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# Fueling The Force:

## Can The Division Support Command (DISCOM) Provide Sufficient Petroleum Support To Sustain A Heavy Division In The Offense?

A Monograph
by

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This monograph examines the problem of providing fuel support in the heavy division during offensive operations. The study recognizes the important role of fuel support in the generation and sustainment of combat power. Yet, it also recognizes that sustainment systems have not kept pace with advances in combat systems. The study posits that the heavy division's support command (DISCOM) does not have sufficient organic fuel support capability to sustain the division during offensive operations.

The investigation includes a study of the WWII armored division and its fuel support concepts. It examines the implementation of these concepts during the 6th Armored Division's offensive in the Brittany Peninsula. Similarly, the monograph explores the modern heavy division's fuel support concepts and its execution during Operation Desert Storm. Both experiences revealed a shortfall in fuel support capability due to insufficient equipment and inadequate support concepts.

Using an offensive scenario and published planning factors, a mathematical analysis is conducted to compare fuel support capabilities against requirements. The study shows that the division requires an additional eighty-nine 5000 gallon tankers to support the scenario's fuel requirements. By displacing fuel tankers to intermediate supply points this shortfall is reduced to fifty-four tankers.

The monograph concludes that the DISCOM does not have sufficient organic fuel support capability to sustain a heavy division. This capability shortfall can be mitigated through better anticipation, integration and improvisation. As a more permanent solution, the study recommends improving fuel support capability by (1) authorizing more fuel tankers, (2) using technology to improve fuel support equipment and reduce fuel requirements, and (3) making use of alternative fuel sources.

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Table of Contents

# I. INTRODUCTION

> Before the fighting proper, the battle is fought and decided by the Quartermasters.[1]
>
> Field Marshal Erwin Rommel

To win battles and engagements, current and future U.S. Army warfighting doctrine requires the creation of combat power at the decisive place and time. Field Manual 100-5, Operations, describes combat power as the "effect created by combining maneuver, firepower, protection, and leadership in combat actions against an enemy in war."[2] These four elements are not only part of our current AirLand Battle doctrine, but are expected to remain key components of combat power in emerging doctrine, known as AirLand Operations. To complement its doctrine, the U.S. Army has made a concentrated effort to enhance combat power by fielding a new generation of combat systems. Weapon systems like the M1 Abrams tank and M2/M3 Bradley fighting vehicle enhance maneuver, firepower, and protection through increased mobility, enhanced lethality, and improved armor.

While the fighting system itself is often viewed as the "symbol" of combat power, sustainment of the system also plays an important role in the combat power equation. Sustainment's role in the creation of combat power was probably best expressed by Field Marshall Rommel when he said:

> The bravest man can do nothing without guns, the guns nothing without plenty of ammunition and guns and ammunition are of little use in mobile warfare unless they can be transported by vehicles supplied with sufficient petroleum.[3]

Rommel's statement reflects an understanding that generation of combat power depends on an adequate supply system. Moreover, it establishes a relationship between sustainment functions. While support of firepower through the supply of guns and ammunition is clearly important, the baseline and primary sustainment function in maneuver warfare is fueling. In short, firepower without the means to move the guns and ammunition is of little use in a mechanized and mobile environment.

Today, heavy mechanized forces rely on fuel to provide the mobility necessary to generate combat power. To this end, the logistician must ensure that the petroleum supply system can adequately support the force. Unfortunately, the army's zeal to produce new fighting vehicles has not been matched by development of new sustainment systems. This has left logisticians with a perplexing dilemma: how to sustain new combat systems with non-modernized support equipment that in many cases is older than the soldiers who operate it.[4] Viewed from a doctrinal perspective logisticians have to sustain fighting systems designed for AirLand Battle with logistic equipment intended to support the Active Defense doctrine of the 1970's.[5]

Not only is support equipment not modernized, but new combat systems have greatly increased fuel requirements. For example, the M1 Abrams tank consumes 53% more fuel when idling than its predecessor, the M60 tank.[6] When operated cross country and on secondary roads the M2/M3 fighting vehicles use 17% more fuel than the M113 personnel carriers they replaced.[7] Overall, the M1, M2 and M3 combat systems consume 47% of the heavy division's total fuel requirements.[8]

To sustain these new fighting systems, with their increased fuel requirements, armor battalions are authorized the new 2,500 gallon heavy expanded mobility tactical truck or HEMTT.[9] Mechanized infantry battalions are now transitioning from the older tank and pump unit (TPU) to the new HEMTT tanker.[10] Yet the Division Support Command (DISCOM) still employs the 5000 gallon fuel tanker and 60,000 gallon fuel system supply point (FSSF) that once supported older combat systems. The impact of introducing new combat systems without improvement in the DISCOM's support equipment may mean that the U.S. Army's capability to fuel the force is actually less than it was before modernization.

Sustaining an offense, given an increased consumption of fuel, ever changing unit locations and lengthened supply lines, places unique challenges on the petroleum supply system.[11] The theoretical foundation for these challenges is grounded in Antoine Henri Jomini's concept of line of operations and communications.[12]

A key component of this theory is the "base of operations," which is defined as the portion of the country from which the army receives its support.[13] The line of communications connects the army with its base of operations and supports the movement of supplies, reinforcements, and other logistic assets.[14] In offensive operations, the line of communications is usually lengthened, placing the army at a greater distance from its base of operations. Conversely, during a retreat the distance between the force and its base is decreased. By shortening its line of communications, a retreating or defending army can quickly concentrate combat power; while the extension of its line of communications tends to dissipate an attacker's combat power. Field Marshall Rommel notes this effect when he writes:

> The further the enemy advances and the longer his supply route becomes, the more troops he must leave behind if he is to be able to maintain himself. During an advance the supply route is lengthened, during a retreat it is shortened. The retreating army always has its strength concentrated.[15]

Both theory and practice support the notion that offensive operations place a heavy burden on the capabilities of the petroleum supply and distribution system. As such, the purpose of this monograph is to determine the DISCOM's ability to sustain the heavy division with fuel during offensive operations. The working hypothesis is that the DISCOM cannot adequately sustain division-level offensive operations with

organic fuel assets. The authorized systems do not provide the mobility, flexibility nor capacity to support a sustained offense as envisioned by present AirLand Battle or emerging AirLand Operations doctrine.

To provide a historical perspective, this paper examines the World War II (WWII) armored division -- its mission, organization, and support concepts. The paper then focuses on fuel support of the 6th Armored Division during its offensive in the Brittany Peninsula. This is followed by a review of the mission, organization and support concepts of today's heavy division. To examine the execution of today's fuel support concepts, this paper focuses on the experiences of the 1st Infantry Division (Mechanized) and 3rd Armored Division during Operation Desert Storm. Emerging logistics doctrine is briefly examined to highlight any significant changes expected in the fuel support arena.

Through an offensive scenario and mathematical analysis, this monograph compares the heavy division's fuel requirements with the DISCOM's fuel support capability. The results of this comparison determine the DISCOM's capability to support the heavy division with fuel. The monograph concludes by assessing the impact of limited fuel support capability on the sustainment imperatives of anticipation, integration and improvisation and addresses implications for petroleum support of the heavy division.

To understand the present it is often wise to examine the past. As such, the next section addresses the World War II

armored division, setting the stage for an in-depth examination of fuel support during the 6th Armored Division's operations in Brittany.

