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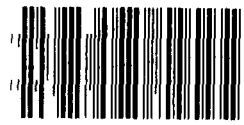
Fact Sheet for the Ranking Minority Member, Committee on Governmental Affairs, United States Senate

February 1987

BRADLEY VEHICLE

Comparison to the M113A3 Armored Personnel Carrier



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February 4, 1987

The Honorable William V. Roth, Jr.
Ranking Minority Member
Committee on Governmental Affairs
United States Senate

Dear Senator Roth:

On November 26, 1986, you asked us to provide you with a report on the vulnerability and mobility of two Army armored infantry vehicles--the Bradley Fighting Vehicle and the M113A3 armored personnel carrier--as analyzed by the Army Materiel Systems Analysis Activity (AMSAA). While both transport troops to battle, the Bradley, with its 25-mm. cannon and the antitank capability provided by its TOW missile launcher, adds firepower to the force that the M113A3 does not.

AMSAA'S analyses, included in a study completed in February 1986, were developed from Army vulnerability and mobility models. These models show that improvements to the engine of the M113A3 have upgraded that vehicle to the point where its mobility is now virtually equal to that of the Bradley. An add-on armor package is currently being tested which, if proven effective, will provide the M113A3 with the same level of armor protection as the Bradley now has. This armor should be available in September 1988. However, the Army is currently testing certain enhancements to the Bradley vehicle, such as improved armor and a spall liner, which, if they prove effective, could make the Bradley more resistant to certain antiarmor weapons, thus decreasing its vulnerability. Tests of these enhancements are now in progress.

Vulnerability and mobility are two of the factors used to determine a vehicle's survivability. Other factors influencing survivability are firepower and battlefield tactics. The Army is conducting live fire tests of the Bradley and will make a final assessment of its survivability following operational testing due to be completed by July 1987.

At the time we began to examine the AMSAA study, the Army published a 1986 "White Paper," which reported that the Bradley Fighting Vehicle was far superior to the M113 armored personnel carrier it is replacing. It compared the vehicles' performance in a number of areas, including mobility, firepower, and armor protection.

The "White Paper," however, did not distinguish between different versions of the M113, which has been modified since it was first deployed. Army officials told us the "White Paper" did not consider the capabilities of the M113A3, the latest version, because it will not be deployed until April 1987. If the add-on armor protection for the M113A3 is proven effective in tests, it will upgrade the vehicle to withstand hits from up to 14.5 mm. ammunition, the same level of threat weapon the Bradleys now fielded can withstand. (The Bradley's armor is also being upgraded, however, and if the new armor is proven effective in tests, the vehicle will be able to withstand certain higher caliber threat weapons.) The models also show that the probabilities of the two vehicles being hit while crossing certain representative terrain in the Federal Republic of Germany are not significantly different. However, the Bradley could more likely suffer a catastrophic loss due to the presence of explosive ammunition on board. A catastrophic loss is defined as one in which the vehicle is damaged beyond repair, often resulting in a high number of personnel casualties. AMSAA's analysis of the two vehicles also shows that their tactical mobility is comparable.

We examined pertinent documentation prepared by the Army concerning the Bradley and M113A3 programs and held discussions with Army officials involved in the programs. We discussed the contents of this fact sheet with cognizant officials at Department of the Army headquarters and incorporated their comments, where appropriate.

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this fact sheet until 20 days from its date. At that time we will send copies to interested parties and make them available to others upon request.

If we can be of further assistance, please call me at (202) 275-4141.

A more detailed discussion of these issues is contained in appendix I.

Sincerely yours,

Henry W. Connor
Senior Associate Director

VULNERABILITY AND MOBILITY COMPARISONS OF ARMORED INFANTRY VEHICLES

In February 1986, the Army Materiel Systems Analysis Activity (AMSAA) completed a study of variants of the Bradley Fighting Vehicle and the M113 armored personnel carrier. The study, based on Army computer models, included analyses of the relative vulnerability and mobility of the Bradley and the M113A3.

Vulnerability and mobility are two factors used to determine a vehicle's survivability. Others include the vehicle's firepower and battlefield tactics. The Army is conducting live fire tests of the Bradley and plans to hold operational tests, which are to conclude by July 1987. The results of these tests are necessary for a final determination of the Bradley's survivability.

The Bradley, which carries up to nine infantry troops, is the Army's newest armored personnel carrier. The troops can either dismount to fight or fight from within the vehicle. The Bradley also carries an antitank TOW missile launcher and, with its 25-mm. gun, can suppress enemy targets, such as fighting vehicles and bunkers.

The M113A3 is the latest version of the M113 series of armored personnel carriers and is scheduled to begin deployment in April 1987. It can carry up to 11 infantrymen. Unlike the Bradley, however, it carries no heavy armament.

VULNERABILITY

The Army's computer models predict a vehicle's vulnerability to a hit from an enemy weapon and--given a hit--the likelihood of its being destroyed or disabled. These predictions contribute to an assessment of a vehicle's relative survivability.

