HAINES RESEARCH GROUP PRESENTATION

ANTI-TANK WAREFARE

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MEMORANDUM FOR Faculty Advisor, Group Room MO3, Fort Bliss, TX 79918-8002

SUBJECT: Anti-tank warfare

1. Thesis Statement. The revolution of the anti-tank warfare from 1941 to present.

2. Discussion: Prior to the beginning of WWII. The United States did not have effective anti-tank capabilities against the enemy. The U.S. constantly improved their systems in which we became the most supreme fighting force in the world.

3. Conclusion. With the increased capabilities in the military's arament. The need for constant improvements of the anti-tank weapons are one of our most powerful resources available today.

4. Counterpoint. None

5. Haines Award. We (do/do not) request that the Haines Award Selection Board consider this paper for the General Haines Award for Excellence in research. Writing Research Papers, 10th Edition by James D. Lester, is the guide used in the preparation of this paper

CHARLES M. WINNICKI II
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Chairperson

SGM Terry McGlothen
MSG Winnicki
MSG Abernathy

MO3 SGM McGlothlen, MSG Winnicki, and MSG Abernathy

GROUP HAINES BRIEFING OUTLINE

1. Introduction

   Good morning SGM Johnson and fellow classmates of M03. Our portion of the Haines briefing will cover the Anti-Tank Warfare from 1941 to present. Questions will be addresses at the end of our presentation.

2. Type and Classification of Briefing

   Educational, informative, and unclassified

3. Purpose and Scope

   Heighten the awareness of anti-tank warfare for our portion of the briefings.

4. Outline or Procedure

   During our briefing, we will address some applications, development, facts, and the types of anti-tank warfare involved during the periods of 1941 to present.

5. Body

   The three area's in order of our briefing:

   a. MSG Winnicki – The various Advancements in armor following the end of WW II, Types of weapon improvements, Failure or technological challenges.

   b. MSG Abernathy –Advancements in the Anti-Tank aircrafts in the beginning of WW II, Types of Anti-Tank Aircrafts and Individual functions of the Anti-Tank Aircrafts.

   c. SGM McGlothlen – The revolution of Missile Guided weapons; Javelin, M20, M33, M47 Dragon, M72 Law, M136 AT4.

6. Closing

   Recap, Questions, and Conclusion

The Revolution of Anti-Tank Warfare from 1941-Present

As World War II was drawing to a close, all the major powers were developing monstrous super tanks of 100 tons or more in weight. The Germans had several prototypes of the Super Heavy Tank, the "Maus" (Porsche 205), weighing in at 188 tons and the Henschel E-100 at 140 tons. The British were developing the Model A39 "Tortoise", and the Americans had their own version of the Super Tank designed to break through the Siegfried line defenses expected to encounter in Germany. The proposal called for mounting a new HV 105mm T5E1/67 gun in a tank with 8" frontal armor. This gun could effectively penetrate concrete fortifications.

Work began on this Super Heavy Tank, designated as the T28, in the spring of 1945 at the Pacific Car and Foundry Co. Initial plans called for 5 prototype vehicles and eventually a total of 25. However, the war drew to a close and only 2 were ordered. These prototypes were evaluated at both the Aberdeen Proving Grounds and the Fort Knox facilities. This tank was very heavily armored, with 12" on the front of the hull, 5-1/4" on the lower front hull and 2-1/2" on the sides. The one foot of frontal armor could provide protection against the famous German 88mm gun at a range of 1100 yds. The hull was cast steel and extended 2/3 of the length of the track assembly set to the rear. The suspension system and lower hull were covered with heavy skirts 4" thick. A turtle shaped superstructure had a cupola for the commander and a ring mounted .50 caliber AA machine gun. The tank had a rather low silhouette with the overall height was only 9" with 5-1/2" at the top of the hatches.

This tank did not have the normal turret. Instead, a new 105mm (T5E1) gun was set into a ball shaped 11-1/2"thick mantle. This gun could achieve muzzle velocities up to 3,700 ft/sec., firing high velocity armor piercing rounds. It was a formidable weapon. The traverse was limited to 10 right and 11 left. Elevation was from -5 to +19.5. When traveling, the gun was

locked at the maximum elevation. Without a turret, this vehicle more closely resembled a Self-Propelled Gun and thus was redesignated as the T95 Gun Motor Carriage in 1945. Later, in June of 1946, the vehicle was redesignated as Super Heavy Tank T-28. The only secondary armament carried was a .50 caliber machine gun mounted above the commander's hatch and was operated by a 4-member crew.

