct rapid battle-field damage

assessment and repair. The Soviets, with depot capability located close to the front, obtained rapid return of severely damaged equipment to the battle, a capability that kept their offensives moving. The ability to push maintenance capability forward is also a function of training. A high level of training enables individuals to move quickly to the correct location, and identify and correct the faults. Training fosters the growth of a team effort - working together producing synergistic effects. The Soviets achieved this, but only after three years of costly trial and error. The Israelis had trained well, and had the experience of a similar war six years prior to use as a basis of experience. Finally, tied to ability to perform forward is motivation. Both the Soviets and the Israelis were fighting for the continued existence of their nations. The individual soldier was aware of this and realized that his and his family's lives were dependent upon his success. These facts were the ultimate motivators. The ability to push maintenance forward, therefore, is a product of training, equipment, organization, and motivation.

The necessity to predetermine and prestock critical repair parts and major assemblies proves to be another historical imperative. On the Soviet western front, a tank engine was for a long time the equivalent of a tank, there always being tanks inoperative because of the lack of an engine. The Israelis used the unit-tailored prestock concept expertly, which assisted in their ability to repair 67% of the equipment at division level and below.

The final imperative is that of the conduct of preventive maintenance. The Soviets conducted maintenance inspections prior to returning to battle and conducted operator maintenance whenever the tactical situation

permitted. The Israelis kept their equipment in excellent working order prior to the conflict, with the knowledge that once a war started they would not have the time to conduct time-consuming maintenance. Equipment had to be ready from the start.

These historical imperatives should be kept in mind as we develop new maintenance and tactical doctrine.

### SECTION III. CONTEMPORARY SETTING, CURRENT AND EMERGING DOCTRINE

A significant amount of time has passed since these historical examples - forty-two years since the Soviets began their last offensives, and thirteen years since the Yom Kippur War. A determination as to what has changed since then is important, as is an appreciation of the future battlefield, so that we may continue to develop an effective maintenance doctrine.

The number of systems on the battlefield has increased significantly since the end of World War II. By the end of that war the concepts of motorization and mechanization had been accepted and there were large numbers of vehicles in armored formations. By 1973, the numbers had increased even more, and most infantry in European-styled formations were mounted in some form of transport such as the armored personnel carrier (APC) of the US Army. Today, most infantry is mechanized, most field artillery is self-propelled and almost all activities on the battlefield are conducted under armor or in some type of tactical vehicle. The J-Series MTOE for heavy divisions authorize approximately 5,000 vehicles. In addition to large numbers of vehicles, there is a proliferation of other types of equipment, especially in the areas of NBC, communications, engineering and aviation. There is a lot more to maintain today.

The second difference is in the area of sophistication. Soviet systems were generally unsophisticated at the end of WW II, and still today adhere to the philosophy of "best is the enemy of good enough". The Israelis utilized some WW II vintage equipment in 1973 - their most modern tanks being the M60 and the Centurion - while their infantry utilized the M113



APC. Today, infantrymen utilize fighting vehicles like the M2 Bradley equipped with anti-tank and large caliber small arms weapons systems and sophisticated night vision, optics and communications systems, and are under heavier armor than before. Main battle tanks are relying more heavily upon electronics - lasers, computers and electro-optics. Communications systems reach into space, as with the tactical satellite (TACSAT) and the Position Locating Reference System (PLRS). These few examples demonstrate what we find at the tactical level. Sophisticated equipment necessitates a maintenance system that can support it, and large numbers plus a wide variety of this type of equipment make maintenance more difficult.

Finally, lethality on the modern battlefield has increased. Large numbers of anti-armor systems are found from the infantry squad level on up as exemplified by the Dragon and the M2. Increasing numbers of attack helicopters exist to destroy enemy systems. Additionally, the introduction of precision-guided and highly lethal artillery ammunition such as copperhead and MLRS clearly forecasts a large workload for maintenance units in the combat zone. Also, the prospect of operating in an NBC environment has greatly increased as evidenced by continued Soviet NBC training and equipping programs. Lethality also applies to the increased threat to the rear area. Soviet doctrine for airborne, air assault and mechanized formations at division level and above specifies rear areas as primary objectives, and this is where the majority of our logistics operations take place.(1)

The three major changes - numbers, sophistication and lethality - all have a tremendous impact on a projected maintenance workload. An

appreciation for the future battlefield is also a necessity in the development of maintenance imperatives and doctrine.

A short war dictates that the capability to sustain through maintenance must be present from the start. Major assemblies and repair parts must be prestocked, thus there must be a continuous process of prestocking, analysis of required types and quantities of parts and restocking. Units must be capable of conducting operations from forward locations for extended periods of time and all levels must be capable of rapid battle damage assessment and repair (BDAR). Reserve components cannot be relied on to be present to assist in fleshing out the maintenance capability at the corps level.

In an extended conflict, there will be more time available to develop an extensive maintenance structure. The maintenance system will have to hold its own until the industrial base can produce replacement items in large quantities. The ability to sustain over an extended period requires extensive preplanning, as initial capabilities will have to support units until they are augmented by the arrival of reserve component maintenance organizations and the industrial base starts to respond. The extended scenario may not differ substantially from the short war scenario in the beginning, thus we may see high attrition at the start, with a gradual slowdown as units are worn out and it becomes obvious that no quick resolution will be obtained.

The battlefield itself, as I envision it based on my studies of the evolution of warfare, will consist of a wide variety and large numbers of sophisticated and lethal systems highly dependent upon electronics. Individuals will be equipped with more powerful weapons and sophisticated

communications devices. The aerial dimension will be utilized more heavily for both combat and support missions, and robotics will be used at all levels. Remotely piloted vehicles will be utilized in the air and on the ground to assist in gathering intelligence and in directing fire. Combat vehicles will be smaller and lighter yet have increased firepower and protection. In almost every case, electronics and computers will be of particular importance. These changes require a maintenance system that is oriented toward electronics. We will rely increasingly upon test, measurement and diagnostic equipment (TMDE), printed circuit boards (PCBs) and plug-in replacement components for diagnosis and repair.

