FMFRP 3-202

Lessons Learned by the Saudi Arabian National Guard

U.S. Marine Corps

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PREFACE

1. PURPOSE

Fleet Marine Force Reference Publication (FMFRP) 3-202, Lessons Learned by the Saudi Arabian National Guard, provides lessons the Saudi Arabian National Guard passed on to U.S. personnel working with them.

2. SCOPE

Each lesson explained in this manual is simple. In total, they provide an overview of desert operations.

3. BACKGROUND

a. Desert operations have much in common with operations in the other parts of the world. The unique aspects of desert operations stem primarily from deserts' heat and lack of moisture. While these two factors have significant consequences, most of the doctrine, tactics, techniques, and procedures used in operations in other parts of the world apply to desert operations. The challenge of desert operations is to adapt to a new environment.

b. FMFRP 3-202 was originally published as a series of lessons-learned reports by the U.S. Army Project Manager, Saudi Arabian National Guard Modernization.

4. RECOMMENDATIONS

This manual will not be revised. However, comments on the manual are welcomed and will be used in revising other manuals on desert warfare. Submit comments to --

Commanding General
Marine Corps Combat Development Command (WF12)
Quantico, VA 22134-5001

5. CERTIFICATION

Reviewed and approved this date.

BY DIRECTION OF THE COMMANDANT OF THE MARINE CORPS

M. P. CAULFIELD
Major General, U.S. Marine Corps
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FMFRP 3-202

LESSONS LEARNED
by the
SAUDI ARABIAN NATIONAL GUARD

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ACKNOWLEDGMENT

This document was developed from material prepared by officers of the Office of the Program Manager, Saudi Arabian National Guard (OPM-SANG) Modernization Program to be used as a handy reference of information and lessons learned regarding desert operations. Its subject matter is intended to supplement other Fleet Marine Force Manuals, Field Manuals, Operational Handbooks and Fleet Marine Force Reference Manuals that address this topic. Special acknowledgement is given to B/Gen John W. Hudachek, US Army who was the Program Manager when the summary report of OPM-SANG observations on desert operations was developed in 1978 that served as a catalyst for this FMFRP.

SUMMARY REPORT
OFFICE OF THE PROJECT MANAGER FOR MODERNIZATION (OMP)
of
SAUDI ARABIAN NATIONAL GUARD (SANG)

OMP SANG OBSERVATIONS/RECOMMENDATIONS ON DESERT OPERATIONS

1001. GENERAL

a. Purpose. To summarize observations on the effect of the Saudi Arabian desert environment on combat, combat support, combat service support operations, personnel, personal equipment and vehicle mobility.

b. Background

(1) The observations contained in this Summary Report were made by members of the Office of the Project Manager for Modernization of the Saudi Arabian National Guard (OPM SANG) during the period July 1977 through December 1978. Project Manager for the US Army was B/Gen JOHN W. HUDUCHEK.

(2) OPM SANG is responsible for the management of three US civilian firms who have contracted with the United States Government to organize and train four battalions of the SANG as modern mechanized combat battalions. OPM SANG is manned by 24 field grade officers and NCOs, and 39 DACs. All branches of the Army with the exceptions of Air Defense Artillery, Chemical, Military Intelligence and Medical are represented on the Project Managers Team.

(3) The SANG battalions being trained are organized as independently operating Combined Arms Battalions (CAB). Each battalion has five subordinate companies: Headquarters and Headquarters Company; three maneuver companies (three mechanized rifle platoons, one anti-armor platoon, and one mortar platoon per company); and one composite Direct Support/ADA Battery. The CABs are being equipped, under Foriegn Military Sales (FMS), with the V150 Armored Car (see Appendix A) manufactured by Cadillac Gage Company. Direct fire weapons mounted on the V150s include 7.62mm MG, 50cal MGs, 20mm cannons, 90mm cannons, and TOW missile systems. Mortar platoon V150s mount the 81mm mortar. Direct support artillery is equipped with the towed M102A1 105mm howitzer. The ADA platoon is equipped with the towed basic Vulcan AD weapon system.

(4) Three Saudi Arabian National Gaurd (SNAG) battalions have completed formal training and are now

conducting operational readiness training on their own initiative. An implied mission requires OPM SANG personnel to monitor and evaluate operational readiness training. Over the past 18 months OMP SANG personnel have observed 25 battalion and company FTXs varying in duration from 1 to 18 days. All FTXs include night operations. Three FTXs involved live fire and maneuver.

c. Saudi Arabian Desert Environment. This paragraph summarizes the environment in the major training areas (MTA) used by SANG within a 200km radius of Riyadh, Saudi Arabia.

(1) Terrain. The desert floor is deceptive - areas which appear to be hard can actually be silt deposits. This type of surface breaks easily and vehicles (including four-wheel drive) will bottom out and become stuck. The MTAs present three types of desert terrain: mountainous, rocky plateau, and sandy and/or dune desert terrain periodically interspersed with generally north-south escarpments.

(a) The mountain desert terrain is characterized by scattered ranges, barren hills, separated by dry flat or gently rolling basins. The hills rise gradually or abruptly from the flat basins to a height of several hundred meters above the basin floor. For the most part the hills are made of granite and lava boulders and sedimentary rocks varying in size from a few inches to several meters in diameter. There is virtually no water to be found in the mountain desert terrain.

(b) The rocky plateau desert terrain is characterized by extensive nearly flat areas cut by deep wadis having nearly vertical walls. The flat areas have little relief and are covered with large quantities of granite boulders varying in size from a few inches to several feet in diameter. Water is occasionally found in the wadis in deep wells dug by the Bedouin tribesmen along ancient trails.

(c) The sandy or dune desert terrain is characterized by extensive flat areas covered with gravel an drifting sand. The sand dunes and gravel hills rise to a height of several meters above the floor of the flat areas. There is virtually no water to be found in the sandy dune desert terrain.

(d) Escarpments rise almost vertically several hundred meters above the floor of the desert. The escarpment walls are similar to wadi walls; in fact, they are the walls of very large wadis.

(2) Climate and Weather.

(a) Temperature in the summer months (May-Sept) vary from a high of 120-140°F during the day to a low of 50-60°F at night. During the winter months (Oct-Apr) temperatures range from 80-90°F in the day to 30-40°F at night. It is not uncommon to experience temperatures as high as 160°F inside parked combat vehicles and closed tents, during summer months.

(b) Generally west to north-west winds prevail in the MTAs. They vary in velocity from 2-3 mph in the early morning hours to as high as 70-80 mph in the early afternoon. Major sand and dust storms can be expected at least once a week. These can occur from ground level to 15,000 feet. Frequently blowing sand and dust are observed suspended in the air at altitudes from several hundred feet up to 15,000 feet.

(3) Water. There is no surface source of water. There are isolated open wells in some of the wadis. Abundant water is only available from wells which are drilled to tap underground rivers and lakes at depths of 6,000 to 8,000 feet. The water from this source has an extremely high mineral content which makes it unsafe to drink.

(4) Vegetation. Scrub trees, palm trees and brush are frequently found along wadis. The remainder of this desert terrain has little or no vegetation.

(5) Wildlife. The most frequently observed animals are camels, goats, and donkeys. Other wild animals occasionally seen are jackels and hyenas. The sand viper is the only poisonous snake in the area.