This vehicle was the largest AFV of American design in WWII. It was almost 15' wide, 36' long and weighed 190,000 lb. (95 tons). Because of its huge size and weight, it was equipped with 4 sets of tracks, two on each side of 19-1/2" width each. This most unusual arrangement was needed to lower the ground pressure to 11.7 lbs./sq. in. Each track assembly was made up of two complete horizontal volute suspension systems (HVSS). In order to reduce width and weight, the outermost tracks could be removed when the tank was being transported. To assist in this Herculean task, the tank carried two hydraulically assisted winches mounted at the rear of the tank. Each track assembly weighed almost 25 tons, and two could be linked together side by side to form a unit that could be towed behind a prime mover or the tank itself and took a crew almost 3hrs to make this change. The running gear included a total of 64 20-1/2" wheels with rubber backed steel tracks 19-1/2" wide and rear drive with support rollers and front idler.

This monster was powered by an anemic single Ford GAF V-8 gasoline engine developing only 410 hp @ 2600 rpm. The power to weight ratio was only 5.37 hp/ton. The power train consisted of a Torquematic transmission with three speeds forward and one reverse. Brakes were an external contracting type and steering was by controlled differential. With this power train, the tank was badly underpowered and could manage speed maximum speed of only eight mph. Four fuel tanks held 400 gallons of gasoline, allowing a range of 100 miles. The

vision and sighting equipment consisted of two periscopes type M6, one type M10E3 periscope and one 3X telescope M8A1 type T.

There was no stabilization of the main gun and a total of 62 rounds of 105mm ammunition were carried. Manual loading was required resulting in a rate of fire of only four rounds per minute. With its enormous mass, mobility was limited. Performance included: maximum grade 60 %, maximum vertical wall 24" and maximum fording depth 47". Two vehicles underwent intensive evaluation trials until 1947 by which time the superior heavy tanks, T29 and T32, were available. The T-29 mounted the same gun in a conventional rotating turret. The program was terminated in October of that year. At that time, this tank with its 105mm gun was the only Western tank capable of opposing the Soviet JS-3. Consideration was given to producing this tank for the contemplated invasion of Japan.

In 1963 West Germany and the U.S.A. entered into a joint development agreement to build the "Tank of the Century". It was to include all the available state-of-the-art technologies to allow it to serve to the end of the century. The tank was designated as the MBT70 by the U.S. and MBT/Kpz-70 by the West Germans. From the onset, there were significant disagreements as each side endeavored to protect its own defense industries by getting as large a piece of the pie as possible. Disagreement arose over such simple matters as the type of technical drawings and whether metric or SAE treads be used on fasteners in the tank. A compromise allowed the U.S. to use SAE while the Germans stayed with metric, requiring two different sets of tools for maintenance. By 1970 the partnership broke up after completion of a few pilot models. By that time costs had skyrocketed and the U.S. Congress cut off additional funds.

Both US and German versions were produced which differed significantly. The engine in the U.S. version used the Continental AVCR air-cooled 120° V-12 variable compression diesel

developing 1470 hp designed to operate on multi-fuels. The German version used the 12 cyl. MTU MB873 Ka water-cooled multi-fuel engine developing 1500 hp, which together with its drive train could be replaced in 15 minutes. Both engines complied with NATO's policy of being multi-fueled to reduce logistical problems in time of war. There were significant differences in the main armament as well. The U.S. version was equipped with a troublesome 152mm gun/missile launcher system that fired the 152mm M409 round with a HEAT anti-tank warhead. Even this round was unique in that it used a combustible cartridge case. This launcher could also fire a missile which when launched fired off its rocket motor to reach speeds in excess of 2600 mph. It had an effective range of 5700 yards and was guided by an IR beam controlled by the gunner. Development of this Shillelagh missile system was plagued with problems in both the M551 Sheridan and the M6OA2.