## II. THE WORLD WAR II ARMORED DIVISION

### MISSION AND ORGANIZATION

The primary mission of the World War II armored division was "offensive operations against hostile rear areas."[16] The armored division's chief characteristics were high mobility, protected firepower, and shock. The division was especially suited for missions such as exploitation; deep penetration into enemy territory; and the destruction of soft targets such as enemy supply and communications facilities.[17]

Two basic types of armored divisions were employed in World War II, the "heavy" division organized under a 1942 table of organization (T/O) and the "light" division organized under a 1943 T/O.[18] Both divisions employed two combat commands, A and B, while the "light" armored division also had a small reserve combat command. Each combat command was a tailored organization that contained both tank and armored infantry battalions.[19] The major difference between the two type divisions were the number of tanks and personnel. The "heavy" division employed 390 tanks and 14,007 personnel, while the "light" armored division employed 263 tanks and 11,029 personnel.[20]

Another significant difference between the two organizations was the lack of a supply battalion in the "light" armored division. The supply battalion, as it existed in the "heavy" armored division, supported with two truck companies containing a total of ninety-six 2 1/2 ton cargo trucks and an equal number of one ton trailers.[21] These trucks and trailers could carry up to 336 tons of critical supplies; giving a "heavy" armored division the capability to sustain itself for up to 250 miles beyond the nearest supply point.[22]

When the question of a supply battalion was raised during the development of the "light" armored division's organization, General George S. Patton Jr., then in North Africa, made the following comment:

> Unquestionably, our original concept that we needed 250 miles of rolling supplies is erroneous. In the fighting we are now having, and did have, you were damn lucky if you go forward three miles a day. When a breakthrough occurs you can always steal enough trucks from corps or army to give you the additional rolling reserve.[23]

This attitude helped convince force developers that the "heavy" armored division was oversupplied and reinforced the belief that the supply battalion was not needed in the "light" armored division. The 1943 T/O deleted the supply battalion and by August 1944 the only "heavy" armored divisions remaining in the force were the 2nd and 3rd, all others were configured as "light" organizations.[24]

LOGISTIC SUPPORT CONCEPTS

Except for the supply battalion, logistical support for both type armored divisions was almost identical. At battalion level, support elements were found in the unit trains. The unit trains were usually divided into "A" and "B" trains.[25] The "A" trains accompanied combat elements and contained essential supplies like fuel and ammunition and critical services such as medical and maintenance. The "B" trains consisted of mess, ration and personnel sections, as well as supply and maintenance personnel not required for the operation. The "B" trains were usually grouped together and attached to the division trains.[26]

The division trains were an organic element of the armored division and contained a headquarters and headquarters company, a maintenance battalion, a medical battalion, a military police platoon, the division band, and elements of the division signal battalion.[27] In the "heavy" armored division the supply battalion was also an element of the division trains.[28] The division trains backed up the unit trains with maintenance and medical services. However, normal resupply of food, fuel and ammunition did not flow through the armored division trains. Because World War II divisions and corps were tactical headquarters they did not get involved in routine resupply functions; leaving this responsibility to the field army.[29]

The field army accomplished resupply to the armored division by locating its railheads, truckheads and supply points within

thirty-five miles of the unit trains service parks.[30] According to doctrine, divisional units pooled all their available transport and picked-up supplies from field army dumps.[31] The two "heavy" armored divisions with their supply battalions were the only units with sufficient organic capability to support themselves when separated from field army supply points.

PETROLEUM SUPPORT CONCEPTS

Now that we have examined general support concepts we will turn to fuel supply. At unit level, fuel resupply began by filling all vehicle tanks using five gallon cans from fuel and lubricant sections in the unit trains. Once vehicle tanks were filled, empty five gallon cans were consolidated, placed on trucks and sent to the field army fuel supply point where they were exchanged for full cans.[32] Under normal conditions, a 2 1/2 ton truck could carry 125 five gallon cans and a one ton trailer carried 50 five gallon cans.[33]

Planning for an armored division's fuel usage was based on the "unit mile," which was the amount of gasoline used to move all the division's vehicles one mile.[34] According to Staff Officers Field Manual 101-10, Organizational, Technical and Logistical Data, the "light" armored division consumed 731.85 gallons per mile.[35] For planning purposes the fuel in vehicle tanks provided at least seventy-five miles of operation and fuel carried in unit trains vehicles provided for an additional 50 miles.[36]

At field army level quartermaster gasoline supply companies operated one or more fuel supply points. Fuel was moved to this point by pipeline, rail or tank truck and then decanted into five gallon cans. To accomplish the five gallon can exchange, field army fuel points required at least twice the number of cans needed to satisfy the total fuel requirement. For example, if a division's daily gasoline requirement was 75,000 gallons or 15,000 five gallon cans, the army supply point needed to have 30,000 cans to effect a one-for-one exchange. As a result, field army fuel points were huge and largely immobile supply dumps containing literally thousands of fuel cans.

## III. THE 6TH ARMORED DIVISION IN BRITTANY

The 6th Armored Division (6th AD), a subordinate element of VIII Corps and General Patton's 3rd U.S. Army, participated in offensive operations in the Brittany Peninsula during August 1944. On 1 August, following the rupture of German defenses at St. Lo, the 6th AD moved through the gap and pushed west into the peninsula.[37] The division's mission was to capture the logistically critical port of Brest, located on Brittany's western tip (see map at Appendix A). By 7 August, the 6th AD had raced 250 miles across the peninsula and for the remainder of the month laid siege to the heavily fortified port.[38]

During the Brittany offensive fuel was the lifeblood of the 6th AD and the supply commodity in greatest demand.[39] In

accordance with doctrine fuel supply was first accomplished with unit trains vehicles travelling to the field army supply point to pick-up fuel.[40] This system worked well at the outset when the field army supply point was within thirty-five miles of 6th AD unit trains. However, by 7 August the division found itself over 200 miles from the closest 3rd Army fuel point.[41] From a theoretical viewpoint, the 6th AD was experiencing the problems associated with an overextended line of communications. As the division moved further from its base of supply, sustainment and ultimately generation of combat power became more difficult.

To help sustain the 6th AD 3rd U.S. Army attached two quartermaster truck companies and a quartermaster gasoline supply company to the division.[42] These units were attached with the idea that they would augment unit trains vehicles and haul fuel to the unit trains from field army depots. Yet, as the line of communications grew the 6th AD departed from convention and established its own non-doctrinal, division fuel point.[43] The theory in creating this supply point was to shorten the line of communication for the unit trains supply vehicles. By establishing a division fuel point the time and distance that unit trains vehicles had to travel for fuel was reduced from a 400 to a 150 mile round trip.[44] Although this effort shortened the travel time for unit trains vehicles, the trucks of the attached quartermaster truck companies still had to make a 250 mile round trip to move fuel from army supply points to the division fuel point.[45]

To meet division fuel requirements, the attached cargo trucks were habitually loaded to twice the recommended capacity.[46] This meant that a 2 1/2 ton truck carried 250 tive gallon cans and a 1 ton trailer carried 100 cans. In essence, the division used its attached transportation assets to form a conveyor belt of overloaded trucks linking the division fuel point with the field army's depot.

Establishing the non-doctrinal, division fuel point was not easy for the 6th AD. Being a "light" armored division, it lacked a supply battalion and was not resourced to operate its own fuel point. To overcome this problem, the division manned the supply point "out-of-hide" using available division trains personnel, the division band, and personnel from the attached gasoline supply company.[47] This improvised concept worked well enough that the 6th AD adopted the following policies:

> a. Division dumps must be established when army installations are not in close support.
>
> b. All available personnel must be used regardless of T/O assignment to accomplish successful resupply.
>
> c. An armored division requires a minimum of two (2) quartermaster truck companies and a quartermaster gasoline supply company for an extended operation.[48]

To complicate matters further, the 6th AD had grossly underestimated its fuel usage during the initial days of the Brittany Campaign. The division G4 found that the 6th AD used two to three times more gasoline than anticipated; consuming up

to 2000 gallons per unit mile when participating in activities that involved temporary halts, increased idling and off-road movement.[49] As a result, the 6th AD called upon corps and field army assets to deliver 190,000 gallons of gasoline. Not surprisingly, this additional support was required during periods of rapid movement through the Brittany Peninsula; 70,000 gallons on 4 August, 80,000 gallons on 7 August and 40,000 gallons on 9 August.[50]

In addition to corps and field army assistance, the 6th AD made use of captured German fuel and "hijacked" 200,000 gallons of fuel that came off an LST onto a Brittany beach.[51] To ensure it got its fair share, the 6th AD also maintained a liaison officer at the 3rd U.S. Army's fuel point.[52]

Bypassed enemy units further complicated 6th AD's fuel supply problems as resistance from these elements harassed division supply points and resupply convoys. To resolve this problem, the 6th AD attached two anti-aircraft batteries to the division trains to provide bivouac protection and convoy escorts. As more enemy units were bypassed, the division trains received an attached company of light tanks, an infantry company and a section of tank destroyers.[53] While this protection was necessary for sustainment of the division it diverted a significant amount of firepower away from the main fight at Brest.