(6) Man-made Characteristics. There are few hard surfaced roads within the interior of Saudi Arabia. Secondary gravel roads and trails exist in the desert, but are not maintained. There are virtually no road nor trail markers. Villages made of brick or concrete block houses are located along wadis which have oases. Major cities located near large oases or the sea are few in number. The only major city in the interior is Riyadh which is a rambling city comprised of both modern and ancient dwellings. The railroad from Dammam to Riyadh is the only one in the country. Several airfields are located near the major cities. There are a limited number of VORTAC Stations to aid aerial navigation.

1002. COMBAT OPERATIONS

a. General Considerations

(1) Current US Army tactical doctrine can be effectively employed with minor common sense changes.

(2) The night desert environment will enhance the capability of night vision devices due to numerous expanses of flat terrain and ambient light levels. Daylight binoculars are effective, except on moonless nights, up to a range of 3 to 4 km. On moonless nights thermal sights will be effective; light amplification devices will not.

(3) Land navigation in the desert even in the daylight is extremely difficult. The lack of clearly definable terrain features coupled with inadequate map coverage will pose a major problem for CONUS- or USAREUR-based combat units. Terrain features which are clearly defined to the eye at one point in the desert will disappear if a person moves one or two km. The terrain definition problem is further complicated by the changing appearance of terrain features during the day due to the positioning of the sun. During moonless nights all terrain features become virtually undiscernible to the eye. Only few portions of Saudi Arabia have map coverage. Coverage is generally limited to the East and West coasts around Riyadh, the capital. Maps which are available are of 1:250,000 scale and were last updated in 1975. These maps are out of date and not accurate.

(4) The most effective means of navigation on the desert is dead reckoning using the compass and mileage/km counters which are integral to the vehicle odometer. The Bedouins effectively use the stars to navigate at night. During the daylight they use trail markers constructed with readily available rocks. Installation of a gyrocompass (similar to those installed in aircraft) and resetable milage/km counters in APCs, tanks, and wheeled vehicles should be considered. Due to the absence of terrain features, it is often necessary to create features to mark the trail. Spray paint and stacked rocks work well, however this technique should not be employed if the enemy will use it to his advantage.

(5) Range estimation by eye, particularly during the heat of the day, is extremely inaccurate. Constant practice on the desert can improve the accuracy.

(6) Terrain driving should be employed at all times to limit enemy observation and fire.

(7) The desert floor is deceptive; areas which appear to be hard can actually be silt deposits. This type of surface breaks easily and vehicles (including four-wheel drive) will bottom out and become stuck.

(8) The extensive dispersion required on the desert to avoid detection will necessitate that platoon leaders and company/troop commanders be exceptionally well trained in independent operations. They should possess a high degree of initiative. They must be well trained to accept the fact that they will be cut off and be out of communications frequently.

(9) Dismounted operations, defensive or offensive, except for patrolling, night security and defense of fixed installations should be minimized. Dismounted troops are easily by-passed by aggressive mechanized forces.

(10) Consideration should be given to deploying combat units with US Army personnel trained in the operation of pipelines, pumping stations and oil refineries to temporarily operate these facilities in the event local civilian technicians are not available due to the combat situation.

b. Command and Control

(1) The nature of the desert will make for a highly mobile situation and sometimes a confusing battle. Commanders will often be deployed forward to monitor and "see" the battle and take advantage of fleeting opportunities for decisive action. This demands mobility, communications and a responsive staff system.

(2) The extent and speed of events in a mobile desert battle provide a large number of reports and the tactical handling of such information is vital. Accurate and timely intelligence assessment and aggressive reconnaissance is vital.

(3) Effective intelligence to locate enemy battle positions prior to the attack is essential. Extensive use of electronic surveillance such as Side Looking Airbourne Radar (SLAR), Stand Off Target Acquisition System (SOTAS), ground and air scouts are necessary.

(4) The lack of command and control makes deception operations more important. Deception must be carefully controlled, imaginative, and coordinated. Using decoys, dummy positions with standard activities, (lighting, cooking, etc.), phoney minefields, battle noise simulation,

creation of dust, towing mats behind vehicles to conceal tracks are all effective deception techniques.

c. Communications

(1) Voice and CW radio communication ranges are reduced from one third to one half the planning ranges due to high temperatures, soil content and the sand/dust storms. VHF radios experience the least reduction in range. Reduced radio communication ranges in conjunction with widely dispersed units suggest the need for additional radio equipment in maneuver units.

(2) Radio antennas must have long lead wires to allow them to be placed above the walls of wadis while the radio vehicle remains concealed in the floor of the wadi.

(3) When encountering a communications "dead spot," execute a small displacement to either flank or to the front or rear of the "dead spot."

(4) Sandstorms and duststorms generate static electricity which adversely affects voice and radio teletype communication. Use VHF FM communications during these storms.

d. Cover and Concealment

(1) Camouflage/concealment. The dark colors (olive green, black) of vehicles, tentage, clothing and equipment, camouflage nets, etc. must be modified to fit the colors of the terrain. Colors that blend with the colors and texture of the desert sand must be used. There is an increased requirement for noise and light discipline. Concealment of units and equipment is extremely difficult due to lack of foliage. Adequate use must be made of sparse natural terrain features -- vehicles and equipment should always be in defilade. Vehicle and helicopter camouflage paint and nets are essential for concealment in wadis, both during daylight and at night. Current US Army camouflage paint colors used on combat and tactical vehicles and helicopters will cause the vehicles/helicopters to standout against the desert terrain. The new camouflage nets issued to USAREUR in the past two and three years are not adequate in the desert. Their brown side is too dark and tend to make the concealed object standout. Camouflage colors should be desert tan and light brown.

(2) Emphasis must be placed upon maximum dispersion and concealment of vehicles and helicopters during the daylight. Six or more vehicles and/or helicopters in one location are easily detected at ranges up to 8-10km from the air or high

vantage point. Platoon sized units (five or less vehicles and/or helicopters) can be effectively dispersed and concealed in a wadi.

(3) Division, brigade, DIVARTY and regimental headquarters as currently employed on FTXs in CONUS and in Europe will be easily detected. Emphasis must be placed upon extensive use of small, mobile forward CP elements (five or less vehicles). The majority of the headquarters vehicles must be concealed well to the rear and in villages and cities.

(4) Movement of vehicles (particularly tracked vehicles) during daylight can be easily detected by the naked eye. If movement is necessary it should be accomplished by infiltration of one or two vehicles at a time. Vehicle movement should be at a slow speed and be in the wadis to minimize dust clouds.

(5) Movement of helicopters during daylight will be easily detected unless they use NOE techniques and stay below the rims of the wadis. Hovering altitudes, even during daylight, must be minimized because of the large dust clouds produced. Hovering and NOE flights over gravel, hardpan or rocky areas will normally produce little dust.

(6) Movement of large numbers of vehicles and helicopters should be conducted at night. Ground vehicles can move through smoke or dust storms during the day. Aircraft can maneuver behind smoke. This suggests that concentration for and conduct of an attack and resupply operations be conducted under reduced visibility conditions. However, a sophisticated enemy will possess night vision devices at least as good as ours thereby reducing the protection offered by darkness. Hence night movement (vehicles and helicopters) should be restricted to wadis to minimize detection.