The Germans were skeptical of this system and designed a second turret equipped with the Rheinmetall 120mm gun. The MBT design included an autoloader in both versions in order to reduce crew size to 3 and reduce the height of the hull. All three crewmembers were situated in the turret with the driver in his own independent counter-rotating cupola that was designed to face forward regardless of the position of the turret. This proved to be a major problem as drivers complained of disorientation and motion sickness. One advantage of the location was that it was close to the center-of-gravity, giving the MBT70 a superior ride performance by reducing the vertical pitch input to the driver. This reduced pitch input to the driver allowed him to drive at higher speeds before the dynamic ride level he experienced exceeded the US Army's limit of six watts of average absorbed power in the vertical direction. This permitted cross-country speeds much better than the M60A2 in tests carried out at the APG facility.

In 1969, tests of the MBT70 vs. the M60A1E2 (M60A2) were conducted at APG. Both tanks were equipped with a 155mm gun/launcher. The longer barrel of the MBT70 allowed it to fire hypervelocity KE ammo. In bridging tests, vertical obstacle tests, the MBT70 was clearly superior. It was three times faster on the 60% grade and in the acceleration it reached 30 mph in 18 sec. vs. 43 sec. for the M60A2. Cross- country tests in various terrains showed the MBT70 to be clearly superior. In simulated combat exposure tests, the MBT70 had 1/3 less exposure time than the M60A2 and was 30% faster on a six mile course. The study concluded that the MBT70 was superior in every aspect tested. Its higher hp gave better speed and acceleration and its variable hydro pneumatic suspension enabled it to take advantage of its powerful engine for greater speeds over rough terrain and yet crouch lower than the M60A2 in a defilade position to reduce target area. The engine and suspension appeared to be the decisive factors in the unusual record-setting performance of the MBT70 during these comparisons.

This tank was and still is very impressive. It is 29' 8" long with gun forward and only 7' 5" at normal operating height and 11' 15" wide. The thick gun mantlet and huge sloping turret are very impressive. The turret was equipped with a pop-up gun mount carrying a remote controlled 20mm cannon and eight single-barreled smoke grenade launchers were mounted on each side of the turret.

Another innovation on this tank was the complex variable height, Teledyne Continental Model 2812 dual piston hydro pneumatic suspension system, which enabled the tank to drop its overall height to reduce its silhouette in a static firing position. It could drop to a clearance of only 4.5 inches and then to rise for cross-country mobility with a maximum clearance of 28 inches. This was engineering and a mechanic's nightmare with leaks and problems. The controls permitted an adjustment of front/rear, left/right or any combination thereof. The turret was fully

stabilized; the tank was equipped with a laser range finder, a ballistic computer, environmental control, life support system, night sights, spaced armor, and advanced power train. The quality control assurance and reliability were set at a standard never before realized.

The MBT70 embodied such excellent safety features as spaced armor to defeat incoming rounds, with bulkheads, fireproof doors and blowout type sections in the ammunition storage area to minimize crew injury when a hit was received. Self-sealing fuel tanks were also included. The MBT70 could travel 400 miles on 400 gallons of fuel, ford an 8-foot deep stream and climb a 70% grade or cross a nine foot trench. The combat weight was 105,273 lbs. or 52.6 tons.

The first prototypes were presented simultaneously in both Germany and the U.S.A. in July 1967 with technical problems abounded delays and costs skyrocketed. At that time the cost of a single MBT70 was estimated at U.S. $1 million, whereas an M60A2 cost about $220,000. Congress grew increasingly restive after spending more than $400 million in R&D and in 1969 denied any further funds. The Army made a valiant attempts to salvage the program with the XM803 less expensive version incorporating many of the desirable features of the MBT70 six were to be built. Instead, an MBT70 was converted to XM803 specifications and this prototype still exists at Fort Knox, Kentucky.

When the joint project disintegrated, both countries began to work on austerity versions of the Main Battle Tank to utilize some of the advanced technology developed. The American prototype was designated initially as the XM815 but later designated as the XM1 that eventually became the M1 Abrams. The Germans developed the Leopard 2 (AV) that was sent to Aberdeen where it was evaluated versus the XMl prototypes. In January 1977, the U.S. formally

announced it had selected the XMl over the German Leopard 2 prototype, not an unexpected decision.

Was the MBT70 born premature? The technology employed was new and experimental with major design flaws and overruns. The problems encountered incorporating so many new systems widened the gap between the partners. Joint ventures always result in differences between the partners and this one was no different. Some differences were minor, but others were major such as the American insistence on using the ill-fated Shillelagh system while the Germans wanted the flexibility of projectile firing cannon. Interestingly, the Rheinmetall 120mm cannon was later adopted for the Abrams M1A1 tank. This program showed what a modern tank would cost. The XM1 program that followed cost more than the projected costs of the MBT70, even without all the high tech features.