Current maintenance doctrine can be found scattered among a number of documents, principally TRADOC Pamphlets 525-27-1 (US Army Operational Concept for Forward Support Maintenance), 525-27-2 (US Army Operational Concept for Recovery and Evacuation) and 525-27-3 (US Army Operational Concept for Three Level Maintenance). Descriptions of the performance of maintenance operations are found in numerous tactical and logistical manuals such as FM 100-5 (Operations) and FM 71-20 (Coordinating Draft (The Tank and Mechanized Infantry Battalion Task Force). The how to of conducting maintenance operations in units is described in more detail in such logistics manuals as FM 100-10 (Final Draft) (Combat Service Support and FM 63-2 (Combat Service Support Operations - Division). Our current maintenance doctrine is outlined in the following paragraphs.

The maintenance allocation chart (MAC) - a document that outlines in which maintenance operations are the responsibility of specific levels of maintenance - is the primary means units use to determine the appropriate level at which a fault should be repaired. (1.5)

Unit maintenance, the first level of maintenance, is performed by operator or crew, the company/battalion maintenance section, or organic maintenance teams deployed from the forward support battalion's maintenance company. The maintenance teams are specially trained and equipped to conduct BDAR. Repairs are made on site or in the unit trains as the tactical situation permits. If repairs are beyond the capability of the unit, it requests support from the forward support maintenance company. The maintenance support team (MST) from the maintenance company decides if the equipment is repairable on site or is to be recovered or evacuated to another maintenance location. Repair parts for the unit are maintained by means of a prescribed load list (PLL), parts listed on a mandatory stockage list (MPL) plus selected demand supported items. These parts are used to perform preventive maintenance checks and services (PMCS), scheduled services and designated mission essential maintenance only.

The second level of maintenance is intermediate maintenance and consists of two orientations - forward and rear. Intermediate forward maintenance (IFM) is performed in support of users, and its focus is on mobile support as far forward as possible, repair by replacement and maintenance of an operational readiness float (ORF). Divisional IFM units provide support to brigades and battalions, to include repair of selected high usage components for direct exchange (DX). Non-divisional IFM units conduct area support, although they may be designated to provide back-up maintenance to divisional units via mobile augmentation teams. Tasks at this level include BDA, diagnosis, fault isolation, repair by replacement, and repair of selected high usage items in support of the DEX system. This level also establishes and operates maintenance collection points (MCP) to which units

recover their unserviceable equipment for quick repair and return to them. If repairs cannot be completed there, the equipment is evacuated to a location where it can be repaired. This evacuation is coordinated among maintenance and supply and transportation units by the supporting materiel management center (MMC). Most IFM units provide Class IX direct support. Brigade/regiment IFM units maintain a combat authorized stockage list (ASL) which supports the combat units' PLLs. The division's main support battalion maintains an ASL which supports the combat ASLs of the forward maintenance companies and the parts needed by them to conduct their routine maintenance operations. Non-divisional IFM units provide Class IX support on an area basis.

Intermediate Rear Maintenance (IRM) units support the theater supply system through repair of assemblies, components and modules; DX items and PCBs; maintain an ORF; and normally are located at echelons above corps. The third level of maintenance, Depot, operates in support of the Army supply system, and, like IRM, is generally beyond the scope of this paper.

(2)

Recovery and evacuation operations in support of ground combat and combat essential support systems are characterized by six principles (3):

(1) Operators conduct self or like-vehicle recovery, units recover disabled materiel to an MCP on a main supply route (MSR), and supporting maintenance personnel clear the MSR and assist in clearing the battlefield of inoperable and/or abandoned vehicles as the situation permits.

(2) Maintenance units manage recovery assets under their control, and MMCs centrally manage evacuation requests that exceed the capabilities of any one unit, coordinating these movements with supporting movement control

centers (MMCs). Evacuation by backhaul on trucks is maximized during tactical operations.

(3) The main support battalion (MSB) provides backup support to the forward support battalions (FSB).

(4) The corps maintenance units provide area support and limited backup recovery support to supported units.

(5) Recovery assets belonging to combat units are normally positioned with the companies yet centrally managed at the battalion level.

(6) Corps and division assets are pooled, when required, to support units in contact, and returned to the parent organization as soon as possible.

The operational concept for maintenance includes four basic precepts:

(1) Mobile maintenance teams from all levels will supplement capability from higher to lower.

(2) While attempting to keep all vehicles mobile, critical repair parts may have to be obtained through controlled substitution and cannibalization.

(3) Based on decisions made by battle damage assessors assigned to MBTs, damaged equipment will be evacuated directly to the maintenance unit capable of effecting the repair.

(4) Timelines, as adjusted by tactical commanders based on the situation, will be used to guide evacuation decisions. Current guidelines are 2 hours for repair on site, 6 hours for repair at the unit maintenance collection point (UMCP), 24 hours at the IFM unit in the brigade support area (BSA), 36 hours in the division support area (DSA) and 96 hours in the IFM unit in the corps rear.

An examination of current maintenance operations as evidenced by recent National Training Center (NTC) notations and major Army exercises is useful in determining what the maintenance imperatives should be. My observations in these areas fell into the four major areas of repair parts operations, recovery and evacuation operations, operations planning, and fixing forward. Recurring problems were interpreted to indicate that those areas must be addressed by the maintenance imperatives.

The first area of analysis is that of repair parts operations. Problems identified at the NTC include the correct identification of required parts to the ordering activity and the failure to push repair parts - to include major assemblies - forward. (5) Exercise observations also reveal that a responsive repair parts system is required, and focus on the ability of maintenance units to transport the ASL. On both Reforger '85 and Reforger '86, the lack of mobility of the divisional ASL was identified as a shortcoming that limited the availability of repair parts and major assemblies. (6)

The second area is the field of recovery and evacuation. In half of the notations studied, recovery operations were ineffective due to the lack of centralized control and the inability to coordinate movement between company locations forward and the UMCP. (7) Exercise observations reveal a shortage of heavy equipment transporters (HET) in forward support units as well as the lack of comprehensive evacuation doctrine. (8) The first problem is severe in that it lengthens the time inoperative equipment is out of the repair system - thus the battle - and forces maneuver and maintenance units to utilize their limited recovery assets to assist in evacuation operations, thus keeping them away from their intended missions.