The experience of the 6th AD offers several lessons that may apply to today's fuel support challenges. First, when doctrinal

support concepts are inadequate the organization must improvise. The 6th AD's methods of improvisation included the use of non-doctrinal division fuel supply points, the use of corps and field army throughput of fuel, and the use of captured enemy fuel. These expedients made up for unexpected shortages and organizational deficiencies, allowing successful and rapid movement through the Brittany Peninsula.

Second, if the division does not possess adequate organic support capability additional units must be attached to facilitate sustainment. Unquestionably, the attached quartermaster truck and gasoline supply companies played a major role in fuel support of the 6th AD. The importance of these units was best told by the 6th AD G4 when he wrote:

> The attachment of the two QM truck companies and a gasoline supply company was undoubtedly a major contributing factor to the success of supply in this [Brittany] campaign. Without them, so rapid a move could not have been made.[54]

Third, the practice of estimating fuel consumption based on distance moved or the "unit mile" proved inadequate. Heavy mechanized systems consume a great deal of fuel from idling or cross country travel without any appreciable advance or withdrawal. As such, planning factors should be based on length of operation and not miles travelled.

Finally, bypassed enemy units posed significant risk to the division's rear elements and resupply convoys. Support

vehicles, such as 2 1/2 ton trucks, are thin-skinned and extremely vulnerable to small arms fire. Therefore, missions that allow enemy units to be bypassed must make provisions to protect support assets; often requiring that combat units be removed from the close battle and allocated to protect the rear.

Recognizing that much has changed since WWII, the next section examines the modern heavy division. As previously, I will review the mission, organization and support concepts of the heavy division, setting the stage for an examination of fuel support during Operation Desert Storm.

## IV. THE MODERN HEAVY DIVISION

### MISSION AND ORGANIZATION

According to FM 71-100, Division Operations, the heavy division provides today's army with great mobility and armor-protected firepower.[55] By rapidly concentrating combat power, the heavy division can break through or envelop an enemy force. Like its WWII predecessor, the heavy division can strike deep into the enemy's rear to destroy command and control and service support elements.[56]

Compared to its WWII forerunner, today's heavy division is a much more robust and complex organization. The studied division controls three brigade headquarters to which five armor battalions and five mechanized infantry battalions are

assigned. An aviation brigade provides aviation support using two attack helicopter battalions and an assault helicopter company. Fire support is provided by the division artillery or DIVARTY, which contains three artillery battalions and a multiple launch rocket system or MLRS battery. Four separate battalions provide air defense, military intelligence, engineer and signal support. Two separate companies provide chemical and military police support.[57]

The modern heavy division also provides for its own logistics support. Today, the heavy division contains a significant combat service support structure in the form of a division support command or DISCOM. The DISCOM consists of a materiel management center, an aviation maintenance company, a main support battalion or MSB and three forward support battalions or FSBs.[58]

LOGISTIC SUPPORT CONCEPTS

Having addressed the heavy division's mission and organization we will now explore its support concepts from lower to higher echelons. Although most company-sized units contain a supply section, the lowest echelon that has any significant support capability is the battalion. The armor and mechanized infantry battalion's combat service support (CSS) assets consist of the medical platoon, maintenance platoon and support platoon.[59] In combat, a "slice" from each of these platoons is provided to the company and form the company combat

trains. The remaining assets are collectively referred to as the battalion "trains."[60]

Normally the battalion trains echelon into a combat and a field trains. The combat trains, analogous to the WWII "A" trains, provides critical supply, medical and maintenance support. At the operation's outset, the combat trains are found four to ten kilometers behind the forward line of own troops (FLOT). The field trains, similar to the WWII "B" trains, locate in the brigade support area (BSA) twenty to twenty-five kilometers from the FLOT. The field trains contain the remaining elements of the support and maintenance platoons, mess sections and other elements not required for immediate support of combat elements.[61]

While the maneuver brigades do not have organic CSS elements each brigade is supported by a FSB made up of a supply company, a maintenance company and a medical company.[62] The MSB provides logistic support to units not associated with a maneuver brigade and back-up support to the FSBs.[63] With this background we will now look at fuel supply in the division.

## PETROLEUM SUPPORT CONCEPTS

Beginning at the company level, fuel is supplied to the M1 Abrams tank and the M2/M3 fighting vehicle by the 2500 gallon HEMTT tanker. A typical refuel mission requires HEMTT tankers to move from the field trains to forward refueling areas; refuel the combat systems; and return to the field trains.[64] Upon

return, 5000 gallon tankers from the FSB's supply company refill the HEMTTs. Based on the tactical situation, the FSB supply company may move 5000 gallon tankers forward of the BSA to a tactical refuel point.[65] This is done to reduce travel time for unit refuelers or to dispense fuel directly from the 5000 gallon tanker into the combat vehicle.

According to FM 63-2-2, Combat Service Support Operations, Armored, Mechanized and Motorized Divisions, the FSB receives fuel from the MSB's supply and service company, delivering fuel to the FSB's ten authorized 5000 gallon tankers.[66] Fuel may be transferred directly from MSB to FSB tankers, or a trailer transfer is used to swap full tankers for empty ones.[67] In some cases, the FSB receives fuel directly from the corps support command or COSCOM, thereby bypassing the MSB and eliminating double handling of fuel.[68]

The MSB receives its fuel from petroleum supply companies of the COSCOM. In most cases, fuel delivered to the MSB is in 5000 gallon tankers. However, it also may be delivered by railcar, barge, pipeline, flexible hoseline, or aircraft. This fuel is either directly transferred into the MSB's thirty-four authorized fuel tankers or discharged into the FSSP; a system consisting of six 10,000 gallon bags with associated pumps, filters, and hoses. The MSB has two of these systems for a total storage capability of 120,000 gallons. The MSB provides fuel to units not supported by a FSB and can provide mobile filling stations in the division support area (DSA).[69]

## FUEL SUPPORT DURING OPERATION DESERT STORM

Operation Desert Storm, conducted in January-February 1991, provided a unique opportunity to evaluate the execution of fuel support doctrine in offensive combat. Interestingly, a review of after action reports reveals significant deviations from doctrine and illustrates the DISCOM's inability to provide fuel support using only its authorized systems.

Evidence from VII Corps after action reports shows that both the 1st Infantry Division (Mechanized) (1st ID) and the 3rd Armored Division (3rd AD) recognized an overall shortage of fuel tankers. Logistic planners realized that the division's authorized fuel tankers, supporting over a long line of communications, would be unable to sustain the combat force needed to defeat the enemy. In short, a lack of fuel would prevent the generation of combat power at the decisive time and place.

The most telling evidence of this problem was seen in 3rd AD's concept of fuel support. To sustain an offensive operation which advanced the division over 280 kilometers, the 3rd AD augmented its DISCOM with extra tankers taken from prepositioned stocks and units not deploying to the Persian Gulf. Each FSB was augmented with twenty additional 5000 gallon tankers.[70] The tankers in the MSB were almost doubled from the thirty-four authorized, to sixty-six.[71] The ninety-two additional tankers were needed to execute the following fuel support concept:

> The 3rd AD plan was to keep the HEMTT tankers in the brigades full by topping them off with the thirty 5000 gallon tankers in the FSBs. The FSB's 5000 gallon tankers were to be replaced by the tankers from the DISCOM [MSB]. . . . In effect 3rd AD set up a round robin link of empties rearward and full tankers forward.[72]

The 3rd AD's fuel support concept was actually quite similar to that employed by the 6th AD in WWII. In both cases, additional fuel support assets, beyond those authorized to the division, were needed to support the offense. Both used the extra support assets to create a virtual conveyor belt of trucks linking combat units with fuel supply points.