The revolution of Anti-Tank Warfare aviation came into its own during the Second World War. The increased performance, range, and payload of contemporary aircraft meant that air power could move beyond the novelty applications of World War I, becoming a central striking force for all the combatant nations. Over the course of the war, several distinct roles emerged for the application of air power.

Strategic bombing of civilian targets from the air was a strategy first proposed by the Italian theorist General Giulio Douhet. In his book, "The Command of the Air" (1941), Douhet argued that future military leaders could avoid falling into bloody World War I-style trench stalemates by using aviation to strike past the enemy's forces directly at their vulnerable civilian population. Douhet believed that such strikes would cause these populations to rise up in revolt and overthrow their governments to stop the bombing. Douhet's ideas were paralleled by other military theorists who emerged from World War I.

The Boeing B-52 Stratofortress is a long-range strategic bomber flown by the United States Air Force since 1955, replacing the Convair B-36. Although built for the role of Cold War-era nuclear deterrent, its conventional capabilities are these days the more important role in USAF operations, where its long range, heavy weapons load and fearsome reputation prove valuable. Air Combat Command's B-52 is a long-range, heavy bomber that can perform a variety of missions. The bomber is capable of flying at high subsonic speeds at altitudes up to 50,000 feet (15 km). It can carry nuclear or precision guided conventional ordnance with worldwide precision navigation capability. In a conventional conflict, the B-52 can perform strategic attack, air interdiction, offensive counter-air and maritime operations. During Operation Desert Storm, B-52s delivered 40 percent of all the weapons dropped by coalition forces. It is highly effective when used for ocean surveillance, and can assist the U.S. Navy in anti-ship and mine-laying operations. The B-52A first flew in August, 1954, and the B model entered service in 1955. A total of 744 B-52s were built with the last, a B-52H, delivered in October 1962. Only the H model is still in the Air Force inventory and is assigned to Air Combat Command and the Air Force Reserves. The oldest B-52 still flying was a B-52B that was built in 1955, though it also has the fewest flight hours of any surviving B-52. The B-52 contributed to the U.S. success in Afghanistan, providing the ability to loiter high over the battlefield and provide Close Air Support (CAS) through the use of precision guided munitions. The long range and endurance of the B-52 provided a U.S. presence unmatched by any other combat aircraft. B-52's also played a key role in the third Gulf War in 2002-2003 (Operation Iraqi Freedom), where they provided close air support and bombing.

What was the most expensive military project of World War Two? It was the Boeing B-29 Superfortress. It cost $3 billion, the most expensive weapon of World War II. Only used in

the Pacific, to rain both conventional and atomic destruction on Japan's cities, the B-29 surely justified the cost of its development. In September, 1943, the first B-29's rolled off the assembly line at Wichita, followed by deliveries from the other plants over the next several months. A few early B-29s were camouflage painted; the rest were left in natural metal finish. Thirty fuel tanks (in the wings and the bomb bay) carried over 9400 gallons of gasoline. Radar-assisted navigation and bombing sets helped the Superforts get to their targets and drop their bombs accurately.

The AH-64 ApacheAH-64A Apache is the Army's primary attack helicopter. It is a quick-reacting, airborne weapon system that can fight close and deep to destroy, disrupt, or delay enemy forces. The Apache is designed to fight and survive during the day, night and in adverse weather throughout the world. The principal mission of the Apache is the destruction of high-value targets with the HELLFIRE missile. It is also capable of employing a 30MM M230 chain gun and Hydra 70 (2.75 inch) rockets that are lethal against a wide variety of targets. The Apache has a full range of aircraft survivability equipment and has the ability to withstand hits from rounds up to 23MM in critical areas. The AH-64 Apache is a twin-engine, four bladed, multi-mission attack helicopter designed as a highly stable aerial weapons-delivery platform. It is designed to fight and survive during the day, night, and in adverse weather throughout the world. With a tandem-seated crew consisting of the pilot, located in the rear cockpit position and the co-pilot gunner (CPG), located in the front position, the Apache is self-deployable, highly survivable and delivers a lethal array of battlefield armaments. The Apache features a Target Acquisition Designation Sight (TADS) and a Pilot Night Vision Sensor (PNVS) which enables the crew to navigate and conduct precision attacks in day, night and adverse weather conditions. The Apache can carry up to 16 Hellfire laser designated missiles. With a range of over 8,000

