

# The Merkava Mk.3 Defies Its Critics

Israel's Tank Far Exceeds Controversial Rating

By International Group, Expert Says

by Lieutenant Colonel David Eshel, IDF, Retired

The article entitled "What's the Best Tank in the World," (*ARMOR*, July/August 1999) prompts me to take up the cudgels on behalf of the Israeli Merkava Mk.3 MBT which, to my surprise, received the lowest marks out of the list of ten. Allow me, therefore, as a loyal reader of *ARMOR* for several decades and one who has spent his entire adult life in armor matters, to offer a few comments to redress the issue, without prejudice to the other tanks mentioned in the article.

The original report by the renowned firm Weapons Group Forecast International based its report on the following parameters:

- Level of mobility
- Lethality
- Ergonomics.

My article will, therefore, follow the lines of these principal criteria while adding a few of my own where these are deemed necessary to highlight any of my arguments regarding the unique technological characteristics of the Merkava Mk.3 MBT.

As your article rightly states, the original Merkava concept "reflects the unique requirements and doctrine" of the Israeli armed forces. Israel has had to fight, sadly, some of the most vicious tank battles since World War II and has, therefore, established its professional credentials through battlefield experience paid in blood. No less than 1,800 out of the 2,700 men killed in action throughout the three weeks of high-intensity fighting in October 1973 were tank crews. This proportion called for urgent measures to provide a platform which would afford survivability under highly lethal battlefield conditions. The result was the Merkava Mk.1, which first saw action in the 1982 Lebanon War, passing that test with flying colors.

The father of the design concept was Major General Israel Tal who, together with his group of top experts, has since upgraded the original design with countless modifications and improvements to



A Merkava Mk.3 rears up as it crosses an obstacle in recent field test.

reflect performance in battle, which is a routine daily occurrence in Israel. The Merkava Mk.3, which includes several technological breakthroughs in its design, has all the systems and components of ultra-modern technologies which have very few equals in other tanks worldwide.

## Level of Mobility

This article will limit itself to the definition of "Battlefield Mobility," which is the most important criterion for a fighting tank. As [British engineer and tank authority] Richard M. Orgorkiewicz has determined, "the ability of tanks to move at speed over rough ground is governed by their suspensions and in particular by the vertical travel which these provide for the road wheels."<sup>1</sup> The Merkava was designed to meet the topographical requirements of the Golan Heights which, with its basalt rocks, boulders, and deep gorges, present perhaps some of the most demanding ground conditions for battlefield mobility.

The designers have, therefore, provided a special suspension system which is typified by a powerful spring and rotary coil-spring design, differing from the double-spring system used in the previous Merkava Mk.1 and Mk.2 versions. The Merkava Mk.3 suspension is optimized for a fast ride over extremely diffi-

cult terrain, and a vertical road wheel travel of up to 600 mm gives the crew a softer ride. The suspension meets the stringent requirements of 60 km/h in rough country, such as the Golan Heights. The forces acting on the crew, thanks to the excellent absorption capacity of the suspension system, never surpass g-1.

In other tanks undergoing similar tests, when the speed approached g-9, crew members suffered injuries and systems failed to function properly. In the Merkava Mk.3 at double the test speed on the same testbed conditions, the g-force never exceeded g-1 with a totally smooth ride. The reliability of the suspension is absolute; it requires no field maintenance at all, and its life span covers years, and thousands of kilometers.

Another criterion given high priority in the Merkava is the power to weight ratio. Battlefield mobility, though, depends not on the theoretical hp/ton ratio, but rather on the actual power which reaches the sprocket, giving the tank its driving power. According to Orgorkiewicz, "the net engine power is generally taken to be not more than 70% of the gross engine power"<sup>2</sup> at the sprocket. The Merkava Mk.3, which is currently powered by a 1200-hp engine, reaches no less than a net 850 hp on the sprocket, which falls well within the required parameters of



This Merkava Mk.3 has been upgraded with modular armor suite and thermal sleeve integrated into the main gun barrel. At right, a view of the rear hull door, useful for MEDEVACing casualties and as an escape hatch for the crew.



71%. In fact, tanks powered by 1500-hp engines do not perform better when measured at the sprocket, as reliable comparisons show. The Merkava designers are already working on a 1500-hp engine, which will further improve battlefield performance.

Another factor which affects battlefield mobility is the acceleration rate, which has a direct bearing on the tank's survivability in combat. Experience has shown that a figure of around 15 seconds is usually the longest time in which a tank can safely dash from cover to cover under combat conditions. This also depends, of course, on the nature of the battlefield; under Continental conditions it can be less, while in the desert the open ground offers less cover, so that acceleration becomes more crucial.

The Merkava Mk.3 offers a 0-32 km/h acceleration in 10 seconds, comparable to the most advanced tanks in the world. Its combination of excellent cross-country speed — thanks to the advanced technological suspension — and the road wheel configuration makes it one of the best battlefield-mobile tanks. It is, therefore, very surprising that the WGFI report mentioned the Merkava Mk.3 as “by Western standards, somewhat deficient in terms of battlefield mobility due to rather anemic power-to-weight ratio, which is lower than what is considered acceptable in most other leading tank developing nations.” In view of the facts I have given above, it seems superfluous to comment further on this issue.