Besides the shortage of fuel support systems, both the 1st ID (Mech) and 3rd AD reported mobility problems with the 5000 gallon fuel tanker. While relatively mobile on improved roads, the 5000 gallon tanker had great difficulty traversing terrain with only limited or nonexistent road networks. The inability of the 5000 gallon tanker to negotiate desert terrain led to its replacement with the 2500 gallon HEMTT refueler.[73] Besides being a newer system, the HEMTT tanker could move off-road and, more importantly, it was specifically designed to support the new generation of combat systems. The HEMTT could keep up with M1 tanks and M2/M3 fighting vehicles, whereas the 5000 gallon tanker could not. In 3rd AD each FSB traded twenty 5000 gallon tankers for forty HEMTT tankers.[74] Many of the HEMTTs used for the excnange were shipped to the Persian Gulf directly from the manufacturer's assembly line. The HEMTT was so successful

in the 1st ID (Mech) that they recommended that all the division's 5000 gallon tankers be replaced by HEMTTs.[75]

Little is written about the FSSP's use in Operation Desert Storm. However, previous studies have documented its weaknesses in supporting highly mobile, offensive operations. One U.S. Army War College study found support battalion commanders reluctant to use the FSSP because of its lack of mobility.[76] To displace a FSSP, the fuel in the 10,000 gallon bags must first be drawn down, then the FSSP's components must be disassembled, loaded on transportation, and moved. At the new site, the FSSP must be downloaded, reassembled and receive fuel again. This entire process can take 24 hours or more to complete.[77] As a result, support unit commanders tend to rely solely on their 5000 gallon tankers for storage. This practice, in effect, reduces the DISCOM's fuel storage capability by 120,000 gallons; the capacity of the unused FSSP systems.

Another issue raised during Operation Desert Storm was use of captured fuel. Although not an "official" supply source, the U.S. Army's keystone CSS manual, FM 100-10, Combat Service Support, notes the following about captured material:

> It [captured material] can contribute to the retention of momentum by maneuver forces and provide a decreased need to consume our own supply stocks and transport them to using units. Obvious sources are captured or overrun fuel supply points. . . .[78]

Captured enemy fuel played a key role in sustaining the 6th AD's combat power during the Brittany campaign, yet this potential supply source was not taken advantage of in Operation Desert Storm. In one case, over 50,000 gallons of captured fuel were destroyed because a U.S. division could not test the fuel to ensure it was suitable for use in U.S. vehicles. According to the VII Corps after action report, use of this fuel would have greatly aided the offensive effort.[79]

The experience of Operation Desert Storm reinforces many of the same lessons learned in the 6th AD's Brittany campaign. First, sufficient fuel support assets must be available to sustain an offense. Just as the 6th AD required additional cargo trucks to move five gallon cans of fuel, the 3rd AD's DISCOM needed additional fuel tankers to support the division's offense and sustain combat power.

Second, fuel resupply vehicles must be as mobile as the combat systems they support. This was not a major issue in Brittany since the relatively mobile 2 1/2 ton cargo truck moved fuel and a well developed road network existed. Today, however, the army uses heavy and cumbersome fuel hauling vehicles like the 5000 gallon tanker. Force designers must ensure that this equipment's operating restrictions and limitations will not adversely affect the support of new combat systems and degrade combat power.

Third, assets that are static in nature and difficult to displace, like the FSSP, have little utility in offensive warfare. The reluctance of support commanders to use the FSSP means that the bulk of a support unit's fuel handling capacity rests with its tankers.

Finally, U.S. units must have the capability to test and use captured fuel. This was an important source of supply in the Brittany campaign and cannot be ignored today. While one should never count on the use of captured fuel, the army should be prepared to take advantage of this supply source when the opportunity presents itself.

## V. EMERGING LOGISTIC DOCTRINE

The logistic concepts previously examined are now evolving to support future warfighting concepts known as AirLand Operations. This section will explore future logistics doctrine and highlight major changes from current support concepts.

AirLand Operations envisions tomorrow's battlefield as nonlinear and characterizes battle as quick, mobile and offense-oriented. The emerging logistics concept to support AirLand Operations provides for combat service support with fewer, but more robust, support echelons.[60] This new concept proposes removing the logistic burden from the maneuver commander by transferring a large portion of the maneuver battalion's support echelon to the FSB.[61] The rationale for

this shift is the belief that the maneuver commander, as both a fighter and logistics operator, has too much to synchronize. This problem is particularly cogent in the armor battalion, where CSS and CSS-related organizations make up 35% of the unit.[82] By "unweighting" the maneuver commander of his logistic responsibilities, he can focus on the battle.

This new concept also proposes that the FSB continue to provide habitual support to maneuver brigades but with a much larger mission and greater capability. The FSB provides both organizational and direct support maintenance, as well as distribution of supplies directly to the combat system. To meet these expanded requirements, a combat maintenance company and a combat transportation company are added to the FSB's current supply, maintenance and medical companies.[83]

While enlarging the support functions of the FSB, emerging sustainment doctrine would reduce the logistic role at division level. Support would no longer flow through the MSB to the FSB, and the MSB would be replaced by a headquarters and main support company and a maintenance company.[84] These organizations would support units in the division base that are not supported by a FSB. The DISCOM's role is to synchronize logistic support and provide command and control of the FSBs and DISCOM companies in the division base.[85]

Most of the former MSB's support assets, such as 5000 gallon tankers, are consolidated into the COSCOM, which assumes responsibility for providing supplies and back-up support to the

FSB. The COSCOM supports the corps and FSBs through corps support groups (CSG). Each CSG provides general support and direct support supply and direct support maintenance to a designated division and the corps units operating in that division's area. Each CSG will command from three to seven multifunctional corps support battalions (CSBs), which allow the COSCOM to project support forward and back-up the FSBs.[86]

For fuel support, the FSB's supply company contains both 5000 gallon tankers and 2,500 gallon HEMTT tankers. The FSB receives fuel directly from COSCOM, transloading it into FSB tankers. Using the HEMTT tankers, the FSB distributes fuel directly to the individual weapons system. Maneuver battalions retain only limited organic refuel capability to support emergency requirements.[87]

These new proposals are surprisingly similar to the support concepts used in WWII. As in the WWII armored division, support focuses at unit level, with the FSB supporting individual combat systems of the maneuver battalions. The COSCOM, like the WWII field army, provides support directly to the FSB, without any requirement to go through a division-level support unit.

The obvious impact of this new concept is reduction of battalion and division support echelons through consolidation in the FSB and COSCOM. While these support echelons are larger, there is no clear evidence that support capability will be increased. In fact, the transfer of support assets from the MSB to the COSCOM reduces the number of 5000 gallon tankers controlled by the DISCOM. During Operation Desert Storm, the

impact of moving these assets to corps was addressed in a message from the 1st Cavalry Division to the U.S. Army Combined Arms Center. The message stated:

> Although the tendency has been to reduce the size of the division and move much of the CS and CSS to EAD [echelons above division], it is our observation that in an immature theater, the division must be self-sustaining and robust. The same holds true with brigades and battalions. We cannot afford to organize so fragilely that without higher level support the division cannot sustain itself. The division must have robustness in signal, transportation, maintenance and supply and services.[88]

A further consequence of consolidation is the need for greater anticipation.[89] Logistic assets would no longer be at the battalion level where they can quickly react to last minute requirements of the maneuver commander. Similarly, the DISCOM no longer has the MSB's fuel tankers with which to reinforce the FSBs. Implicit in this new concept is the need for units to predict when and where support is needed.

## VI. REQUIREMENTS VERSUS CAPABILITIES ANALYSIS

The experience of the 6th AD in Brittany and the 1st ID (Mech) and 3rd AD in Operation Desert Storm have highlighted flaws in accepted fuel support concepts and demonstrated the inability of most authorized systems to satisfy fuel requirements. Through an offensive scenario, this section will mathematically analyze the division's support capabilities and compare them to fuel requirements. The studied scenario is a

five day attack against a defending enemy which requires a heavy division to advance 250 miles and then establish a position to block an enemy's withdrawal.

In this scenario the heavy division has three brigades. The 1st Brigade has two mechanized infantry battalions and one armor battalion. The 2nd Brigade, the division's main effort, is a balanced force of two mechanized infantry battalions and two armor battalions. The 3rd Brigade consists of one mechanized infantry and two armor battalions. The 1st and 2nd Brigades attack abreast and the 3rd Brigade follows the 2nd Brigade.