meters, the Hellfire is used primarily for the destruction of tanks, armored vehicles and other hard material targets. The Apache can also deliver 76, 2.75" folding fin aerial rockets for use against enemy personnel, light armor vehicles and other soft-skinned targets. Rounding out the Apache's deadly punch are 1,200 rounds of ammunition for its Area Weapons System (AWS), 30MM Automatic Gun. The Apache fully exploits the vertical dimension of the battlefield. Aggressive terrain flight techniques allow the commander to rapidly place the ATKHB at the decisive place at the optimum time. Typically, the area of operations for Apache is the entire corps or divisional sector. Attack helicopters move across the battlefield at speeds in excess of 3 kilometers per minute. Typical planning airspeeds are 100 to 120 knots during daylight and 80 to 100 knots at night. Speeds during marginal weather are reduced commensurate with prevailing conditions. The Apache can attack targets up to 150 km across the FLOT. If greater depth is required, the addition of ERFS tanks can further extend the AH-64's range with a corresponding reduction in Hellfire missile carrying capacity (four fewer Hellfire missiles for each ERFS tank installed). Apache production began in FY82 and the first unit was deployed in FY86. As of November 1993, 807 Apaches were delivered to the Army. The last Army Apache delivery is scheduled for December 1995. Thirty-three attack battalions are deployed and ready for combat. The Army is procuring a total of 824 Apaches to support a new force structure of 25 battalions with 24 Apaches for each unit (16 Active; 2 Reserve; 7 National Guard) under the Aviation Restructure Initiative. Apache production began in FY82 and the first unit was deployed in FY86. As of November 1993, 807 Apaches were delivered to the Army. The last Army Apache delivery is scheduled for December 1995. Thirty-three attack battalions are deployed and ready for combat. The Army is procuring a total of 824 Apaches to support a new force structure of 25 battalions with 24 Apaches for each unit (16 Active; 2 Reserve; 7 National

Guard) under the Aviation Restructure Initiative. The AH-64 fleet consists of two aircraft models, the AH-64A and the newer Longbow Apache (LBA), AH-64D. AH-64A model full-scale production began in 1983 and now over 800 aircraft have been delivered to the U.S. Army and other NATO Allies. The U.S. Army plans to remanufacture its entire AH-64A Apache fleet to the AH-64D configuration over the next decade. The AH-64A fleet exceeded one million flight hours in 1997, and the median age of today's fleet is 9 years and 1,300 flight hours. The AH-64A proved its capabilities in action during both Operation Restore Hope and Operation Desert Storm. Apache helicopters played a key role in the 1989 action in Panama, where much of its activity was at night, when the AH-64's advanced sensors and sighting systems were effective against Panamanian government forces. Apache helicopters also played a major role in the liberation of Kuwait. On 20 November 1990, the 11th Aviation Brigade was alerted for deployment to Southwest Asia from Storck Barracks in Illesheim Germany. The first elements arrived in theater 24 November 1990. By 15 January 1991 the unit had moved 147 helicopters, 325 vehicles and 1,476 soldiers to the region. The Apache helicopters of the Brigade destroyed more than 245 enemy vehicles with no losses.

During Operation Desert Storm, AH-64s were credited with destroying more than 500 tanks plus hundreds of additional armored personnel carriers, trucks and other vehicles. They also were used to destroy vital early warning radar sites, an action that opened the U.N. coalition's battle plan. Apaches also demonstrated the ability to perform when called upon, logging thousands of combat hours at readiness rates in excess of 85 percent during the Gulf War. The Apache is clearly one of the most dynamic and important programs in aviation and the Army, but it is not without limitations. Due to the possibility of surging the engines, pilots have been instructed not to fire rockets from in-board stations. According to current doctrine, they are

to fire no more than pairs with two outboard launchers every three seconds, or fire with only one outboard launcher installed without restrictions (ripples permitted). These are the only conditions permitted. Other firing conditions will be required to be approved via a System Safety Risk Assessment (SSRA).