Efficient conduct of recovery and evacuation operations is crucial to the success of battlefield maintenance.

The third area is the planning of tactical maintenance operations. In nearly every NTC rotation, neither the battalion maintenance officer (BMO) nor the battalion maintenance technician (BMT) were involved in planning unit operations, nor were battalion maintenance operations themselves well planned. Maintenance sites, management of maintenance operations at those sites, UMCP security and recovery operations were poorly managed and were further indicators of poor planning. (9) Center for Army Lessons Learned (CALL) observations also support the requirement for maintenance planning, especially in the area of coordinating higher echelon maintenance teams operating at lower echelons and command and control of units' MSTs. (10) Without the ability to plan, maintenance operations will not be able to support the fast paced, intense modern battlefield, as our historical imperatives dictate.

The final area is the ability to support forward - another historical imperative. Exercise observations reveal that there are some problems with MSTs - inadequate numbers of radios authorized for communication, command and control, inadequate numbers of MSTs themselves, and MSTs otherwise improperly equipped. (11)

These four areas are key aspects in the development of tactical maintenance imperatives.

The final aspect of our contemporary setting which must be examined is that of emerging doctrine. Emerging doctrine is being driven by the bottom line - dollars. Dollars, in turn, drive the active force troop ceiling as well as the procurement and operations budgets. A fixed troop ceiling under



which more missions must be accomplished - such as the manning of the new divisions - means that in order to provide adequate combat forces, combat service support units must absorb manpower cuts. Maintenance units must therefore do more with less manpower, and this is a major determinant in the structure of the future maintenance system (12).

Several aspects of emerging doctrine are clear today. The first aspect is the nature of maintenance operations in tactical units. Equipment will be repaired quickly as far forward as possible through extensive use of on-board built in test equipment (BITE), the pushing forward of well trained, well equipped, tailored MSTs and by repair through component/assembly/part replacement. "Equipment /component design will support the following maintenance priorities: first, discard at failure, second, repair forward by replacement, and third, evacuate for repair." (13) The concept of minimum essential maintenance only (MEMO) will be used in battle - maintenance only to return the equipment to mission capable status. After the battle, the remaining faults will be corrected. Additionally, much greater emphasis will be placed on operating in an NBC environment.

The second aspect is the increased use of electronics in systems to diagnose faults, and the use of computers in the maintenance management process. The extensive use of electronics will reduce the number of repair parts, thus contributing to mobility, and will shorten the amount of time needed to diagnose failure and effect repair. The use of computers within systems and by maintenance units at all levels will facilitate repair parts ordering, assist in monitoring readiness and maintenance problems, and will be the major tool in coordinating all maintenance activities. (14)

Thirdly, forward repair will be facilitated through the provision of pre-assembled assemblies such as the roadwheel arm assembly and full up power packs (FUPP) to units. Use of these items will reduce the time it takes to repair vehicles inoperable because of transmissions, engines, transfers, and other assemblies requiring extensive time to put together. (15)

Finally, a significant increase in maintenance training for mechanics, maintenance supervisors, and maintenance officers will be forthcoming to compensate for the increased number of sophisticated systems and the anticipated fast pace of maintenance operations on the future battlefield. (16) Master diagnosticians and technical inspectors trained in BDAR will be key personnel in the maintenance structure. (17)

Emerging maintenance doctrine appears to be extremely well thought out, is comprehensive, and, if authorized and funded, will well provide the appropriate direction for maintenance activities and support to sustain maintenance imperatives.

#### SECTION IV. TACTICAL MAINTENANCE REQUIREMENTS

As previously stated, the Army will not be able to replace damaged and destroyed equipment on the modern battlefield through new production if the war lasts less than a year. To support ALB, the maintenance system must be capable of rapid repair and return of equipment to the user.

There are a number of factors which influence the Army's ability to provide the forward maintenance required by ALB and as such constitute the requirements of a responsive system.

The first requirement is the ability to fix forward. Battle damage assessment and repair is crucial. To accomplish BDMR, technicians must be well trained and equipped, to include state-of-the-art TME. In order to focus the maintenance effort, tactical commanders must prioritize equipment to be repaired during the battle prior to its commencement and notify the appropriate agency of any changes during the battle. Training for the conduct of forward maintenance must focus on the MEMO concept. (1)

The second requirement is the ability to provide responsive repair parts support. Units must have a PLL that supports their combat operations, and the ASLs that support the units must be mobile, support the PLLs and the direct support maintenance units requirements, and include PUPPs and critical preassembled assemblies and components. A responsive D system is required to support combat operations as well. Although an ORF is a good concept, the intensity of the battlefield will quickly eliminate it as a major factor. Finally, controlled exchange and cannibalization must be used effectively and extensively as a major source of repair parts. (2)

Third, recovery and evacuation operations must be performed rapidly and tightly controlled and coordinated at all levels. With damaged equipment serving as the major source of resupply and a key source of repair parts, battlefield recovery and evacuation serves as the means of moving the equipment to the repair site and is thus a critical step in the repair process. "Probability statistics predict, and the Middle East experience bears this out, that three operable systems can be made from every five disabled ones. In a 1,000 tank force with a loss rate of 100 tanks per day, without recovery and evacuation, the force is annihilated in ten days. With a system that can return three of five, at the end of ten days, there are still 600 operable systems." (3) Additionally, soldiers must be trained and vehicles equipped for self and like vehicle recovery.

The fourth requirement is the ability to command, control and communicate. This concept also includes the ability to conduct effective planning in limited time. Planning determines the organization of maintenance assets in support of tactical operations, establishes priorities, and assists in preparing for subsequent operations. Operating within the commander's intent, actions take place which sustain the battle, and a combined arms effort must be achieved if we are to be successful. A critical factor in this effort is the responsiveness of the maintenance system to the tactical situation. Communications must be maintained between supported and supporting units as well as among the various components of the maintenance system such as recovery and evacuation teams, MSTs and BDAR teams. Planning is the basis for success, with command, control and communications permitting its implementation in all theaters of operations.