(7) Sun glint (reflection) off vision blocks can be seen for miles. Some makeshift shading device or non-reflective coating is needed to reduce reflections.

(8) Emphasis must be placed on noise and light discipline. On a clear calm night the slightest metallic sound will be heard at a range of several hundred meters. A lighted match or a cigarette can be seen up to several hundred meters.

(9) When moving in the desert cover can only be provided by terrain masking due to lack of heavy vegetation or man-made objects. Shade, smoke and heat shimmer, and

dust will all provide some degree of not being seen during a day move.

(10) Smoke tends to rise with the heat of the desert floor and hangs a few meters above the ground.

(11) Attacks "out of the sun" at sunrise/sunset will provide some concealment for company sized attacking forces. Such attacks will degrade the effectiveness of enemy direct fire.

e. Mobility

(1) In a desert environment speed of execution is essential and requires highly mobile forces (air-mobile/mechanized) with excellent communications. Dismounted infantry are suitable in mountainous deserts.

(2) Four-wheel drive vehicles are essential for cross-desert mobility. Vehicles equipped with large off-road tires which have a high ground clearance (at least 15 inches) have little difficulty in cross-desert movement. Dual tires should never be used as they tend to break up the bearing surface and embed themselves much more than single tires.

(3) Heavy equipment (bulldozers, scrapers, front-end loaders, graders) and tanks/APCs that must move long distances require prime movers. Use of prime movers is dependent upon availability of established road systems. Graders and bulldozers should be equipped with rear mounted hydraulic rippers.

(4) Tracked vehicles will cope better with soft sand than wheeled vehicles. Wheel vehicles may be acceptable as they will go many places that tracked vehicles can go; however, their much lower average speed in poor terrain may be unacceptable during some operations.

(5) The desert floor is deceptive; areas which appear to be hard can actually be silt deposits. This type of surface (desert crust) breaks easily and vehicles (including four-wheel drive) will bottom out and become stuck. Once broken, heavy blowing sand and dusty conditions will exist. Traveling on-line or in echelon formation is best. Vehicles should not follow each other in-line unless restricted by narrow wadi or when required to travel in soft sand. When traveling keep vehicles open, not buttoned up.

(6) Land navigation is difficult at best due to lack of clearly defined terrain features and terrain features that constantly change. Map coverage (availability, accuracy,

adequate detail) is inadequate. The terrain definition is further complicated by the changing appearance of terrain features due to the positioning of the sun. The most effective means of navigation is dead reckoning using the compass and an odometer with maps as a secondary reference. The fact that vehicles will seldom travel in straight lines complicates the issue. Gyrocompasses and resetable milage counters are helpful. Stars can be useful. Knowledge of celestial navigation would greatly enhance cross-country movement.

(7) If road movement is not an option, artillery, Medevac, and ammunition will need to be high on the priority list for helicopter lift. Keep in mind the reduced payload capability of aircraft in the desert heat and the wide dispersion of units. Tactical movement and resupply activity should be done at night to cover the distances undetected. Navigation and desert hazard problems are more apt to happen during night movement.

(8) Minimize the use of towed equipment in desert warfare. Well trained drivers can drive many types of vehicles over "mixed" terrain and not get stuck. Training and experience is essential. Lack of weight classification on roads, bridges, and overpasses may hamper movements. Route reconnaissance is a must.

(9) Pipeline crossings (both hasty and deliberate) must be expected. Go over it or remove it. Removal is the last resort.

(10) The presence of water will reduce trafficability in loam and wadi areas, however, it may improve it in sand. Chain link fencing can be utilized to develop semi-permanent roads.

f. Defensive Operations

(1) The active defense is the most effective means of conducting defensive operations against an enemy mechanized, airmobile, or armor force in the desert. Static defenses should only be used to defend key installations.

(2) The active defense must be conducted on a wide frontage due to the lack of cover and concealment.

(3) Effective terrain analysis at all levels of command is the key to success of the active defense. Platoon leaders through brigade commanders must make actual ground reconnaissance as opposed to map reconnaissance. Leaders must move forward and to the flanks of tactical positions and observe them through the eyes of the enemy since terrain

which may appear defensible from the friendly side may be easily bypassed by the enemy without being seen. Avenues of withdrawal must be physically checked to avoid "box" wadis.

(4) Emphasis should be placed on retaining a strong mobile reserve. The reserve must be dispersed to avoid presenting a lucrative target, but must also be able to concentrate quickly when required.

(5) Due to wide dispersion and rugged terrain, security will be especially difficult. Patrolling and/or observation between elements must be constant. Flank security will remain a priority. The use of security elements such as observation devices and LPs/OPs that are able to observe wadis leading into or by-passing battle positions is recommended.

(6) The desert terrain will tend to canalize enemy armor and mechanized units to movement through wadis to avoid detection. Long range artillery and air dropable mines can be effectively employed to canalize enemy units into wadis which will significantly restrict the enemy maneuverability. Movement through wadis offer the defender ample opportunity to conduct effective hasty and preplanned ambushed.

(7) Main battle areas must be effectively screened to detect enemy movement at maximum artillery range. The screen should be made up of lightly armed scouts mounted in 1/4 ton vehicles and Light Observation Helicopters (LOHs). Extensive use should be made of electronic-surveillance equipment such as SLAR and SOTAS to supplement the scouts. The scouts should have the capability to adjust artillery fire at maximum range, direct movement of attack helicopters to establish hasty ambushes, and direct air strikes.

(8) Defensive engagements should be conducted from the flank and rear within the main battle area.

(9) Smoke and dust will significantly degrade the effectiveness of direct fire weapons. Degradation is worse than is normally experienced in CONUS and USAREUR MTAs.

g. Offensive Operations

(1) Night offensive operations should be the rule rather than the exception to achieve maximum concealment. This will require extensive accurate terrain analysis by maneuver units to insure that they do not move into "box" wadis or get misoriented. The use of experienced scouts mounted in 1/4 ton vehicles preceding maneuver units is essential.

(2) Effective intelligence to locate enemy battle positions prior to the attack is essential. Extensive use of electronic surveillance such as SLAR and SOTAS and ground and air scouts is directed.

(3) Attacks which would by-pass enemy battle positions at distances of 50 to 100km to allow the attacking force to attack from the rear appear to be feasible. These could be effectively conducted with ground and heliborne maneuver units.

(4) Attacks "out of the sun" at sunrise or sunset will provide some concealment for company sized attacking forces. Such attacks will degrade the effectiveness of enemy direct fire.

(5) Once started the attack will be difficult to control. Dust and smoke will obscure the battlefield. Enemy EW and the terrain itself will impede radio communication. In rugged terrain the elements attacking would become separated by hills between narrow wadis.

(6) Attacking forces should move on multiple routes, from dispersed positions, to concentrate for the attack. They should concentrate on the move near the objective. They should not concentrate and conduct a long approach march in mass.

(7) When concentrating or moving at night good light and noise discipline is a must. Indirect fire may be necessary to hide the noise of moving vehicles.

1003. COMBAT SUPPORT OPERATIONS

a. Aviation

(1) Sudden sand storms and strong winds may preclude aircraft operations at tactical altitudes for several hours each week.