The AH-64D Longbow Apache is a remanufactured and upgraded version of the AH-64A Apache attack helicopter. The primary modifications to the Apache are the addition of a millimeter-wave Fire Control Radar (FCR) target acquisition system, the fire-and-forget Longbow Hellfire air-to-ground missile, updated T700-GE-701C engines, and a fully-integrated cockpit. In addition, the aircraft receives improved survivability, communications, and navigation capabilities. Most existing capabilities of the AH-64A Apache are retained. During Army operational testing in 1995, all six Longbow Apache prototypes competed against standard AH-64A Apaches. The threat array developed to test the combat capabilities of the two Apache designs was a postulated 2004 lethal and digitized force consisting of heavy armor, air defense and countermeasures. The tests clearly demonstrated that Longbow Apaches are 400 percent more lethal (hitting more targets) than the AH-64A, already the most capable and advanced armed helicopter in the world to enter service; 720 percent more survivable than the AH 64A; and meet or exceed Army requirements for both target engagement range and for probability of acquiring a selected target. The specific requirements and results are classified. It easily can hit moving and stationary tanks on an obscured, dirty battlefield from a range of more than 7 kilometers when optical systems are rendered ineffective. They can use either its Target Acquisition Designation Sight or fire control radar as a targeting sight, offering increased battlefield flexibility. It has the ability to initiate the radar scan, detect and classify more than 128 targets, prioritize the 16 most dangerous targets, transmit the information to other aircraft,

and initiate a precision attack, all in 30 seconds or less. It also requires one third less maintenance man hours (3.4) per flight hour than the requirement. They are also able to fly 91 percent of the time, 11 percent more than the requirement.

With the addition of new and highly sophisticated fire control radar (FCR), more commonly called the Longbow Fire Control Radar; the AH-64D has become the most advanced aerial fighting vehicle in the world. The FCR provides the Apache with the ability to detect, classify, and prioritize stationary and moving targets both on the ground and in the air. With state of the art fire control, digital communications, automatic target classification and many other up to date features, the AH-64D Longbow Apache will dominate the battlefield for years to come.

The revolution of High Explosive Anti-Tank (HEAT) weapons has changed dramatically over the years since beginning in 1941. The bazooka weapon was one of the first anti-tank weapons based on the HEAT (High Explosive Anti-Tank) shell to enter service, used by the United States Armed Forces in World War II. It was nicknamed a "bazooka" from a vague resemblance to the musical instrument. Development took place in Corcoran Hall at the George Washington University in Washington, DC. It was highly effective, so much so that the Germans copied it outright to produce their own version known as the Panzerschreck. The bazooka could be found in all theatres of war during World War II, and was used until the Korean War when it was then replaced by newer weapons such as the LAW in time for the Vietnam War.

Prior to the war the US Army had developed a shaped-charge hand grenade for anti-tank use that was effective at defeating up to 100mm of armor, by far the best such weapon in the

world at the time. However, it was very hard to use in combat, requiring placement directly on the tank, and for this reason it was largely ignored.

Things changed when Colonel Skinner suggested placing the grenade on the front of his experimental rocket launcher, which was a weapon looking for a role. This proved to be a good match, and by late 1942 the Rocket Launcher, M1A1 was introduced. This consisted of a 4 ft (1.2 m) tube with a simple wooden stock and sights, into which the 60 mm rocket grenades were inserted at the rear. A small battery provided a charge to ignite the rocket when the trigger was pulled. The main drawback to the weapon was the large back blast and smoke trail which gave away the position of the shooter.

In 1944 the M1A1 model was supplemented by the improved M9 and then the M9A1 which could be broken into two halves for easier carrying. A larger 3.5 lb (1.6 kg) warhead was under development, but didn't reach service until after the war had ended. By the time of the Korean War an even larger M20 with a 2lb (900 g) 3.5 in (89 mm) warhead was starting to enter service, which could penetrate well over 200 mm of armor and had an extended range of about 150 m. As with the heavier German tanks, the 2.36" bazooka was not sufficiently effective against the rugged T34, arguably the best tank developed in WWII. Actually, it should never have been deployed in Korea, as the M9A1 and other 2.36" models had been withdrawn from service shortly after WWII, and nominally replaced with the M20, of similar design but with a larger rocket. The M20 was deadly against the T34. The 3.5in rocket launcher M20 is a two-piece, smooth bore weapon of the open tube type, and is fired electrically. A bipod and rear support permit firing in a prone position, and the rocket may also be fired from sitting, kneeling and standing positions. The high-explosive anti-tank (HEAT) rockets are capable of penetrating heavy armor at angles of impact up to 30 degrees. Sighting on target is by means of a reflecting

site mounted on the launcher. In firing, the front and rear barrel assemblies are joined to form the firing tube. While carrying, the barrels are unjoined and fastened together side-by-side with a carrying sling, to be less cumbersome. A magneto-type firing device in the trigger grip provides the current for igniting the rockets.