Fifth, maintenance units must be mobile. At division level and below, maintenance units must be 100% mobile, to include the ASL. MSTs that operate with the maneuver units must be equipped with armored maintenance vehicles so that they have the same mobility as the units they support.<sup>(4)</sup> Other MSTs must have the ability to move quickly around the battlefield to conduct BDAR. All maintenance units must have the proper communications equipment to allow them to respond quickly to the situation.

The sixth requirement is that maintenance units must be capable of operating in an NBC environment and at night. "The Soviets do not perceive clear delineations between conventional, chemical and nuclear warfare. It is possible that chemical weapons will be used early in an operation or from its onset."<sup>(5)</sup> Additionally, the rapid and intense pace of the battle means that units will be operating twenty-four hours a day. The requirement for nighttime operations means that maintenance units will require the capability to work under some type of protection that permits use of lights.

The Air Force is investigating collective protection shelters for maintenance operations,<sup>(6)</sup> and so must the Army if we are to sustain the battle. In some instances, operating in MOPP 4 degrades maintenance capability by a factor of five.<sup>(7)</sup> Utilizing fixed facilities in a built up area will help reduce the signature of heat and light and assist in NBC protection; however, some type of lightweight, portable shelter that can also accommodate heavy lifting equipment must be made available.

The final requirement is that of the development of an increased tactical capability for maintenance units. The threat to our rear area has

become more pronounced, as previously mentioned. Maintenance units must be able to defend themselves against partisans and small enemy units, thus require heavier weapons than currently authorized as well as greater knowledge and training in defensive operations. Maintenance leaders must be able to monitor and understand what is happening in the battle so as to anticipate maintenance requirements. General Galvin points out that "The logistician must be a tactician with a keen ability to sense the flow of the battle", and that logistics units will be doing more fighting than ever before. (8)

These are the requirements that our current AirLand Battle doctrine demands of our tactical maintenance units in order to sustain the modern battle.

AirLand Battle doctrine, however, is not theater unique. The US Army has no guarantee that it will fight its next battles in Europe, and that is why we have a number of OPLANs which cover various contingencies throughout the world. The theater we operate in has major implications for the type of maintenance support that needs to be provided, yet few logistics doctrinal publications more than acknowledge the obvious differences.

Field Manual 100-5 (Operations) clearly recognizes the difference among theaters and devotes a full page to the concept as well as three pages to special environments. On the other hand, FM 100-10 (Combat Service Support) mainly addresses contingency planning when considering non-routine support, and caveats the planning process by stating that the "principles set forth ...can apply as well to military operations anywhere in the world." (9) FM 63-2 (Combat Service Support Operations - Division) indicates that by

exhibiting responsiveness, flexibility and initiative, we can support anywhere in the world. (10)

Maintenance operations are directly influenced by the various physical aspects associated with different theaters of operation, particularly terrain, climate, lines of communication and host nation support (HNS). Whereas Europe closely resembles the United States in almost every respect, other theaters are vastly different - Southwest Asia being an excellent example. The terrain is desert in many locations, rocky and mountainous in others. These factors dictate that there will be numerous suspension problems. The abundance of places for combat vehicles to hide indicates that there will be a large number of turrets hit by direct fire. Vehicles will bog down in the sand, thus recovery will be a major requirement. The climate is hot, with blowing dust and sand. This translates to a lot of engine problems - cooling and air filtration - and associated repair parts, such as filters and coolant. Lines of communication are very limited. Roads are few and of generally poor quality. This, combined with few major ports and airfields, imposes restrictions on vehicular flow, thus effecting resupply and evacuation rates. The distances from our sustaining bases in the US and West Germany are extremely long. By air, for example, it is, from Bonn: to Cairo and Tel Aviv about 2,100 miles; to Riyadh about 2,900 miles; and to Muscat about 3,500 miles. The theater itself is huge, and internal lines of communication would be much greater than in Europe. (11) Fixed facilities are limited, as is water. Finally, Host Nation Support is extremely limited, as there are no major industries and a lack of heavy equipment transportation assets.

Other theaters offer contrasting requirements. In Korea, rugged mountain ranges and very bitter winters have maintenance implications, as do the jungles, heat and humidity and poor lines of communication in Central America. Maintenance doctrine must make provision for influences of the theater, as does FM 100-5, not just address it in specific how to fight manuals, or write it off under the guise of "we'll make it work". Although the theater influences doctrine, it does not influence the maintenance imperatives. We must be able to accomplish the maintenance mission effectively any place and at any time. The requirements outline how we go about it, whereas the doctrine tells us more specifically what to do.

We must now determine if historical imperatives, the requirements to support the future battle, and the requirements of supporting ALB coincide. For means of comparison, I will utilize the requirements of tactical maintenance support of ALB.

The first requirement is the ability to fix forward. Both the Soviets and the Israelis considered this crucial to the success of the battle. They realized that they could not afford extended repair times, and utilized mobile, forward capabilities to secure rapid repair and return. The increasing lethality and sophistication also dictates that fix forward will continue to be critical. This requirement is common to all three elements of comparison.

The second requirement, responsive supply support, also is common to the three elements. The Soviets formed repair parts units and pushed them forward. The Israelis developed repair parts packages tailored for specific



units. Additionally, the developing trend of fixing forward by replacement dictates the requirement of a responsive supply system.

Third, immediate recovery and evacuation was appreciated and practiced by both the Soviets and Israelis. Distances required to be covered were reduced by locating maintenance units forward. Increased numbers of systems on the battlefield of the future, plus the length of time it would take to gear up the industrial base confirms the requirement of the maintenance system to serve as the primary source of supply of equipment, thus, this equipment must first arrive at the repair site before the repairs can begin.