(2) Dust created by rotor downwash and windborne dust clouds will cause instrument metrological conditions (IMC) near the ground and interfere with observation and target acquisition. Windborne dust will obscure vision and may cause IMC at low level and contour levels.

(3) Blowing sand and dust will scratch and craze windscreens and chin bubbles thereby restricting night flight.

(4) Additional mechanics may be required because of increased failure rates of engines, seals, bearing and rotor blades, due to sand and dust.

(5) Laser range finders will eliminate the visual range estimation problem for helicopter crews.

(6) On board navigation systems such as PLRS, Doppler or Inertial are needed to reduce pilot workload and make accurate reporting possible.

(7) Night flight on moonless nights may increase incidents of vertigo at Nap Of the Earth (NOE) altitudes. Flight over open flats and gently rolling terrain may be possible. Flight through the rugged hills and wadis will require the Terrain Avoidance Detection System/Personnel Night Vision System (TADS/PNVS). In such terrain, features and the horizon disappear into blackness.

(8) Unit command posts (CP) and billeting areas can be hidden in small wadis and branches of large wadis. Maintenance facilities and aircraft undergoing maintenance will be difficult to conceal and camouflage. Maintenance facilities should be concealed in villages.

(9) Aircrew availability will be reduced by the stress imposed by living and operating in the desert. Heat, sand, dust, and lack of water will impact living conditions and the ability to rest and relax once out of the cockpit. Night NOE flight will be even more demanding than usual on moonless or near moonless nights.

(10) Flying time and performance is degraded as altitude and heat increases. Engines and rotor systems are less efficient.

(11) Semi-permanent heliports or aviation unit areas will require peneplain or similar soil treatment.

(12) Helicopters should not be moved under their own power. Push helicopters on the ground and minimize rev-ups. Dust can be reduced by landing/taking off on rock, oiled or wet sand surfaces.

(13) Low hovering can lead to sand ingestion by engines, observation clouds, and pilot disorientation.

(14) Helicopters should not land in the same area twice - the first aircraft breaks the desert crust, then the second creates "brown-out" when it lands. Best helicopter landing formation is echelon, that way each pilot can see

and be moved forward without being hindered. Keep the radius of operation as short as possible.

b. Field Artillery

(1) Survey accuracy is greatly reduced due to the absence of survey control points and reliable maps throughout much of the country.

(2) Forward observers are able to see targets at distances of 8-10km. However, range estimation is frequently in error due to deceptive terrain in many areas. During the very hot months, refraction of light passing over the hot desert surface produces mirages that further confuses observers. Laser range finders would be highly desirable.

(3) The extreme heat during the summer months is sufficient to melt chemical munitions such as white phosphorous. They must be stored in upright position and covered. Powder temperatures should be closely checked because the day/night temperatures change inside the rounds may exceed 80°F.

(4) Great dispersion of units and resulting large frontages places a heavy burden on vehicles and equipment. Towed artillery is frequently delayed during displacements due to deep sand and/or extremely rugged terrain. It is not unusual to have several sections bogged down in sand and be required to "hip" shoot in place. Extreme howitzer position corrections are usually required as a result. Severe terrain delays ammunition resupply so that the available supply rate invariably is far less than the required supply rate.

(5) The limited range of reliable communications is a problem for the artillery. Fire missions must frequently be relayed through other units causing delays and occasionally errors. Only aggressive, determined action on the part of the Fire Direction Officer can overcome the confusion and frustration that invariably develops as result.

c. Observation and Field of Fire

(1) Open terrain and a predominantly clear atmosphere generally offer excellent long range visibility, but at certain times of the day it may be limited or distorted by heavy effects. Dust from helicopters flying NOE can be seen from a distance of 10-20 km and columns of vehicles can be easily identified at more than 5 km from observation posts on dominant terrain.

(2) The ideal OP should have the sun behind it and be as high as possible to lessen the effects of mirage and heat radiation from the ground.

(3) Open terrain and clear visibility offer long range observation. This puts increased emphasis on accurate shooting and on the importance of the medium and heavy machine gun, mortar (problems associated with getting them and the ammunition to a suitable base plate positions to support operations), field artillery and close air support. The machine guns and mortars will be vital weapons at the platoon and company level on any desert operation. Dismounted infantry may well find the burden of the tripod a worthwhile investment because of the additional range and accuracy this affords.

(4) The night desert environment will enhance the capability of night vision devices due to numerous expanses of flat terrain and ambient light levels. Daylight binoculars are effective, except on moonless nights, up to a range of 3 to 4 km. On moonless nights thermal sights will be effective; light amplification devices will not.

(5) Forward observers are able to see targets at distances of 8-10 km. However, range estimation is frequently in error due to deceptive terrain in many areas. Heat shimmer (mirage) further confuses observers. Laser range finders would be highly desirable. Observation is best at dawn and dusk when the air is cooler.

(6) Observation of fires, especially direct fires, may be difficult. Considerable dust clouds can be thrown up by high velocity, direct-fire weapons. Burst-on-target corrections may be almost impossible. Crews may have to use flank observers to report elevation and azimuth errors. Corrections of field artillery fires, especially those of larger pieces, may be complicated by dust hanging in the air following the impact of ranging rounds. Forward observers should, therefore, place initial rounds beyond a target rather than short of the target.

(7) Smoke and dust will significantly degrade the effectiveness of direct fire weapons after the initial engagement. Degradation is worse than is normally experienced in CONUS and USAREUR MTAs.

(8) The TOW weapon system is highly effective in the desert. Its dust signature is a consideration but not a drawback.

d. Air Defense Artillery

(1) The Towed Vulcan found in non-divisional ADA battalions and in airborne and airmobile divisions lacks desert mobility. The weapons frequently become stuck and receive damage to tires, rims and suspension. The same problems can be expected with Towed Hawk.

(2) The large distances between friendly units and support units will make it difficult to position ADA assets to provide mutual support and overlapping fires, thereby adequately protecting assets. Additional ADA assets and radio relay stations will be required to alleviate the problem.

(3) Windborne dust and thermal effects (on the air) will hinder target acquisition by Stinger and Chaparral/Vulcan gunners.

1004. COMBAT SERVICE SUPPORT OPERATIONS This paragraph summarizes observations on the effect of the desert environment on maintenance, supply/transportation, services and medical combat service support operations.

a. Maintenance/Equipment Operation.

(1) The anticipated great dispersion and wide frontages suggest the need for increased numbers of DS/GS maintenance contact teams.

(2) Special attention must be paid to equipment having operational temperature limitations, e.g. TOW. Extreme desert temperatures may exceed these operational limitations.

(3) High failure rates can be expected for wheels and tires, especially on 105 howitzers. Failure of suspension arms and bushings can be expected because of the extremely rough terrain. Separation of cargo bodies and cabs from frames due to vibration during cross country operations can be expected. Extremes of heat and cold during days and nights respectively causes failure of seals, rubber hoses and contributes to tire failure.

(4) High usage rates on filters must be planned for. Increased requirements must be anticipated for repair parts. These parts include tires, shock absorbers, springs, bench stock, oils, greases, U-joints, drive shafts, clutch components, axles, steering components, wheel bearings, ball joints, batteries, and all cooling system components/parts.