The M72 Light Anti-Armor Weapon was the world's first disposable anti-armor weapon. The M72 66mm LAW (Light Anti-armor Weapon) was developed in the 1960s. It was a revolutionary idea: a pre-packaged rocket which could be fired and the launcher then thrown away. Like the RPG-7, the M72 is capable of penetrating a foot of armor, but its effective range is only 170 to 220 meters. Manufactured by Talley Industries in the U.S. and under license in Norway, it not only became a NATO standard but was copied and produced in Czechoslovakia and Russia (as the RPG-18 and RPG-26). Early versions were frequently inaccurate, corrected by an improved sight and a more powerful rocket motor.

The M72-series LAW is a lightweight, self-contained, anti-armor weapon consisting of a rocket packed in a launcher. It is man-portable, may be fired from either shoulder, and is issued as a round of ammunition. It requires little from the user--only a visual inspection and some operator maintenance. The launcher, which consists of two tubes, one inside the other, serves as a watertight packing container for the rocket and houses a percussion-type firing mechanism that activates the rocket.

The Dragon was developed for the US Army in 1970. The Dragon is a medium range, wire-guided (guidance of the missile to target is controlled by a thin wire), line-of-sight anti-tank/assault missile weapon capable of defeating armored vehicles, fortified bunkers, concrete gun emplacements and other hard targets. The system contains a launcher, tracker and missile. The launcher is an expendable, smooth bore, fiberglass tube with tracker and support bipod,

battery, sling and front and back shock absorbers. It is designed to be carried and fired by an individual gunner.

The US Dragon was redesigned twice, and evolved into the present Super dragon by 1990. The first-generation Dragon, a 1000-meter system requiring 11.2 seconds flight-to-target time, was developed for the US Army and fielded in 1970. A product improvement program (PIP) was initiated by the Marine Corps in 1985 and managed by NSWC Dahlgren. The PIP, designated Dragon II, was designed to increase warhead penetration effectiveness by 85%. The Dragon II missile is actually a retrofit of warheads to the first generation missiles already in the Marine Corps inventory. The current version is capable of penetrating 18 inches of armor at a maximum effective range of 1,500 meters. The Dragon saw limited use in Operation Desert Storm, and Iraq is believed to have captured Dragons from Iran. The Dragon guidance system has been criticized for requiring excessive gunner control, inaccuracy in general, and some early versions suffered recurrent rocket thruster failure. Manufactured by McDonnell Douglas, the Dragon was adopted by the US Army and Marine Corps and is used by at least 10 other countries. The Army has 7,000 systems in its inventory with approximately 33,000 Dragon missiles. The Marine Corps has 17,000 Dragon missiles in its inventory.

The AT4 was designed in the late 1980's for use against the improved armor of light armored vehicles. Although the AT4 is mainly used as an anti-armor weapon, it may be used with limited success against secondary targets such as gun emplacements, pillboxes, buildings, or light vehicles. It replaced the M72 LAW in U.S. service. The M136 AT4 is the Army's primary light anti-tank weapon. The M136 AT4 is a recoilless rifle used primarily by Infantry Forces for engagement and defeat of light armor. The recoilless rifle design permits accurate delivery of an 84mm High Explosive Anti-Armor warhead, with negligible recoil. The M136

AT4 is a lightweight, self-contained, anti-armor weapon consisting of a free-flight, fin-stabilized, rocket-type cartridge packed in an expendable, one-piece, fiberglass-wrapped tube. The M136 AT4 is man-portable and is fired from the right shoulder only. The launcher is watertight for ease of transportation and storage. Unlike the M72-series LAW, the M136 AT4 launcher need not be extended before firing. Though the M136 AT4 can be employed in limited visibility, the firer must be able to see and identify the target and estimate the range to it. Subsequent to the initial fielding of the weapon, a reusable night sight bracket was developed and fielded. It permits utilization of standard night vision equipment. The system's tactical engagement range is 250 meters and has been used in multiple combat situations. The round of ammunition is self-contained in a disposable launch tube. The system weighs 15 pounds and can be utilized effectively with minimal training.