The next requirement is one which has always been a problem, and most certainly will continue to be - the requirement for effective command, control and communication. The Soviets had to implement an extensive system of couriers and designated maintenance units to patrol roads looking for business.(12) The Israelis established a straggler line to the rear of the combat area where equipment could be recovered to. (13) HUE today, and in the future requires maintenance units equipped with adequate radios and highly trained, well equipped units to respond rapidly to the fast paced, changing tactical situation. This includes the growing requirement to be able to defend themselves. (14)

The fifth requirement, mobility, was, is and will be crucial to successful tactical maintenance operations. Soviet maintenance units were motorized, to include numerous depot activities. Today, Soviet tactical maintenance operations are 100% mobile.(15) Israeli pushing of maintenance teams and repair parts forward indicates their belief in mobility. Our

ability to support ALB today and in the future depends on our mobility on the battlefield, thus all three elements are in accord. (16)

Finally, the ability to operate at night and in an NBC environment have only been partially demonstrated historically. Both the Soviets and the Israelis worked continuously during intense combat, however the optics and night vision capabilities that exist now and will in the future dictate the requirement to operate in a mode secure from observation. The NBC aspect is one that we must prepare for given the Soviet capabilities, and this preparation requires proper training and equipment.

The differences that exist among historical imperatives and current ALB requirements, as well as what will be required in the future, are almost non-existent.

## SECTION 5. CONCLUSIONS AND IMPLICATIONS

Based upon historical imperatives, the requirements of supporting ALB, and the maintenance needs of the future battlefield, I have concluded that the six imperatives of tactical level tank-automotive maintenance operations are: Fix forward; Provide responsive repair parts support; Conduct responsive recovery and evacuation operations; Establish and maintain effective command, control and communications capabilities among maintenance elements and with supported and supporting tactical and logistical organizations; Secure a 100% mobility capability for all maintenance elements that provide support forward; and Develop the capability to operate in an NBC environment and at night.

During the conduct of my research, several other issues have come to light which, although beyond the scope of this paper, are directly related to the conduct of maintenance at the tactical level. Even though current and emerging doctrine do support the tenets of ALB, the following issues still need to be examined by the maintenance community and HQDA as well.

"Modern weapons systems require: special tools, special parts, specially trained mechanics, special documentation, special technical assistance, and test, measurement and diagnostic equipment." (1) The Army and the maintenance community must keep this in mind as they make force structure and procurement decisions.

General Galvin rightly believes that "Tooth to tail is a magnificently effective image, but it conveys a vastly oversimplified and dangerous concept for logistics." (2) While we seek to increase combat strength, we are counting on productivity gains and the transferring of logistics

functions to the reserve components - with selected reserve units being moved higher on certain TPFDLs (Time Phased Troop Deployment List) - to provide the correct level of support and not lose any logistical capability. (3) These concepts must be scrutinized very carefully. The Army must determine the 'how' to do more with fewer people, and fund that 'how', before spaces are removed from active component logistical units. I fear that this has not been done adequately.

The ability to fix forward is currently limited by force structure and equipment authorization, and this disparity will continue as long as we operate in an environment of constrained resources. Responsive supply support reveals some minor discrepancies - some dealing with funding, the remainder operational. Tactical maintenance units must be able to provide parts quickly, thus using units must have the capability rapidly to identify the required parts correctly and transmit them quickly to the supporting repair parts supplier. Maintenance units must have prestocked the correct parts, to include FUPPs and assemblies. The operational aspect involves the provision of historical repair parts consumption data to maintenance planners. This data must be developed in order to permit planners to anticipate requirements. The command, control and communication requirement is similar to that of supply support. Adequate equipment must be authorized to enhance the activities of BDAR, MSTs, MCPs and recovery and evacuation, as well as to monitor the current tactical situation - all of which occur simultaneously. Equipment must also provide the means for mobile operations, at night, and in an NBC environment. The maintenance community must quantify the minimum requirements to accomplish this forward maintenance mission, in various theaters, under varying intensities of

conflict. The Army must be made aware of these personnel and equipment requirements, and realize that there is a cost which must be paid in order to realize the tactical maintenance imperatives.

The second issue is one that concerns the human dimension of command, control and communication - training and morale. Our most recent experience under extended combat conditions - Vietnam- indicated that some maintenance units subjected to even short periods of indirect fire may have a problem maintaining productivity. Maintaining productivity under extended, intense combat conditions is something that maintenance training must emphasize.

(4) We must train in the areas of NBC, MEMO, BDAR, cannibalization and controlled substitution, and at night.

LTG David Elazar of the Israeli Army believes that quality in an army is a function of three factors: the will to fight, a sense of nationality and cultural/technological sophistication, and its efficiency, organization, training, specialization, discipline and the ability of its commanders. (5) For quality maintenance, these aspects of the human dimension must be incorporated into maintenance doctrine. It is also my belief that through focusing on these issues, a high level of morale will be a by-product.

The third issue concerns the imperative of fixing forward, specifically our increasing reliance on electronics, an issue of primary concern to the maintenance community. TMDE is becoming more crucial as this dependence grows, and I question the adequacy of TMDE units as currently structured, to support forward. (6) We also must "increase the experience level of our electronic maintenance personnel, structure more generic MOS, and procure equipment that is designed to be supportable within the manpower, quality, and quantity constraints" (7) currently imposed by force authorization

documents. Further complicating this is the fact that some TMDE used at intermediate DS and GS units is outdated. (8) This ties in directly with the cost of fixing forward of which DA must be aware. Finally, the effects of EMP must be considered in the development of hardened tank-automotive equipment and a hardened storage capability for electronic repair parts and components. (9)

The final area of concern, and perhaps the most important, pertains to the Army at large. It is the imperative of command, control and communication, and specifically concerns command involvement in maintenance. Quoting General Galvin again, "He who carries the saber must also carry a wrench." (10) Commanders at all levels and of all types of units - to include maintenance units - must involve themselves in preventive and corrective maintenance. It must be emphasized in peacetime so that it will be conducted properly in combat. The practices of the Israeli Army are useful in this area. Maintenance is one of the highest priorities of any unit and is the top priority in armored units. In these units, the maintenance officer attends all staff meetings at all levels, and the maintenance officer holds the same rank as the senior logistics primary staff officer. The maintenance officer also assists in development of operational plans. Preventive maintenance is conducted faithfully, to include daily in combat. Also, to place it in perspective, if maintenance faults are detected which could have life-threatening consequences, an investigation is conducted which can result in prison sentences and/or relief - to include the commander and the maintenance officer. The successful performance of the Israelis in combat is in no small manner related to the importance they place on maintenance. (11)

The tactical commander must also be aware of the importance of maintenance to the sustainment of combat power, and consider the maintenance imperatives in the planning and execution of tactical operations.