(5) Vehicle Recovery Operations will generate an increased need for tow ropes, bars and matting. Vehicle operators and recovery personnel must be well trained in the use of field expedients in recovery equipment. "Dead man" anchors are scarce.

(6) Batteries will tend to boil over if not properly maintained. Battery hold down devices work loose due to excessive vibration.

(7) Grease and lubricants must be protected from dust and sand contamination.

(8) Fuel tankers must be protected to preclude sand and dust contamination. Constant inspection is required to insure against vibration induced leaks.

(9) Maintenance operations are difficult due to sustained high winds, blowing sand and extreme temperatures. Enclosed maintenance tents are not practical from the standpoint of heat, mobility and concealment. Alternatives to maintenance shelters include tarpaulins stretched between vehicles and/or more shop van type vehicles. The increase in shop vans also increases the requirement for generators.

(10) Frequent high winds and extreme heat preclude extensive use or maintenance shelters. An alternative is tarpaulins stretched between two vehicles as a wind break and to provide shelter. Consideration should be given to increasing the number of shop vans as another alternative. Whenever possible, maintenance facilities should be located in villages or oases, since these provide the most effective concealment.

(11) Special attention must be given to equipment and components whose operational effectiveness is sensitive to high ambient temperatures. During the heat of the summer temperatures in excess of 160°F are not uncommon inside combat vehicles and closed tents. These high temperatures will damage TOW system and vehicle batteries in particular.

(12) Command emphasis must be placed on timely and effective operator and crew maintenance of equipment and weapons to minimize damage from dust and sand.

(13) Sand dunes, silt deposits and steep wadi walls will significantly increase the need for tow bars, ropes and matting to assist in vehicle recovery operations. Vehicle operators and recovery personnel must be well trained in the use of field expedients.

b. Communications/Electronics. A 50% reduction in operating range of VHF and HF equipment is possible and may be expected. Increased wear and tear on wire due to increased solar radiation and blowing sand should be expected. If required to bury wire, a minimum depth of 24 inches is recommended. Slack must be left in wire to allow for shifting sand. Increase maintenance (operator) on all types of communications is necessary due to dust and sand. Constant inspection of grommets and gaskets is required due to extremes in temperature and dust. Sandstorms reduce radio communications drastically. If selection of frequencies is possible, particular attention should be given to LUF (Lowest Usable Frequency) and MUF (Maximum Usable Frequency) charts.

c. Supply/Transportation

(1) Fuels and lubricants must be carefully protected against dust and sand contamination. All but the most tightly sealed containers will allow the fine dust and sand particles to enter and cause contamination.

(2) The lack of good primary and secondary roads will severely strain the supply and transportation system supporting combat units. This suggests increased stockage levels over and above that indicated for PLLs and ASLs. Increased usage of aerial resupply is suggested.

(3) It should be anticipated that there will be increased usage of artillery ammunition and anti-tank missiles due to the extensive open terrain.

(4) Trailers versus Cargo Trucks. The varied and harsh desert terrain affects the choice of vehicles to haul cargo. Current experience dictates more use of cargo trucks rather than trailers. Trailers (water, POL, cargo) may not withstand cross country movement over extended periods of time. Pods (water and POL) mounted in cargo vehicles is a recommended alternative to trailers.

(5) Extrodinary measures must be taken to secure cargo.

d. Recovery. Recovery operations are magnified in the desert. More recovery vehicles than normal will be needed. Winches should be included on all tactical vehicles. Sand dunes, silt deposits and steep wadi walls will significantly increase the need for tow bars, ropes and matting to assist in vehicle recovery operations. Vehicle operators and recovery personnel must be well trained in the use of field recovery expedients. Heavy Equipment Tractor Trailer (HETT) evacuation will be limited to paved roads.

e. Services

(1) Sources of potable (drinking) water are minimal and extreme heat temperatures require consumption of large quantities of water. In most cases there are wells that can supply water for vehicles and personnel cleanliness. Extended drinking of this high mineral water is not recommended. Wells can be drilled in most areas, however the high mineral content would prove difficult or impossible for engineer purification units to extract. Water must be pumped from underground wells, purified and trucked to tactical units. Water, laundry and bath points will be difficult to establish and maintain. Well drilling equipment may be required. Experience indicates that a 900-man battalion will require at least 6400 gallons of water per 24 hour period (7 gallons/man) in the heat of the summer.

(2) Scarcity of water results in a lack of ice, therefore consideration must be given to alternate forms of refrigeration for class A rations and medical supplies.

(3) Water trailers should be replaced with truck-mounted tankers because trailer suspensions and towing systems will fail.

(4) In many rocky and hardpan areas burial of remains will be vary difficult and shallow graves will be required. Remains should be removed from the battlefield before wild animals (jackel, hyena) and the sun make identification difficult.

(5) Gasoline deteriorates with time due to gum formation which causes filter clogging and lowering of the octane number. Twelve months at 100°F will result in the beginning of the gumming process. The gumming rate significantly increases as temperatures increase.

e. Medical

(1) Heat casualties are likely to exceed battle casualties. Minor sicknesses can have serious effects in the desert predisposing more serious conditions caused by the heat.

(2) The temperature of the body is regulated within very narrow limits. Too little salt and water can lead to heat exhaustion, heat cramps or heat stroke; the last being a total breakdown of the body's cooling system. Sound leadership, being physically fit, being thoroughly acclimatized, and drinking sufficient water with the necessary salt will preclude such disaster.

(3) Expect a higher than normal incidence of urinary disorders, possibly as a result of poor drinking water. Skin diseases can be caused by polluted water. Do not use polluted water for washing clothes unless it has been treated first.

(4) Diseases found in the desert include plague, typhus, malaria, dengue fever, dysentery, cholera, and typhoid. Some of these can be prevented by vaccines. High levels of field hygiene and sanitation are necessary to preclude disease where there are no vaccines.

(5) As a campaign lingers on depression can set in. Ill health caused by insects, heat, irregular rest and short supplies will exacerbate this psychological state. Crew fatigue caused by heat, dust, and glare will be a problem both in the air and on the ground. Optimum tour lengths and good leadership can minimize these problems.

(6) Expect higher than normal incidence of respiratory disorders and sinus problems caused by sand and dust. Surgical masks and bandannas can help. Dust will preclude desired sanitary conditions in field hospitals, and aid stations.

(7) Flies and dirt will make minor injuries potentially serious.

(8) Goggles, sunglasses and dust (surgical) masks are required to reduce respiratory irritation and infection. One day of riding an APC without goggles and mask can result in eye/respiratory irritation that will last for days.