Each brigade has its normal "slice" of combat, combat support, and combat service support elements; specifically, a field artillery battalion, an air defense artillery battery, a combat engineer company, a military intelligence team, a forward support signal company, a military police platoon, a chemical defense platoon and a FSB. The MSB supports those divisional elements not associated with a maneuver brigade from the DSA.

## THE REQUIREMENT

Table 2-15 of U.S. Army Field Manual 101-10-1/2, Staff Officer's Field Manual Organizational, Technical, and Logistical Data Planning Factors (Volume 2), provides planning factors to estimate fuel consumption. Unlike the "unit mile" used in WWII, these factors are based on hours of operation rather than miles of advance. Also, current planning factors attempt to account for a combat vehicle's fuel consumption based on idling,

cross-country and secondary road movement.[90] Using these planning factors for a heavy division of five, M1 equipped, armor battalions and five, M2 equipped, mechanized infantry battalions (SRC87000J440), Table 1 provides a combined daily ground fuel requirement for the heavy division based on 90 percent availability of combat system.[91]

TABLE 1
ESTIMATE DAILY FUEL CONSUMPTION
(MOGAS & DIESEL)

| UNIT | FUEL RQMT |
|---|---|
| 1st Bde (2 MECH X 1 AR) | 103,300 gal |
| 2nd Bde (2 MECH X 2 AR) | 145,450 gal |
| 3rd Bde (1 MECH X 2 AR) | 127,000 gal |
| Div Rear | 45,550 gal |
| Total | 421,300 gal |

As the operation progresses the above requirements decrease due to attrition of combat systems. To project attrition Student Text 101-6, G1/G4 Battle Book, provides estimates for equipment losses based on type of operation, duration and type of equipment. For purposes of this monograph, my analysis focuses on the major fuel consumers: the M1 tank and the M2/M3 fighting vehicles. There are a total of 58 M1 tanks and 6 M3 fighting vehicles in an armor battalion, and 54 M2 and 6 M3 fighting vehicles in a mechanized infantry battalion.[92] Table 2 gives the projected loss rates for these systems, by percent.

TABLE 2
ESTIMATED EQUIPMENT LOSS RATES[93]

| | OFFENSE | |
|---|---|---|
| END ITEM | 1ST DAY | SUC DAYS |
| M1 TANK | 25% | 25% |
| M2/3 | 25% | 20% |

While the leading brigades, 1st and 2nd, might expect to experience losses at the above rates, it is likely that the following brigade will experience fewer losses due to limited exposure and a weakened enemy. As such, this study will assume a loss rate of 15% for the 3rd Brigade.

Loss rates reflect both battle damage and maintenance failures, resulting in both repairable and nonrepairable equipment losses. According to Student Text 101-6, G1/G4 Battle Book, in an offense, one can expect 80 percent of equipment losses to be reparable and the remaining 20 percent to be nonreparable.[94] By doctrine, reparable losses will be fixed either on-site, by a direct support maintenance unit, by a back-up direct support maintenance unit or by theater army maintenance units. Table 3 provides the percent of repairable losses that will be fixed at each category of maintenance.

TABLE 3
REPAIR ESTIMATIONS BY MAINTENANCE LEVEL[95]

| CATEGORY | |
|---|---|
| ON-SITE | 20% |
| DIRECT SUPPORT | 20% |
| BACK-UP DIRECT SUPPORT | 30% |
| THEATER ARMY (GENERAL SUPPORT) | 30% |

Unit mechanics perform on-site repairs and return equipment to operation in less than 24 hours. The FSB carries out direct support maintenance and returns equipment after 24 hours. The MSB performs back-up direct support maintenance for units supported by a FSB. Equipment repaired at back-up direct support maintenance returns after 72 hours. Equipment evacuated to theater army maintenance units will be repaired and placed in the supply system.[26] Assuming an initial availability rate of 90% and using the above factors, equipment loss worksheets were completed for each brigade and are located at Appendix B. Assuming no issues from the supply system, Table 4 provides the number of mission capable tanks and fighting vehicles at the start of each day.

TABLE 4
MISSION CAPABLE COMBAT SYSTEMS

| | 1ST BDE | | 2ND BDE | | 3RD BDE | |
|---|---|---|---|---|---|---|
| DAY | M1 | M2/3 | M1 | M2/3 | M1 | M2/3 |
| 1 | 52 | 114 | 104 | 120 | 104 | 65 |
| 2 | 42 | 90 | 84 | 96 | 90 | 57 |
| 3 | 36 | 79 | 72 | 84 | 81 | 51 |
| 4 | 30 | 68 | 60 | 74 | 73 | 45 |
| 5 | 27 | 66 | 54 | 71 | 70 | 43 |

Based on the above availability projections, one can make a more accurate prediction of the heavy division's daily fuel consumption. Table 5 provides this adjusted fuel requirement for each day of the scenario.

TABLE 5
HEAVY DIVISION ADJUSTED FUEL REQUIREMENTS
(GALLONS)

| UNIT | DAY 1 | DAY 2 | DAY 3 | DAY 4 | DAY 5 |
|---|---|---|---|---|---|
| 1st Bde | 103,300 | 92,900 | 87,200 | 81,500 | 79,200 |
| 2nd Bde | 145,450 | 126,600 | 118,900 | 109,500 | 105,100 |
| 3rd Bde | 127,000 | 116,650 | 109,200 | 103,000 | 100.700 |
| Div Rear | 45,550 | 41,800 | 39,150 | 38,100 | 36,950 |
| Total | 421,300 | 379,950 | 354,450 | 332,100 | 321,950 |

THE CAPABILITY

The ability of the DISCOM to sustain the heavy division depends on the amount of fuel that can be carried and the distance it must be transported. Carrying capability is determined by the amount of available refueling equipment, while distance travelled is reflected in the number of round trips a fuel tanker can make each day.

Each FSB has ten authorized 5000 gallon fuel tankers and ten 5 ton tractors.[97] The MSB has thirty-four 5000 gallon tankers, but is authorized only twenty-five 5 ton tractors. The MSB also has two authorized FSSPs that provide 120,000 gallons of storage capability.[98]

According to Student Text 101-6, G1/G4 Battle Book, a fuel tanker/tractor readiness rate of 83% can be used for operations of 30 days or less.[99] Based on this readiness rate, the FSB will support the fuel requirements of the brigade with eight 5000 gallon tankers and eight tractors. The MSB will refill FSB tankers and support fuel requirements in the DSA with

twenty-eight 5000 gallon tankers pulled by twenty-one 5 ton tractors.

Besides the number of available tankers, the distance the fuel tankers must travel also determines fuel support capability. On day 1, the FSB and MSB are within their respective doctrinal distances of 20 and 40 kilometers behind the FLOT. Given this disposition, fuel tankers are within the local haul distance of 20 miles (32 kilometers) from the unit they support.[100] For example, MSB tankers are within local haul distance from the FSB, and the FSB is within local haul distance from the maneuver battalion. According to Student Text 101-6, G1/G4 Battle Book, a total of four round trips per day can be made at these distances.[101] However, since the maneuver battalions will be moving at a rate of 50 miles (80 kilometers) per day, one can only reasonably expect three round trips on day 1.

By the beginning of day 2, the maneuver battalions will be 100+ kilometers from the FSB. At these distances, fuel tankers can only make two round trips per day. By day 3, the FSB will be almost 200 kilometers from the maneuver battalions, reducing the number of round trips to one per day. One round trip per day is also the most that can be expected on days 4 and 5. To summarize, the number of round trips per day for the scenario is three trips on day 1, two trips on day 2, and one trip each day on days 3, 4 and 5.

To maintain a minimum capability of two trips per day, the fuel tanker assets of the FSB and MSB must displace to intermediate supply points. These intermediate points, in effect, shorten the line of communications between supported and supporting units. Given the rapid advance envisioned by this scenario, FSB and MSB tankers would have to displace daily. For the purposes of this study, I will assume that fuel support assets of the COSCOM and higher echelons also move forward. Since the FSSP requires at least 24 hours to displace, its use at more than one location is unlikely. This analysis assumes that the FSSP was established prior to the start of the offense, and therefore remains at the initial DSA location.