Crossing gaps while under fire

An Army "Gap Crossing Model" calculates the probabilities of a vehicle being hit by enemy fire while crossing certain stretches of open terrain, or "gaps." The vehicle is assumed to be accelerating at full throttle from a stop. The model thus offers a means of quantifying the effect a vehicle's performance has on its vulnerability. In the model, as the vehicle begins its acceleration, the threat weapon detects it, begins an acquisition/aiming procedure, and fires. The vehicle continues to accelerate while the threat weapon continues to fire. When the gap is crossed, the number of shots taken by the threat weapon and the

probability of each shot hitting the vehicle are tabulated and plotted.

AMSAA's analysis simulates the Bradley and the M113A3 accelerating across gaps representative of certain terrain in the Federal Republic of Germany (FRG). Two gap lengths are used in the analysis, 830 feet and 1,594 feet, with three different types of soil. The soil is quantified by a Rating Cone Index (RCI), with the hardest soils having an RCI of 300 and the softest soils an RCI of 0. AMSAA used 290 RCI, 120 RCI, and 60 RCI in its gap crossing analysis. AMSAA used the Fulda area of the FRG as the setting for this model. This area has a soil surface type that, when dry, is hard, with most of the surface having an RCI greater than 250. During the wettest period likely for that area, most of the area has an RCI of 130 or less.

Table 1.1 shows that the Bradley and the M113A3 have similar probabilities of being hit while crossing the two gap lengths under various soil conditions, with two types of weapons firing at them. The identity of those weapons is classified.

Table 1.1: Probabilities of the Bradley and M113A3 Being Hit

	830-foot gap			1,594-foot gap		
Vehicle	290 RCI	120 RCI	60 RCI	290 RCI	120 RCI	60 RCI
Threat number one:						
Bradley	.4643	.4983	.5640	.5633	.6010	.7569
M113A3	.4513	.4902	.5855	.5549	.6053	.7940
Threat number two:						
Bradley	.7364	.7364	.7364	.7364	.7364	.7364
M113A3	.6835	.6835	.6835	.6835	.6835	.6835

Effect of storing highly explosive ammunition

The Army models show the Bradley Fighting Vehicle could be more prone than the M113A3 to a catastrophic loss and high personnel casualties because of the highly explosive ammunition stored in its troop compartment. When both vehicles are fully exposed to enemy weapons, the Bradley could suffer, on the average, more vehicle losses than the M113A3 when hit by certain Soviet antiarmor weapons. The average personnel casualties could be

higher for the Bradley than for the M113A3, even though the M113A3 carries more troops. This is due primarily to the catastrophic losses that could be inflicted on the Bradley by those weapons. A catastrophic loss is one in which the vehicle is destroyed beyond repair, often resulting in high personnel casualties. The M113A3 is not apt to suffer any catastrophic losses from such weapons, because its ammunition is not highly susceptible to explosion.

MOBILITY

In its analysis, AMSAA used mobility and acceleration models to assess mobility for the Bradley and M113A3. The analysis shows that the vehicles' speed and acceleration are virtually the same. The mobility model provides average speeds for off-road and on-road conditions in two areas of the FRG. For the off-road condition, the model calculates the vehicles' average speeds over a terrain in the Fulda area. For the on-road condition, the model calculates the vehicles' average speed on primary roads, secondary roads, and trails for a road network in Schotten. For both off-road and on-road conditions, dry and very wet conditions were examined. The acceleration model calculates a vehicle's maximum acceleration and top speed performance over paved, level, and dry roads.

Off-road mobility

AMSAA determined (1) the average speed of the Bradley and the M113A3 over the 50 percent of the Fulda terrain that is easiest to traverse (V-50) and (2) the portion of terrain denied to each vehicle (stated as a No-Go percent) due to insufficient traction and soil too soft to support the vehicles. AMSAA stated that because the Bradley is wider (10 feet 6 inches versus 8 feet 9 inches) and longer (20 feet 5 inches versus 16 feet) than the M113A3 vehicle it cannot avoid certain vegetation that the M113A3 can.

Table 1.2 shows that the Bradley has a slight advantage over the M113A3 in both dry and very wet off-road conditions. However, AMSAA officials stated that they consider a difference of three miles per hour or less as not being significant.

Table 1.2: Off-Road Performance

	Dry conditions		Wet conditions	
	V-50 (miles per hour)	No-Go (percent)	V-50 (miles per hour)	No-Go (percent)
Bradley	22.8	5.2	18.7	21.0
M113A3	20.3	6.0	15.8	21.1

APPENDIX I

On-road mobility

The size and weight of the Bradley causes it to be slightly slower than the M113A3 on trails. However, the Bradley is faster on paved and secondary roads. Table 1.3 summarizes AMSAA's analysis.

Table 1.3: On-Road Performance

Vehicle	Paved	Secondary	Trails
	(miles per hour)		
Dry conditions:			
Bradley	38.7	31.6	15.6
M113A3	36.1	26.6	16.2
Wet conditions:			
Bradley	38.3	31.6	15.6
M113A3	35.8	26.4	16.1

Paved road acceleration

AMSAA also analyzed the Bradley's and the M113A3's maximum speed and acceleration when roads are paved, level, and dry. Under these conditions the two vehicles have similar characteristics, as shown in table 1.4.

Table 1.4: Paved Road Acceleration

Vehicle	Maximum road speed	Acceleration from 0-20	0-30
	(miles per hour)	(in seconds)	
Bradley	41	9.2	18.4
M113A3	40	8.6	20.6

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