1005. PERSONNEL This paragraph summarizes observations on the effect of the desert environment on personnel.

a. Acclimatization. A period of acclimatization is required to avoid casualties. If deployment occurs during the summer months 14 to 30 days will be required. Two weeks of progressive exposure and exertion seems to work well. A winter deployment would require less (3 to 5 days). Jet lag is a serious consideration. As rule of thumb - one day is required to get adjusted for each time zone crossed.

b. Pre-Environmental Training. Before deployment, personnel should be thoroughly indoctrinated concerning desert survival measures, prevention and symptoms of heat stroke/exhaustion and the necessity to protect the eyes from the heat and dust. Personnel to be deployed should be thoroughly indoctrinated in Bedouin customs and traditions to minimize conflict between troops and the ultra-conservative native population.

c. Physical Conditioning. Deployed personnel who are in excellent physical condition should have little difficulty effectively operating in the desert. Those who are in poor physical condition will be ineffective.

d. Water Consumption. Drinking water should never be rationed. If necessary, work load must be reduced. Natural thirst makes an individual want to drink about 2/3 of the water needed to maintain combat efficiency. Leaders must force fluids. Alcohol and cigarettes must be avoided as both contribute to dehydration and lessens resistance to the heat. Individuals should carry two-quart canteens.

1006. PERSONAL EQUIPMENT

a. Clothing. Clothing should be light and loose fitting; must withstand rough wear; light colors are recommended rather than dark colors. Cleated footwear is more appropriate than smooth soled shoes. Boots should be light in color and lightweight to reduce heat and fatigue. Jungle fatigue style uniforms are appropriate for desert use only if they are of a suitable camouflage pattern in light brown and tan. Standard US Army issue fatigues absorb heat and do not blend into the terrain. Load bearing equipment should also be so camouflaged. Combat boots should be lightweight and be made of rough textured (brushed tan/light brown) leather and have a thick cleated sole.

b. Survival Vest. For issue to pilots in desert areas the SRU-21 survival vest should be augmented with sun screen, chap-stick, and some means of providing shade such as a small nylon tarp or commercial "space blanket."

c. Temperature Changes. Due to the great variations between daytime and nighttime temperatures, individuals need clothing that can be easily donned in layers and removed and packed. Layers of clothing that include a sweater, field jacket, scarf, wet weather gear, and gloves are recommended.

e. Head Gear. For wear when contact is not imminent, floppy head gear is needed that will shade the face, ears and neck. A helmet will be worn only when necessary. A scarf around the neck is helpful providing protection against the sun and sandstorm and it can be utilized as a sweat rag. Sunglasses and goggles are recommended.

f. Individual Items. Chapstick and eye ointment are recommended due to irritation from the sun and wind. Deodorant, hair spray, cologne are not recommended as they will attract insects.

1007. ORGANIZATIONAL EQUIPMENT. The desert environment is extremely hard on vehicles and equipment which requires a very high standard of maintenance. Particular attention to both interdependent lubrication and cooling systems is required. Severe impacts can be expected on suspension systems, tracks, transmissions, tires and steering mechanisms. Water-cooled engines should have condensers.

a. Accessory Equipment. Vehicles should carry an air pump, sand ladders, and shovel. Increased the numbers of tow bars, ropes, and matting in the unit and equip all tactical vehicles with winches. Seat belts are a must for all vehicles.

b. Tires. Inner tubes should be installed in all tubeless tires. Sidewalls should be at least 4-ply and tread should be 6-ply for overall strength.

c. Hoses. Water hoses must be kept tight and periodically inspected.

d. Batteries. Batteries will not hold a charge effectively in intense heat. Batteries filled with drinkable water may fail. Local water will contain many dissolved minerals. Evaporation causes many refills which can weaken acidic solutions which will reduce their ability to hold a charge. Vehicle batteries have been known to go dead after as little as 5 days inactivity. Exercise vehicles regularly. Dry cell battery supplies must be increased to offset the high attrition rates caused by the heat. High temperatures will damage TOW system batteries

e. Position engine compartments downwind.

f. Mine Detectors. The nonmetallic mine detector, AN-PRS-7, does not function well in soils with extremely low moisture content.

1008. VEHICLE MOBILITY. This paragraph summarizes observations on the effect of the desert environment on wheeled vehicle mobility. Tracked vehicle mobility is not addressed because it has not been observed.

a. Vehicles. Four-wheel drive vehicles are essential for cross-country desert mobility. Vehicles equipped with large off-road tires and which have a high ground clearance (at least 15 inches) should have little difficulty in cross-country desert movement.

b. Winches. All tactical wheeled vehicles should be equipped with winches.

1009. WEAPONS AND AMMUNITION

a. Dust/Sand/Lubrication. Weapons clogging occurs due to sand and dust accumulation and in-bore detonation is possible. Keep muzzles covered when not in use. Working parts must have absolute minimum amount of lubrication - some weapons experts say that damage caused by firing dry is less than with a sand and oil abrasive paste that is created when lubrication is used.

b. M-16. The 5.56mm M-16 and M-16A1 would not do well in the desert. It lacks the power needed for effective long range fires. The new upgraded M-16A2 has a greater muzzle velocity, much greater range, and therefore, may be adequate.

c. Gun Tube Bend. Gun tube bend which is commonly referred to as "droop" is caused by temperature variations between tube sides which can affect accuracy. It should correct itself once a few rounds are fired. Tanks equipped with thermal gun tube shrouds will compensate on their own.

d. Effect of Extreme Temperature on Mines and Ammunition. Extreme temperatures and extreme temperature variations can affect the functioning of buried mines and increase chances of mine detonation. Surface laying can exacerbate the situation. As with most US ammunition, land mines are built to function in temperatures as high as 125°F and may be stored in temperatures up to 160°F. Do not store ammunition or mines in rooms where temperatures will exceed 160°F.

e. Ammunition Storage. The extreme heat during the summer months is sufficient to melt chemical munitions such as white phosphorous. These munitions must be stored in an upright position and covered. Powder temperatures should be closely checked because the day/night temperatures change inside the rounds may exceed 80°F. Whenever possible store ammunition 1 meter below desert floor with sun-shading (this reduces the ambient temperature to below 100°F.

1010. NUCLEAR, BIOLOGICAL, AND CHEMICAL

a. Temperature. Hot daytime temperatures, due to highly unstable convection currents, will limit chemical agent usage and essentially eliminate the danger of attack with biological agents. Persistent chemical agent attacks will be used primarily to canalize movement and to block avenues of approach.

b. MOPP Gear. During daytime operations, commanders will experience difficulties in keeping their units in protective MOPP gear. Soldiers forced to wear this protective gear during the day cannot be expected to do much work without risking numerous heat casualties.

c. Best Time for Attack. Experience has shown that chemical and biological attacks are most successful and predictable between dusk and dawn. However, the cooler nighttime temperatures will allow soldiers to wear their protective gear without too much discomfort.

d. Nuclear Effects. Nuclear burst effects will be generally the same in the desert as in a temperate climate.

CHAPTER 2

DESERT PREVENTIVE MAINTENANCE AND LESSONS LEARNED

DRCPM-NGL-O 2 Apr 80

MEMORANDUM FOR RECORD

SUBJECT: Desert Preventive Maintenance and Lessons Learned

2001. INTRODUCTION. This MFR will identify lessons learned during desert operations in the Northern Training Areas and during FTX Operations "SUNRISE" conducted in the Layla, Saudi Arabia area. Some lessons learned are also drawn from experience in American deserts. It will also identify maintenance problems and recommend certain preventive maintenance procedures.