Based on the number of round trips and available tankers, one can derive a total fuel support capability. Table 6 provides this capability when fuel tankers are not displaced to intermediate supply points.

TABLE 6
DISCOM FUEL SUPPORT CAPABILITY
(WITHOUT INTERMEDIATE SUPPLY POINTS)
(GAL)

| UNIT | DAY 1[a] | DAY 2[b] | DAY 3-5[c] |
|---|---|---|---|
| FSBs(X3) | 360,000 | 240,000 | 120,000/DAY |
| MSB | 315,000 | 210,000 | 105,000/DAY |

[a] 3 round trips/day
[b] 2 round trips/day
[c] 1 round trip/day

Table 7 reflects fuel support capability when using intermediate supply points.

TABLE 7
DISCOM FUEL SUPPORT CAPABILITY
(WITH INTERMEDIATE SUPPLY POINTS)
(GAL)

| UNIT | DAY 1[a] | DAY 2-5[b] |
|---|---|---|
| FSBs(X3) | 360,000 | 240,000/DAY |
| MSB | 315,000 | 210,000/DAY |

[a] 3 round trips/day
[b] 2 round trips/day

REQUIREMENT VS CAPABILITY

Comparing the requirement's data with the capability information one can assess the DISCOM's ability to provide fuel support. Table 8 provides this comparison when fuel tankers are not displaced to intermediate points.

TABLE 8
HEAVY DIVISION FUEL REQUIREMENTS VS CAPABILITY
(WITHOUT INTERMEDIATE SUPPLY POINTS)
(GAL)

| UNIT | DAY 1 | DAY 2 | DAY 3 | DAY 4 | DAY 5 |
|---|---|---|---|---|---|
| 1ST BDE | | | | | |
| REQ | 103,300 | 92,900 | 87,200 | 81,500 | 79,200 |
| CAP | 120,000 | 80,000 | 40,000 | 40,000 | 40,000 |
| +/- | +16,700 | -12,900 | -47,200 | -41,500 | -39,200 |
| 2ND BDE | | | | | |
| REQ | 145,450 | 128,600 | 118,900 | 109,500 | 105,100 |
| CAP | 120,000 | 80,000 | 40,000 | 40,000 | 40,000 |
| +/- | -25,450 | -48,600 | -78,900 | -69,500 | -65,100 |
| 3RD BDE | | | | | |
| REQ | 127,000 | 116,650 | 109,200 | 103,000 | 100,700 |
| CAP | 120,000 | 80,000 | 40,000 | 40,000 | 40,000 |
| +/- | -7,000 | -36,000 | -69,200 | -63,000 | -60,700 |
| DIV REAR (MSB) | | | | | |
| REQ | 421,300 | 379,950 | 354,450 | 332,100 | 321,950 |
| CAP | 315,000 | 210,000 | 105,000 | 105,000 | 105,000 |
| +/- | -106,300 | -169,950 | -249,450 | -227,100 | -216,950 |
| TOT SHORTFALL | -122,050 | -267,450 | -444,750 | -401,100 | -381,950 |
| 5K TKR EQUIV | 25 | 54 | 89 | 81 | 77 |

Even when reducing fuel requirements to reflect combat system attrition, the above comparison reveals a fuel support shortfall on each day. The greatest shortfall occurs on day 3, where requirements exceed capabilities by 444,750 gallons or the equivalent of eighty-nine 5000 gallon fuel tankers. Not surprisingly, this shortfall is close to the ninety-two extra tankers 3rd AD needed to support its offensive in Operation Desert Storm. This shortfall is reduced by moving fuel support equipment to intermediate supply bases, thereby ensuring that fuel tankers accomplish two round trips per day. Table 9 provides a comparison of requirements versus capabilities when fuel tankers are displaced to intermediate supply bases.

TABLE 9
HEAVY DIVISION FUEL REQUIREMENTS VS CAPABILITY
(WITH INTERMEDIATE SUPPLY POINTS)
(GAL)

| UNIT | DAY 1 | DAY 2 | DAY 3 | DAY 4 | DAY 5 |
|---|---|---|---|---|---|
| 1ST BDE | | | | | |
| REQ | 103,300 | 92,900 | 87,200 | 81,500 | 79,200 |
| CAP | 120,000 | 80,000 | 80,000 | 80,000 | 80,000 |
| +/- | +16,700 | -12,900 | -7,200 | -1,500 | + 800 |
| 2ND BDE | | | | | |
| REQ | 145,450 | 128,600 | 118,900 | 109,500 | 105,100 |
| CAP | 120,000 | 80,000 | 80,000 | 80,000 | 80,000 |
| +/- | -25,450 | -48,600 | -38,900 | -29,500 | -25,100 |
| 3RD BDE | | | | | |
| REQ | 127,000 | 116,650 | 109,200 | 103,000 | 100,700 |
| CAP | 120,000 | 80,000 | 80,000 | 80,000 | 80,000 |
| +/- | -7,000 | -36,000 | -29,200 | -23,000 | -20,700 |
| DIV REAR (MSB) | | | | | |
| REQ | 421,300 | 379,950 | 354,450 | 332,100 | 321,950 |
| CAP | 315,000 | 210,000 | 210,000 | 210,000 | 210,000 |
| +/- | -106,300 | -169,950 | -144,450 | -122,100 | -111,950 |
| TOT SHORTFALL | -122,050 | -267,450 | -219,750 | -176,100 | -156,950 |
| 5K TKR EQUIV | 25 | 54 | 44 | 36 | 32 |

Shortening the line of communications by displacing fuel tankers forward results in reduced requirements for extra 5000 gallon tankers. Yet, even when fuel tankers make at least two round trip per day, a fuel support shortfall of up to 267,450 gallons or the equivalent of fifty-four 5000 gallon tankers occurs. With or without intermediate supply points, the foregoing mathematical analysis supports historical evidence and reveals that the DISCOM must be augmented with additional fuel tanker assets to sustain a heavy division conducting offensive operations.

## VII. CONCLUSION AND IMPLICATIONS

Both empirical evidence and mathematical analysis support the conclusion that the heavy division's DISCOM cannot adequately sustain a division-level offense with its authorized fuel assets. While logisticians must always adhere to the five sustainment imperatives of responsiveness, continuity, anticipation, integration and improvisation, this capability shortfall requires that particular attention be paid to the latter three.

FM 100-5, Operations, defines anticipation as the ability to foresee future requirements and provide the assets needed to support future operations at the decisive place and time.[102] By using accurate planning factors, the division logistics planner can anticipate fuel needs, identify when requirements exceed capabilities, and determine when to request additional

assets. 3rd AD's ability to anticipate the need for ninety-two extra fuel tankers was critical to sustaining the combat power needed during Operation Desert Storm. Conversely, the 6th AD's inability to anticipate its fuel requirement led to a serious shortage and robbed the division of combat power.

Integration is defined as the inclusion of sustainment in the plans and operations of the maneuver force.[103] While fuel requirements do not necessarily "drive" the tactical plan, refueling sustains combat power and must be an important consideration in any maneuver plan. Due to limited capability, maneuver should be planned to stagger fuel requirements so they do not all occur simultaneously. As exemplified by the 6th AD in Brittany, maneuver plans also must integrate protection of these limited fuel support assets. The mathematical analysis showed that fuel tankers best support when displaced forward; however, at forward locations fuel tankers are more vulnerable to enemy activity and hostile fire. Therefore, the tactical plan must provide a means of protecting these critical assets as they support forward.

Although the logistics planner does his utmost to predict fuel needs, the friction and fog of war will inevitably lead to unanticipated requirements. Because of limited organic capability, these unanticipated fuel requirements will likely be satisfied through improvisation. In this context, improvisation is the deviation from routine and traditional methods in order to provide logistic support.[104] The 6th AD's use of

non-doctrinal, division supply points illustrates the importance of improvisation in overcoming unexpected problems and shortfalls. In Operation Desert Storm, 3rd AD DISCOM went to extraordinary means to support the division and sustain combat power. In an environment of limited resources, success or failure may well depend on the logistician's ability to improvise.

While better anticipation, integration and improvisation can help minimize problems associated with limited fuel support capability, they alone cannot correct the deficiency. As such, this capability shortfall has significant implications in the areas of force structure; technology research and equipment design; and the identification and use of alternative fuel sources.