These four issues can be reconciled with the maintenance imperatives only by a concerted effort of the Army's and the maintenance community's leadership. Current and emerging doctrine is sound and forward-looking. "The US Army Operational Concept for Forward Support Maintenance in the AirLand Battle", prepared by the Ordnance Center, and DA Pamphlet 700-xxx, "Maintenance - Preparing for the 21st Century" prepared by the Office of the DCSLOG, are excellent works and clearly address the majority of the maintenance needs of a modern army. Our basic requirements are twofold. First, the maintenance community must determine and clearly articulate its personnel and equipment needs to support the future battle. Secondly, the Army must examine those requirements and determine what sort of capability it wants at the tactical level. There is no cheap solution, as both highly trained personnel and sophisticated equipment are required in order to provide forward maintenance. To put this into perspective, there will be no battlefield success without forward maintenance, and the US Army needs to recognize this.

Historically, countries fighting intense combat for national survival have recognized the requirement for forward maintenance. We have the right doctrine. The imperatives are clear. The US Army must now respond appropriately to the requirements of tactical maintenance or risk failure on the modern battlefield.

## APPENDIX A

### DEFINITIONS AND CONCEPTS



## DEFINITIONS (1)

**Active Repair Time.** The time during which one or more technicians are working on an item to effect repair.

**Automatic Test Equipment.** Equipment which carries out a predetermined program of testing for possible malfunction without reliance on human intervention.

**Battle Damage Assessment.** The process of determining the extent of battle damage in order to decide whether to repair, recover, cannibalize or evacuate.

**Cannibalization.** Authorized removal of serviceable or economically repairable parts, components, and assemblies from unserviceable, uneconomically repairable or excess end items to support supply and direct exchange operations, or for immediate reuse in restoring another item of equipment to a combat operable/serviceable condition. In peacetime, only maintenance units may perform cannibalization, while in wartime, the policy is established by higher headquarters.

**Controlled Exchange.** Removal of serviceable parts, components, assemblies, and subassemblies from unserviceable, economically repairable equipment for immediate reuse in restoring another item to a combat operable/serviceable condition. When possible, the mobility of vehicles from which parts are removed is maintained. Controlled exchange is performed by all levels of maintenance, under guidelines established by higher headquarters.

**Connective Maintenance.** That maintenance performed to restore an item to a satisfactory condition by providing correction of a malfunction which

has caused degradation of the item below specified performance.

**Evacuation.** The removal of equipment from the battle area to a point where it can be repaired. This action is coordinated among supply, maintenance and transportation elements.

**Forward Support Maintenance.** Maintenance oriented toward quick turnaround to the user in order to maximize combat time by minimizing repair and evacuation time. A thrust to repair items as far forward within tactical time criteria, or to recover and evacuate to the point where repair can be accomplished.

**Major Maintenance Tasks.** Inspection, replenishing consumable parts, troubleshooting, removal, removal and replacement, removal and reinstallation, repair, adjustment/alignment, calibration, functional testing, refurbishing, and conditioning.

**Maintainability.** A characteristic of design and installation which is expressed as the probability that an item will conform to specified conditions within a given period of time when maintenance action is performed in accordance with prescribed procedures and resources.

**Maintenance.** All actions necessary for retaining an item in or restoring it to, a serviceable/operable condition. Maintenance includes servicing, repair, modification, modernization, overhaul, inspection, and condition determination.

**Maintenance Collection Point.** A point operated by organizational, divisional or corps maintenance units for collecting equipment for repair, controlled exchange, cannibalization or evacuation.

**Maintenance Guidelines.** Criteria established by maintenance commanders on which maintenance priorities are established. Maintenance guidelines

are based on the tactical situation, criticality of equipment type and extent of repairs required, time and resources available, in accordance with priorities established by the force commander.

**Maintenance Sequence.** Detect, locate and isolate, repair remove and replace/remove and repair/reinstall, adjust/align and calibrate, and test.

**Major Assembly.** An assembled, major powertrain component. Examples are engines, transfers and transmissions.

**Prescribed Load List (PLL).** Those repair parts and other maintenance related items required to perform authorized unit maintenance tasks. The PLL includes those items designated as combat PLL items - combat essential repair parts necessary to sustain a unit during its initial entry into combat. Under combat conditions, non-combat essential parts, such as those required for peacetime legal or safety requirements, and those used for comfort or cosmetic purposes, will be evacuated or left behind. The PLLs of the companies of a battalion may be colocated for ease and efficiency of management.

**Productivity.** Efficiency of work, facility in producing output.

**Recovery.** A unit responsibility involving the retrieval of immobile, inoperative or abandoned materiel from the effects of direct fire or other hazards - e.g. contamination - and its movement to an MCP, the MSR, or a forward maintenance site for disposition, repair or evacuation. Recovery operations include self recovery, recovery by a similar or another type of vehicle, recovery by specialized recovery equipment, and recovery by supporting maintenance units.

**Repair.** The process of returning an item to a specified condition,

including preparation, fault isolation, item procurement, fault correction, adjustment, calibration and testing.

Repairability. The capability of an item to be repaired.

Test, Measurement and Diagnostic Equipment (TMDE). Equipment used to locate and/or isolate malfunctions, measure mechanical/hydraulic/electrical performance and determine deviance from prescribed standards.

Troubleshooting. The process of investigating and determining the cause of an equipment malfunction by means of systematic checking or analysis.