2002. DUST/SAND

a. Even in the absence of dust/sand storms, the effect of dust caused by vehicular traffic on air cleaners, air filters, lubricated joints, radiator collars, electronics (all types), optics, etc., takes a heavy toll on equipment.

b. All equipment must be thoroughly cleaned daily. It is not uncommon for an air filter to become completely useless in three days even with cleaning on a daily or more often basis. Oil bath air cleaners require daily cleaning. The fluid level must be constantly checked. A change of oil in the filter is required weekly when severe conditions of dust/sand are experienced.

c. Radiator collars become completely clogged over a period of time causing high engine and transmission failure due to overheating. Daily cleaning with air pressure helps, however it is my experience that a complete periodic steam cleaning is required to fully restore the cooling efficiency.

d. Lubricated joints are a problem. The dust/sand has a habit of infiltrating these joints and rendering them useless. Frequent lubrication is a must (sometimes daily). All excess grease must be wiped off.

e. Electronic gear is very susceptible to dust/sand. It gets in the electric fittings causing poor connection, renders micro-switches inoperable, and can cause overheating by reducing heat conduction. Daily cleaning is a must. Dust/water covers much be serviceable and in place on hand mikes, etc. Daily cleaning with low air pressure or soft brush is a must.

f. Optics almost instantaneously become covered with dust. Prior to use they must be cleaned. This is especially true of sights, binoculars, aiming circles, etc. This effect is lessened by keeping the optics dry and cleaning them as often as possible. Care must be exercised so the lenses do not become scratched. They must be kept in their cases except when in use.

g. Weapons are very susceptible to dust/sand. Dust covers, magazines, etc. must be in place. The weapons must be as dry as possible. Dust/sand will collect on the lubricants and render the weapon inoperable in a short period of time. Even when dry, enough dust/sand can collect around the moving parts to disable the weapon. Vulcan weapons systems become so saturated with dust/sand during a motor march in the desert that the system jams and the cannons lock in place. When tactically feasible, the bolts must be removed during the march. This allows the system to have enough movement to be cleaned and put back into operation. The dust cover must remain on the weapon except when being employed. Frequent cleaning is imperative. Weapons should be cleaned immediately after each sustained cross desert movement.

h. Dust, with the exception of sinkholes, does not usually affect traction. Sand, however, can bog a vehicle down to the axles. Wheeled vehicles with trailers are especially susceptible to getting stuck (estimated 10 times more often than similar vehicles without trailers). Recovery operations are hampered due to poor traction conditions. The use of a deadman anchor presents a problem. Recovery teams should travel with two vehicles of the same type. The use of tow bars and tow ropes is almost ineffective when conducting recovery operations. Winching out a stuck vehicle has proven to be the most effective means of recovery. The low traction conditions result in a high usage of clutches. Self recovery can be accomplished by letting the air pressure down to 10 to 15 pounds and digging yourself out. (NOTE: This must be accomplished immediately when traction is lost. If the wheels dig into the axles, it is too late.) Immediately reinflate the tires after the vehicle is on firm ground. Jacking the vehicle to allow sand to flow under the tires is sometimes effective. A jack base, at least one foot by one foot, is required. Without the jack base, the jack is forced down into the sand and does not raise the vehicle. A jack with a larger piston travel than normal is required for this type operation.

i. A condition know as "cap rock" is often encountered. The terrain appears rocky, however the substrate will not support weight and a vehicle can sink up to the frame when attempting to traverse "cap rock."

j. The occasional desert rain turns the dust to quagmire, the sand to quicksand, and "cap rock" to treacherous mud. The

threat of a flash flood is always present - a dry bed may be five meters deep, 50 meters across, with a current of several kilometers per hour. It is highly advisable to seek high ground during a rainstorm.

k. A sand/dust storm heightens the effects of sand/dust and reduces visibility to a few meters or less. If feasible, stop desert movement during these storms. Rain can follow (and usually does in the Middle East) a severe sand storm to complicate matters.

l. Sand and dust and "cap rock" that support the occasional vehicle can become impassable if several vehicles use the same route. The dust cloud also presents a safety problem in reduced visibility for vehicles following in column. The majority of cross desert travel should be on line or in echelon. Following another vehicle's tracks is not recommended except when crossing dry washes or restricted by the topography.

2003. HEAT

a. Heat is a killer of both people and equipment in the desert. Heat protective clothing is required when working on vehicles. The Arabian desert reaches 140°F in summer and it is impossible to even change a tire without gloves. The vehicle bodies get so hot, severe burns can result when bare skin touches armor or other metal directly exposed to sunlight. A tent or some other form of sunshade is required to perform maintenance during daylight hours.

b. Radiator type coolers are very susceptible to heat. Fluid levels must be kept at their proper level. Even when this is done, a vehicle that has a hard workout has a tendency to overheat quickly.

c. Hoses and lines must be thoroughly inspected. A pin hole leak can cost the serviceability of the vehicle in a short time. An unserviceable vehicle can leave you stranded. Extra hoses, coolant, belts, and drinking water must be carried in the vehicle. Failure to do this, especially taking extra water, can be fatal.

d. The absence of heat must also be addressed. Daytime temperatures can reach 100°F while nighttime temperatures might reach freezing (or close to it). This is very hard on people and equipment. The best time to do preventive maintenance is in the morning.

e. Extreme heat can cause the fail-safe mechanisms in electronic gear to shut the equipment off. Radios, etc., must be shielded from direct sunlight in order to function more

efficiently. Likewise, optics should be shielded from the direct effects of the sun.

f. Extreme heat and temperatures cycling is extremely hard on batteries. Fluid must be kept at the proper level. Battery life is shortened considerably.

g. Prolonged heat degrades C rations quickly. The estimated shelf-life of C-rations at 130°F is three months. Temperatures on the desert floor and inside closed vehicles can exceed 130°F by several degrees. There have been several instances where cases of C-rations have been rendered unfit for human consumption by continued exposure to desert heat.

h. The temperature of the desert often exceeds the safe operating zone of weapons systems (TOW, etc.) and ammunition (especially artillery ammunition). Erratic ballistic behavior has been observed on artillery/tank rounds due to excessive heat. Ammunition must be stored in areas with a double sun shade. Wherever possible, in addition to the double sun shade, the ammunition should be stored approximately one meter below the desert floor. This method reduces the ambient temperature in the storage site below 100°F.

i. The desert is alive with snakes and scorpions. Both of these can be fatal. Anti-snake bite and anti-scorpion sting sera requires refrigeration. Battalion aid stations must be equipped with refrigeration capability to store medicines.

2004. ROUGH TERRAIN

a. It is not uncommon for desert terrain to be rocky. There are some parts of the Yakima desert and the Arabian desert that are impassable due to the rock and topography.

b. Track tension must be adjusted properly. Improper track tension can result in track being thrown in towards the hull.

c. Sidewall damage to wheeled vehicles tires is most common in rocky desert terrain. Most tire failure is due to sidewall damage. Treads do not wear out before the tires need replacing.

d. The roughness of rocky desert terrain takes its toll on suspension, steering, tire rims, and nuts and bolts. It is necessary to do a daily inspection of all nuts and bolts and tighten them as required. The vibrations caused by travelling across rocky terrain loosens them quickly, and further operation then causes them to shear. Incidents of sheared motor mounts, sheared steering gear boxes, broken truck cabs, shifting of tanks on tanker trucks have all been observed. Tire rims, especially on towed Howitzer and towed Vulcan, are easily rendered unserviceable due to the roughness of the terrain.

e. The rocky desert terrain also requires the use of seat belts for safe vehicle operation.