The most obvious implication is the need to authorize more fuel tankers in the heavy division's DISCOM. Yet, as Operation Desert Storm proved, adding more of the old 5000 gallon tankers may not be the best solution. Not only must there be additional tankers, but these vehicles must be as mobile as the maneuver force they support.

New technologies must be explored to find ways to increase load carrying capability and improve mobility. Research is needed into methods that will make the FSSP more mobile. In addition to increasing support capabilities, technologies that can reduce fuel requirements also must be investigated. One example is a ceramic engine that uses 10% less fuel than conventional engines and reduces overall vehicle weight.[105]

Another way to improve fuel support is to make use of alternative fuel sources. As in WWII, today's army must be capable of using captured enemy fuel. Units must be equipped with the ability to quickly test captured enemy fuel. Damaged combat vehicles are another potential fuel source. Since a M1's fuel tank holds 511 gallons, each disabled tank becomes a source of fuel on the battlefield. The U.S. Army Armor School is currently testing a small pump that can be used to transfer fuel from both U.S. and captured enemy equipment.[106]

All the preceding ideas, if implemented, promise to improve fuel support capability and help provide the division with the fuel support it needs to conduct offensive operations.

## VIII. SUMMARY

The U.S. Army's efforts to increase combat power are manifested in the development and fielding of new combat systems like the M1 tank and M2/M3 fighting vehicles. Yet, the fielding of these new systems, without commensurate attention to their sustainment has created a fuel support capability shortfall in the heavy division. Through historical investigation and mathematical analysis, this monograph has shown that the heavy division's DISCOM cannot adequately sustain a division-level offense with its authorized fuel assets.

The affects of this capability limitation can be somewhat mitigated by increased emphasis on the sustainment imperatives

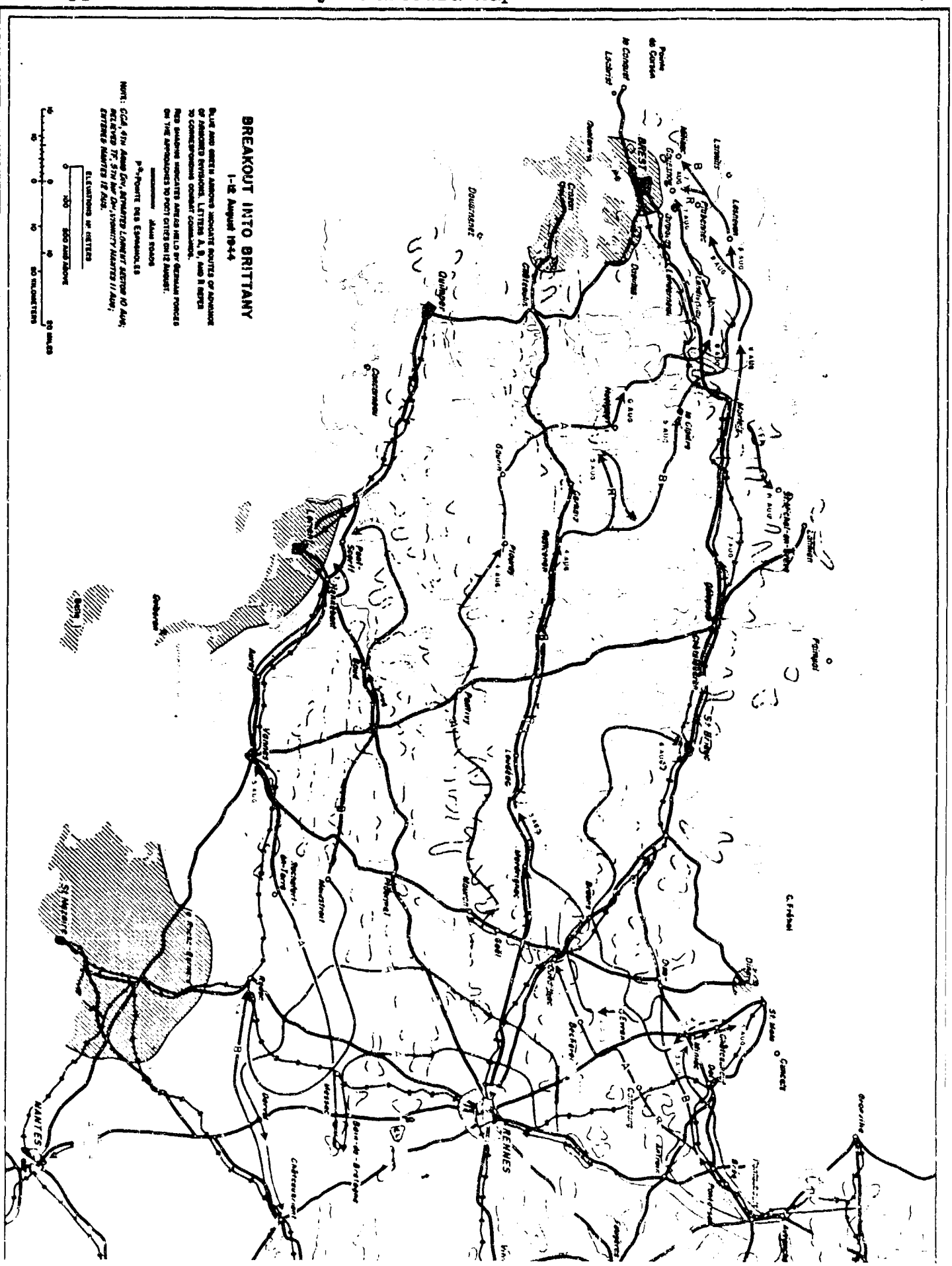
of anticipation, integration and improvisation. However, long term implications call for increased fuel tanker authorizations; the use of technology to both increase support capabilities and reduce fuel requirements; and the use of alternative sources such as captured enemy fuel and fuel from damaged combat vehicles.

Most important, in our quest to increase combat power, we must not neglect sustainment. The army must approach solutions to sustainment shortfalls with the same enthusiasm that it displays for new combat systems. Further, army leaders must determine the proper mix of combat and support forces, recognizing that efficiency is not necessarily accomplished by maximizing combat forces, while minimizing support. Martin Van Creveld puts this relationship into proper perspective when he writes:

> The aim of a military organization is not to make do with the smallest number of supporting troops but to produce the greatest possible fighting power. If, for any given campaign, this aim can only be achieved by having a hundred men pump fuel, drive trucks and construct railways behind each combatant, then 100:1 is the optimum ratio.[107]

In short, we must recognize fuel support's role in the generation of combat power and ensure we have sufficient means to provide it. In the words of Operation Desert Storm logistician, Lieutenant General William G. Pagonis, "Good Logistics is Combat Power."[108]

# Appendix A: Brittany Peninsula Map



Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 1ST BDE EQUIPMENT: M1

| ROW | ITEM | SOURCE/COMPUTATION | DAY 1 | DAY 2 | DAY 3 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 52 | 42 | 36 |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FACTOR 25% | NON-OP FACTOR TIMES ROW 1 | 13 | 10 | 9 |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 2 | 2 | 2 |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 11 | 8 | 7 |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 3 | 2 | 2 |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 2 | 1 | 1 |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 3 | 3 | 2 |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 3 | 2 | 2 |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 3 | 2 | 2 |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | -- | 2 | 1 |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | -- | -- | -- |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 3 | 4 | 3 |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 42 | 36 | 30 |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 1ST BDE EQUIPMENT: M1 (CONT)

| ROW | ITEM | SOURCE/COMPUTATION | DAY 4 | DAY 5 | DAY 6 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 30 | 27 | |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FACTOR 25% | NON-OP FACTOR TIMES ROW 1 | 8 | 7 | |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 2 | 1 | |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 6 | 6 | |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 1 | 1 | |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 1 | 1 | |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 2 | 2 | |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 2 | 2 | |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 1 | 1 | |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | 1 | 1 | |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | 3 | 3 | |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 5 | 5 | |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 27 | 25 | |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 1ST BDE EQUIPMENT: M2/3