CONCEPTS (2)

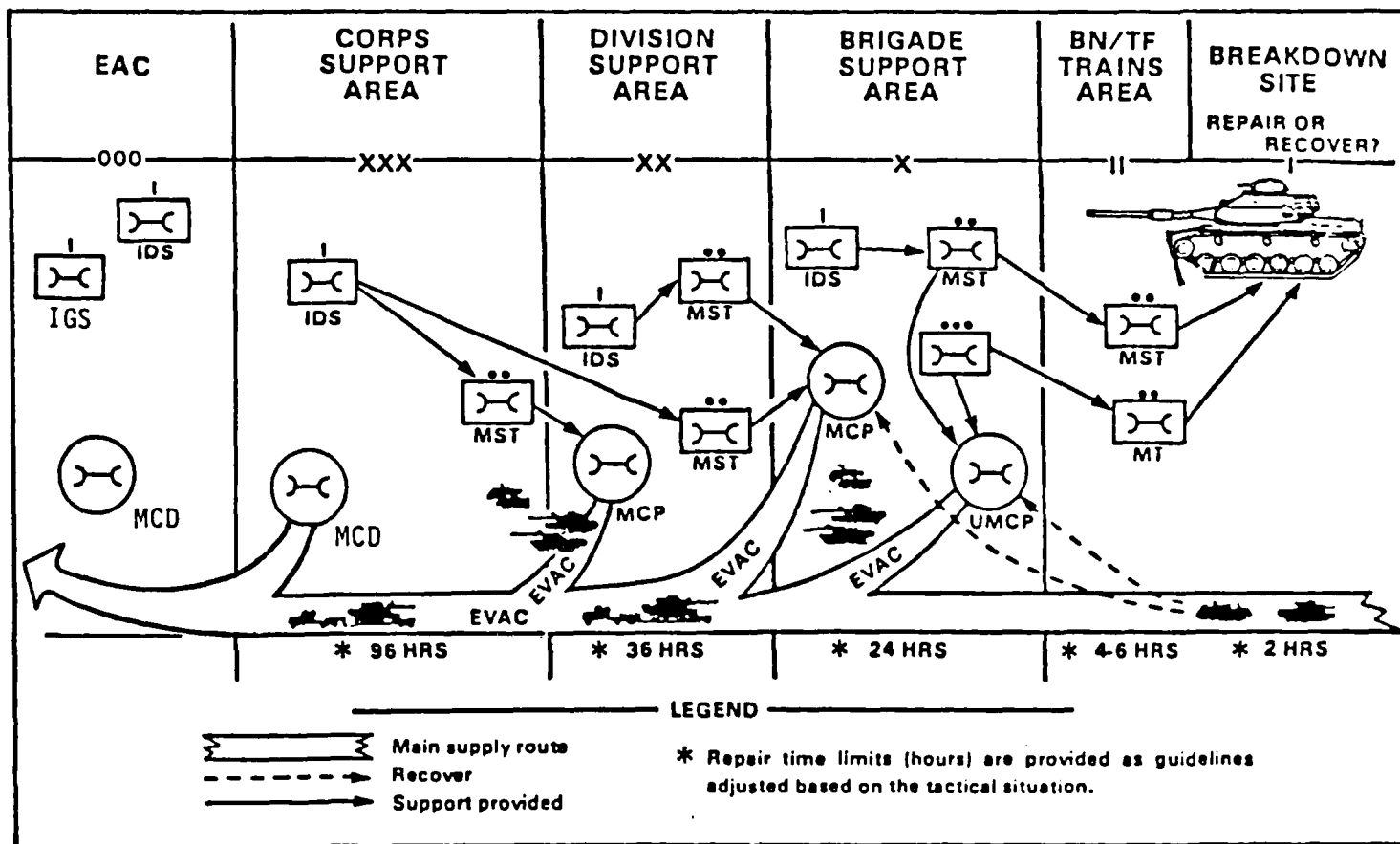


Figure 1. Maintenance Support in the Theater

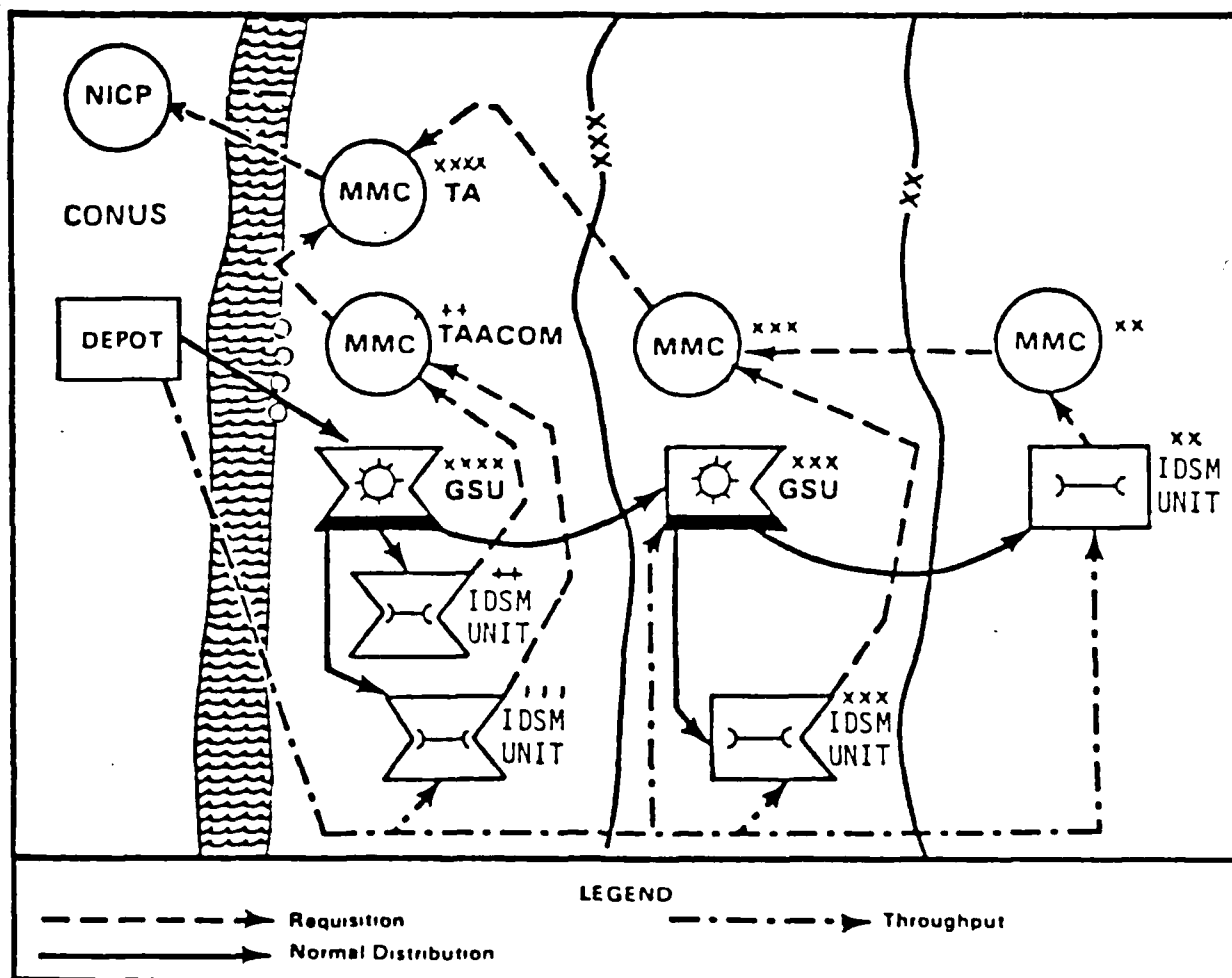


Figure 2. Requisition and Supply Flow of Class IX in Support of ALOC Units in War and Peacetime

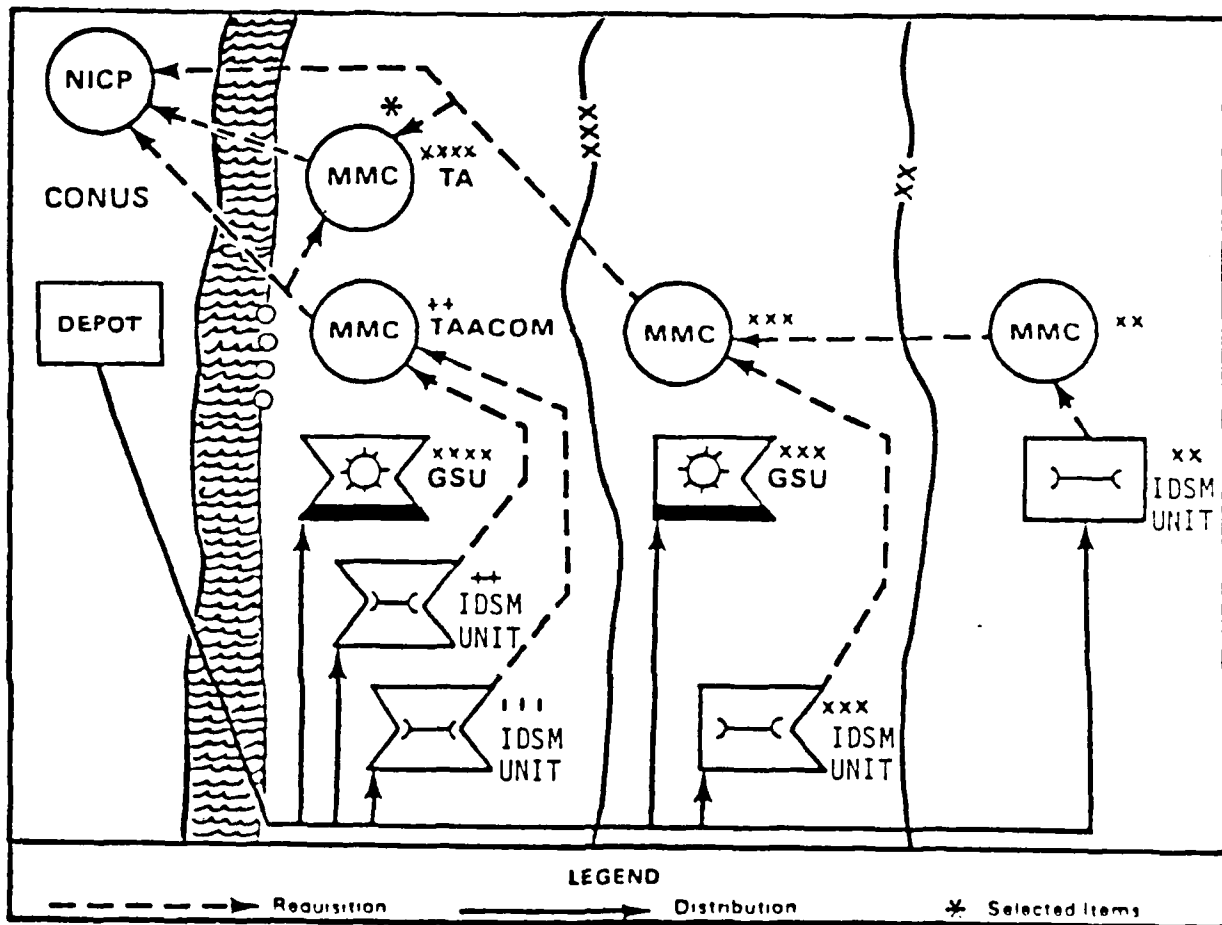


Figure 3. Requisition and Supply Flow of Non-ALOC Delivered Class IX in Wartime



## ENDNOTES

## SECTION 1.

1. Dr. Azriel Lorber, "Technological Education for Field Commanders", Ma'anachot, pp 224-225.
2. John A. English, On Infantry, p 218.
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#### APPENDIX A

1. Terms listed are a compilation of definitions and my modifications of definitions from the following sources:

Appendix A, US Army Operational Concept for Maintenance Support to the Deep Maneuver in the AirLand Battle:

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2. The three concept diagrams are from FM 100-10 (DRAFT).

Figure 1: p 7-3.1

Figure 2: p 5-36.2

Figure 3: p 5-36.1

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