2005. SUMMARY AND ADDITIONAL COMMENTS.

a. PLLs and ASLs must be increase, especially in the following areas:

(1) Air cleaners and filters.
(2) Bulk POL products.
(3) Engines.
(4) Transmissions.
(5) Hoses and belts.
(6) Hydraulic lines.
(7) Cleaning materials.
(8) Tires.
(9) Rims.
(10) Radiator coolers.
(11) Suspension systems and repair parts.
(12) Steering systems and repair parts.
(13) All types of bearings.
(14) All types of seals.
(15) Batteries.

b. Due to the heat and terrain, speeds must be reduced considerably.

c. Special equipment is required in the dessert. Some examples of desert special equipment are:

(1) Heat protective clothing.
(2) Jack bases.
(3) Pioneer tools for all vehicles (especially a D-handled shovel).
(4) Extra water carrying capability. (Each vehicle in Saudi Arabia that does desert travel is equipped with a water tank or several jerry cans with a capacity of approximately 20 gallons.)
(5) Sunshades and maintenance shelters.
(6) A vehicular mounted compass for navigation.
(7) Desert survival kit.
(8) Any vehicle (or group of vehicles) travelling in the desert requires a radio for communication.

d. Radio communications can be degraded by as much as 50 percent by the heat and dust.

e. Vehicles should travel in pairs whenever possible.

f. Relief from the heat is required. To prevent heat injuries, personnel must consume large amounts of water and often seek shade. Even in the shade, the hot, dry desert wind gives

the same effect as working next to a blast furnace. Tent flaps must be open and face the prevailing wind.

g. Desert winds have been observed during sandstorm and rainstorms at over 80 kph. Under these conditions, tents and loose equipment may be lost downwind. Whenever high winds are expected, all equipment must be secured.

EDWARD L. WIEHE
MAJ, OrdC

APPENDIX A

ARMORED CARS IN DESERT OPERATIONS

DEPARTMENT OF THE ARMY
US ARMY PROJECT MANAGER
SAUDI ARABIAN NATIONAL GUARD MODERNIZATION
APO NEW YORK 09038

11 Jun 80

SUBJECT: Armored Cars in Desert Operations

THRU: MG J. R. D. Cleland
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1. The purpose of this letter is to provide you with my observations of the armored car (V-150) currently being used by the Saudi Arabian National Guard (SANG) in tactical operations and to present some considerations which might have application to U.S. Army quick reaction forces.

2. I have now observed the armored car for a period of 12 months and am greatly impressed by its performance in an environment which is extremely hard on any vehicle. This area is composed of generally three types of terrain: mountains, rocky plateaus, and sand or dunes areas periodically interspersed with generally north-south escarpments. The mountain desert is characterized by scattered ranges of barren hills, separated by dry, flat or gently rolling basins. Hills are made of granite and lava boulders and fractured sedimentary rock, all of which vary in size from a few inches to several feet in diameter. The rocky plateau desert terrain is characterized by nearly flat extensive areas cut by deep wadis having nearly vertical walls. The sandy, or dunes terrain is covered with gravel and drifting sand which often rise to a height of 30-40 meters. Escarpments rise almost vertically several hundred meters above the floor of the desert. There is no surface water to be found in this terrain. The climate is extremely harsh during the summer months (May-September). Temperatures during this period vary from a high of 130-140° Fahrenheit to 50-60° at night. It is not uncommon to have temperatures of 160°F inside of vehicles during the summer months.

3. The armored car has shown itself to be exceptionally well suited for desert operations, and is able to negotiate most terrain in the area. It provides a rapidly moving (90 kph), relatively stable firing platform during tactical operations. In several recent field exercises we have observed that the British Land Rover, a vehicle similar to our 1/2 ton, cannot begin to stay with the armored car in either open or rough terrain. I firmly believe that current U.S. tracked vehicles, while being able to traverse much of this terrain, would encounter severe maintenance problems particularly in the suspension systems. Tracked vehicles would require extremely high replacements of road wheels, torsion bars, shock absorbers, sprockets and track pads. In frequently encountered rocky terrain, tracked vehicles would also experience a high rate of thrown track.

4. Another favorable aspect of the armored car is that the basic system is extremely flexible and allows for a wide variety of weapons to be mounted on the platform. Weapons systems currently used by the SANG include TOW, 90mm gun, Vulcan, 20mm cannon, 81mm mortar, and light and heavy machine guns. Additionally, the armored cars which SANG use are available in a number of configurations which include: ambulance, command post, communications, and personnel carriers.

5. Transportability and mobility considerations give the armored car a significant advantage over tracks. This is especially true in the Middle East. Armored cars are not tied to movement along rail or road networks for long hauls. Likewise there is no requirement for transporters. The armored cars can cross great distances quickly with little regard for the terrain. If track laying vehicles were driven over the same route, crew fatigue, travel time and mechanical failures would be considerably higher.

6. The maintainability and reliability of the armored car is, without question, the most significant feature of the V-150. Although SANG drivers and maintenance personnel are not as qualified as comparable US troops, the Operational Readiness (OR) rate has been consistently high. Over the past four years the OR rate has averaged 93% based on data from a fleet of as large 384 vehicles. During peak utilization periods, such as the two multi-battalion exercises (average vehicle mileage was 2000 k/m), and during the Mecca incident, the OR rate was excellent and exceeded 96%. Recent analysis of the maintenance program for the V-150, found at Enclosure 2, established approximate repair costs at $4380 per car per year which represents a high side figure and is considerably less than the $10,500 per year for our own tracked vehicles as expressed in a recent study performed by TARADCOM (TACI). The armored car repair costs also include wages for a high cost civilian work force.

7. In September 1979, the V-150 was subjected to a road test of over 9,900 kilometers directed by the Saudi Arabian National

Guard. Although this vehicle was a product improved car, having a diesel engine and automatic transmission, durability tests reflected basically the same or better results as would be expected of the gas driven model. The vehicle was tested on various types of terrain and performed flawlessly throughout. One minor breakdown did occur 934 kilometers into the test. An oil pressure gage transmitter malfunction (unit replacement) was corrected immediately. Results of the road test are found at Enclosure 3.

8. It is my opinion that a unit formed and equipped with armored cars would be well suited to respond to rapid deployment missions. Such a unit would have a marked advantaged over traditional light or heavy units, especially in initial engagements. Although, there is no advantage between tracked and wheeled vehicles in an airlift, the scales tip in favor of the armored cars once they arrive on the ground. Mobility, durability, reliability and weapons mix of armored cars give the commander more firepower in the engagement area in a shorter period of time than with tracks. This advantage would continue throughout the array of reconnaissance, security and economy of force missions until the arrival of a follow-on heavy force. An armored car rapid reaction force would also be able to perform joint operations with the heavy force with out degradation of either force and would be especially suited for performing reconnaissance and security missions for the heavy force.

9. I would be pleased to provide any further information which you might desire on this subject and my staff is prepared to provide supplementary data on the armored car in the desert.

GERALD T. BARTLETT
BGen, USA
Project Manager

3 Enclosures
as stated

NOTE: Enclosures deleted.