| ROW | ITEM | SOURCE/COMPUTATION | DAY 1 | DAY 2 | DAY 3 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 114 | 90 | 79 |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FCTR 25/20% | NON-OP FACTOR TIMES ROW 1 | 28 | 18 | 16 |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 6 | 4 | 3 |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 22 | 14 | 13 |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 4 | 3 | 2 |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 4 | 3 | 3 |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 7 | 4 | 4 |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 7 | 4 | 4 |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 4 | 3 | 2 |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | -- | 4 | 3 |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | -- | -- | -- |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 4 | 7 | 5 |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 90 | 79 | 68 |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 1ST BDE EQUIPMENT: M2/3 (CONT)

| ROW | ITEM | SOURCE/COMPUTATION | DAY 4 | DAY 5 | DAY 6 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 68 | 66 | |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FACTOR 20% | NON-OP FACTOR TIMES ROW 1 | 14 | 13 | |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 3 | 3 | |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 11 | 10 | |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 2 | 2 | |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 2 | 2 | |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 4 | 3 | |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 3 | 3 | |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 2 | 2 | |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | 3 | 2 | |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | 7 | 4 | |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 12 | 8 | |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 66 | 61 | |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 2ND BDE EQUIPMENT: M1

| ROW | ITEM | SOURCE/COMPUTATION | DAY 1 | DAY 2 | DAY 3 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 104 | 84 | 72 |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FACTOR 25% | NON-OP FACTOR TIMES ROW 1 | 26 | 20 | 18 |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 4 | 4 | 4 |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 22 | 16 | 14 |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 6 | 4 | 4 |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 4 | 2 | 2 |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 6 | 6 | 4 |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 6 | 4 | 4 |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 6 | 4 | 4 |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | -- | 4 | 2 |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | -- | -- | -- |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 6 | 8 | 6 |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 84 | 72 | 60 |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 2ND BDE EQUIPMENT: M1 (CONT)

| ROW | ITEM | SOURCE/COMPUTATION | DAY 4 | DAY 5 | DAY 6 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 60 | 54 | |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FACTOR 25% | NON-OP FACTOR TIMES ROW 1 | 16 | 14 | |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 4 | 2 | |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 12 | 12 | |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 2 | 2 | |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 2 | 2 | |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 4 | 4 | |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 4 | 4 | |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 2 | 2 | |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | 2 | 2 | |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | 6 | 6 | |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 10 | 10 | |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 54 | 50 | |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 2ND BDE EQUIPMENT: M2/3

| ROW | ITEM | SOURCE/COMPUTATION | DAY 1 | DAY 2 | DAY 3 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 120 | 96 | 84 |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FCTR 25/20% | NON-OP FACTOR TIMES ROW 1 | 30 | 18 | 16 |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 6 | 4 | 4 |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 24 | 14 | 12 |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 6 | 2 | 2 |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 4 | 4 | 2 |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 8 | 4 | 4 |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 6 | 4 | 4 |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 6 | 2 | 2 |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | -- | 4 | 4 |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | -- | -- | -- |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 6 | 6 | 6 |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 96 | 84 | 74 |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 2ND BDE EQUIPMENT: M2/3 (CONT)

| ROW | ITEM | SOURCE/COMPUTATION | DAY 4 | DAY 5 | DAY 6 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 74 | 71 | |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FACTOR 20% | NON-OP FACTOR TIMES ROW 1 | 15 | 14 | |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 3 | 3 | |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 12 | 11 | |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 2 | 2 | |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 2 | 2 | |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 4 | 4 | |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 4 | 3 | |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 2 | 2 | |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | 2 | 2 | |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | 8 | 4 | |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 12 | 8 | |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 71 | 65 | |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 3RD BDE EQUIPMENT: M1

| ROW | ITEM | SOURCE/COMPUTATION | DAY 1 | DAY 2 | DAY 3 |
|---|---|---|---|---|---|
| | | BEGINNING EQUIPMENT POSTURE | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 104 | 90 | 81 |
| | | DISPOSITION OF NON-OPERATIONAL EQUIPMENT | | | |
| 2 | TOT NON-OP FACTOR 15% | NON-OP FACTOR TIMES ROW 1 | 16 | 14 | 12 |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 3 | 3 | 2 |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 13 | 11 | 10 |
| | | DISPOSITION OF REPARABLE EQUIPMENT | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 2 | 2 | 2 |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 3 | 2 | 2 |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 4 | 3 | 3 |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 4 | 4 | 3 |
| | | DISPOSITION OF RETURNS | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 2 | 2 | 2 |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | -- | 3 | 2 |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | -- | -- | -- |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 2 | 5 | 4 |
| | | ENDING EQUIPMENT POSTURE | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 90 | 81 | 73 |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 3RD BDE EQUIPMENT: M1 (CONT)

| ROW | ITEM | SOURCE/COMPUTATION | DAY 4 | DAY 5 | DAY 6 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PRFV DAY | 73 | 70 | |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FACTOR 15% | NON-OP FACTOR TIMES ROW 1 | 11 | 10 | |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 2 | 2 | |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 9 | 8 | |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 2 | 2 | |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 2 | 1 | |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 3 | 3 | |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 2 | 2 | |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 2 | 2 | |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | 2 | 2 | |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | 4 | 3 | |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 8 | 7 | |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 70 | 67 | |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 3RD BDE EQUIPMENT: M2/3

| ROW | ITEM | SOURCE/COMPUTATION | DAY 1 | DAY 2 | DAY 3 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 65 | 57 | 51 |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FCTR 15% | NON-OP FACTOR TIMES ROW 1 | 10 | 9 | 8 |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 2 | 2 | 2 |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 8 | 7 | 6 |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 2 | 2 | 1 |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 1 | 1 | 1 |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 3 | 2 | 2 |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 2 | 2 | 2 |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 2 | 2 | 1 |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | -- | 1 | 1 |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | -- | -- | -- |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 2 | 3 | 2 |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 57 | 51 | 45 |

Appendix B: WORKSHEET -- ESTIMATE OF DAILY EQUIPMENT LOSSES

UNIT: 3RD BDE EQUIPMENT: M2/3 (CONT)

| ROW | ITEM | SOURCE/COMPUTATION | DAY 4 | DAY 5 | DAY 6 |
|---|---|---|---|---|---|
| | | **BEGINNING EQUIPMENT POSTURE** | | | |
| 1 | # MSN CAP | EQUIP STATUS RPT OR LINE 13 PREV DAY | 45 | 43 | |
| | | **DISPOSITION OF NON-OPERATIONAL EQUIPMENT** | | | |
| 2 | TOT NON-OP FACTOR 15% | NON-OP FACTOR TIMES ROW 1 | 7 | 6 | |
| 3 | NON-REPAIR FACTOR 20% | NON-RPR FACTOR TIMES ROW 2 | 1 | 1 | |
| 4 | REPARABLE FACTOR 80% | REPAIR FACTOR TIMES ROW 2 | 6 | 5 | |
| | | **DISPOSITION OF REPARABLE EQUIPMENT** | | | |
| 5 | REP ON SITE FACTOR 20% | ON SITE FACTOR TIMES ROW 4 | 1 | 1 | |
| 6 | REP DSU FACTOR 20% | DSU FACTOR TIMES ROW 4 | 1 | 1 | |
| 7 | REP GSU FACTOR 30% | GSU FACTOR TIMES ROW 4 | 2 | 2 | |
| 8 | EVAC TO TA FACTOR 30% | TA FACTOR TIMES ROW 4 | 2 | 1 | |
| | | **DISPOSITION OF RETURNS** | | | |
| 9 | RTN ON SITE (SAME DAY) | ROW 5 | 1 | 1 | |
| 10 | RTNS DSU (ONE DAY) | ROW 6 YESTERDAY | 1 | 1 | |
| 11 | RTNS GSU (THREE DAYS) | ROW 7 THREE DAYS AGO | 3 | 2 | |
| 12 | TOTAL RETURNS | SUM OF ROWS 9, 10 AND 11 | 5 | 4 | |
| | | **ENDING EQUIPMENT POSTURE** | | | |
| 13 | ENDING DAY MSN CAP | ROW 1 MINUS ROW 2, PLUS ROW 12 | 43 | 41 | |

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