The AT4 can penetrate more than 17.5 inches (450 mm) of armor plate. Its warhead produces highly destructive results behind the armor. Tests against typical urban targets are still ongoing, but the AT4 should penetrate at least as well as the 90mm recoilless rifle if not better. The AT4 has a minimum arming distance of 33 feet (10 meters), which allows it to be fired successfully against close targets. Firers should be well covered by protective equipment when firing at close targets. The AT4 causes only a small entry hole in an armored vehicle target, though some fragmentation or spall may occur. Of all the common building materials, heavy stone is the most difficult to penetrate. The AT4 usually will not penetrate a heavy European-style stonewall. Surface cratering is usually the only effect. Layered brick walls are also difficult to breach with light weapons. Some brick walls can be penetrated by multiple firings, especially if they are less than three bricks thick. The AT4 may require three to five rounds in order to penetrate brick walls. Wooden structural walls offer little resistance to the AT4. Even heavy

timbered walls are penetrated and splintered. Because of its high velocity, the AT4 may penetrate a soft target, such as a car body or frame building, before exploding.

The M3 Multi-Role Anti-Armor Anti-Personnel Weapon System (MAAWS) was originally fielded to the US Ranger in 1990; the program has grown to include NAVY Seals. It is a shoulder-fired, air jumpable and swimmable recoilless rifle system consisting of the M3 Carl Gustaf Rifle and a family of 84mm ammunition. The family of ammunition consists of a High Explosive Anti Tank (HEAT), High Explosive (HE), High Explosive Dual Purpose (HEDP), Smoke, Illumination, Target Practice (TP) and Sub-Caliber Adapter training system.

A January 1978 Anti-Armor Mission Need Statement identified the deficiencies of the Army's current man portable anti-armor weapon, the Dragon. The Joint Service Operational Requirements document for the Javelin was approved in 1986 and amended in 1988. The contract for Javelin EMD was awarded in 1989. The IOT&E, which was completed in December 1993, resulted in the conclusion that the Javelin was effective, but required further assessment for suitability, necessitating follow-on testing in the form of a Limited User Test (LUT) beginning in April 1996. LRIP was approved by the DAB in July 1994. There are several Javelin enhanced producibility program (EPP) changes that are being incorporated in the system to enhance producibility and reduce cost.

The Javelin is a man portable, fire-and-forget, antitank missile employed by dismounted infantry to defeat current and future threat armored combat vehicles. Javelin is intended to replace the Dragon system in the Army and the Marine Corps. JAVELIN has significant improvements over DRAGON. The Javelin's range of approximately 2,500 meters is more than twice that of its predecessor, the Dragon. The Javelin has secondary capabilities against helicopters and ground-fighting positions. It is equipped with an imaging infrared (I2R) system

and a fire-and-forget guided missile. The Javelin's normal engagement mode is top-attack to penetrate the tank's most vulnerable armor. It also has a direct-attack capability to engage targets with overhead cover or in bunkers. Its "soft launch" allows employment from within buildings and enclosed fighting positions. The soft launch signature limits the gunner's exposure to the enemy, thus increasing survivability. JAVELIN is also much more lethal than DRAGON. It has a top attack dual warhead capability which can defeat all known enemy armor systems. The Javelin is a tactical precision engagement system that enhances the Army's ability to dominate the ground maneuver battle. The Javelin's impact on scout capabilities will be significant. It will allow dismounted scouts to execute reconnaissance and combat patrols with a relatively lightweight thermal sight. It will also give dismounted patrols the capability of dealing with unexpected armored vehicle threats.

The US Army's new Javelin anti-tank missile uses neither wires nor lasers; the missile has a small thermal imaging TV camera in the nose and a computer that is sufficiently sophisticated that once locked onto a tank, it will follow it autonomously, even if it is moving.

It is a "fire and forget" system which utilizes a top-attack flight profile against armored vehicles and also has a direct-attack mode for use against buildings or fortifications. The system has a soft launch arrangement which ejects the missile from the tube to a safe distance before igniting the main rocket motor. This reduces the firing signature and allows use from within buildings. Javelin was used in the 2003 invasion of Iraq.

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