### Lethality Protection and Firepower

The WGFI report and subsequent *ARMOR* article rightly gives due credit to the Merkava Mk.3's firepower, but some further comments are in order here. The tank mounts a 60mm mortar firing a wide

range of ammunition, such as smoke, illumination and high explosive, up to a range of 3,000 meters. The weapon is highly accurate and has a high rate of fire. It is operated from the fighting compartment, geared to the firing mechanism of the main gun. Apart from three flat trajectory machine guns, the mortar is an important addition in close combat, for the protection of the tank crew against hostile tank killer teams and AT guided missiles.

The Merkava Mk.3 incorporates an extremely reliable threat warning system, which has already proved itself in combat on the battlefield against most enemy threats, such as electro-magnetic, laser, and other means. The tank carries 50 rounds of ammunition for its main armament, rounds which rate among the most effective of their kind, and all battle-proven.

Although full details of the ammunition have not been released for reasons of security, two of the more unique rounds were seen recently. The Anti-Personnel (APAM) cartridge was developed in Israel to meet the requirement for tanks to engage soft ground targets, such as enemy infantry tank killer teams, against which Israeli tanks had no effective countermeasures in the 1973 War.

The other round which has entered service is the Laser Homing Anti-Tank (LAHAT) gun-launched weapon system, which extends the range of normal gun-fired rounds substantially. Both weapons are fully integrated into the tank's fire control system, which in itself is extremely advanced technically. It includes elements developed with the latest state-of-the-art technology, as a result of long combat experience in modern tank fighting. The FCS enables a high rate of first-round hit at long ranges by day and night and under adverse weather conditions,

from stationary or moving platforms against stationary or moving targets.

Using the unique Baz (“Hawk”) auto-tracking system, which locks onto targets at several km ranges, the Merkava's gunner can track and destroy enemy helicopters in flight with his main gun firing APDSFS or HEAT (or the latest LAHAT if available). The gunner's sight is locked onto its target throughout the firing sequence irrespective of any evasive maneuvers the target attempts when aware that it is under threat. The auto tracker system is based on the video output from either a TV camera (daylight channel) or a thermal imaging camera (night channel). The commander's sight is also of the latest design, the result of long years of research and combat experience. One of the main reasons for Israeli tank commander losses in combat was their exposure to enemy fire when operating with their hatches open. Now a new commander's sight enables the Merkava TC to operate with hatches shut down completely, while maintaining full all-round observation without having to traverse the turret. The sight enables the commander to overlap the gunner's sight at the throw of his switch, or override the gunner's sight when priority targets appear in his own sector.

Moreover, the commander's sight is independent of the gunner's, so that he can search for a new target while the gunner is engaging a previous one. The fact that the commander's sight protrudes slightly over the turret top affords the few inches necessary to observe hostile targets from turret-down position.

The Merkava Mk. 1, 2, and 3 have been fighting almost incessantly since 1982 and have destroyed a wide range of targets of all kinds, from tanks to ATGW, bunkers and helicopters. They have also

been hit repeatedly by all kinds of enemy weapons, from hypersonic anti-tank rounds to the latest generations of anti-tank guided weapons. In all of these cases, the Merkava, especially the latest design, has averted major damage to the crew, and is thus regarded as the safest tank in battle. In an incident in Lebanon in 1997, a Merkava Mk.3 took no less than 20 hits by ATGWs, but only a single warhead penetrated from a sharp angle, killing one crew member who had his head outside the tank turret hatch.

### Fightability and Ergonomics

Israeli tank designers have placed the human element at the top of their list of priorities, and the Merkava is a shining example of what this attitude can do to make life more bearable for the tank crew under even the toughest battle conditions. The human element is at the center of the Merkava designers' considerations and this was the main reason for placing the engine in front of the hull, as this is still where the main threat comes from in a tank-versus-tank battle.

The Merkava Mk.3 is protected by a modular armor system, which is a unique approach to modern tank protection suites. It enables the basic tank to be upgraded with special armor suites to fit state-of-the-art technologies as they become available. Today, for example, the Merkava Mk.3 has already upgraded with its fourth generation of special armor. But the Merkava crew is not only protected from incoming rounds; the hybrid air-cooling system CBR is ultra-modern and adapted to meet the most stringent threat conditions presented by both present and future chemical warfare. This enables the crew to fight without cumbersome protective clothing and harness gear. It operates on the principle of a pressure chamber inside the fighting compartment. Optionally, filtered air can be directed to flow into the face masks and protective personal gear when worn by the crew operating with open hatches. The system also includes a modern air conditioning mechanism designed especially to meet the hot climatic conditions prevailing in Israel and its surroundings. It inserts fresh filtered air into the tank hull and crew clothing, dispensing with the heavy special vests worn by most tankers over their coveralls.

Due to special configurations included in the Merkava design, a definite breakthrough has been achieved as regards the survivability of the tank crews. Moreover, the dreaded fire hazard, which has haunted every tanker since WWI, has been virtually eliminated in the Merkava design concept. The percentage of

wounded tank crews suffering from burns when Merkava MBTs were hit has been reduced to *ZERO*. There were no burns whatsoever as a result of Merkava tanks being hit by enemy action, or otherwise, during the 1982 Lebanon War or in the anti-guerrilla campaign since then. In Lebanon, where the Merkava Mk.1 first saw combat, although dozens of crew members were wounded in action, none suffered burns of any kind; in other tanks, like the M60 or the Centurion, the rate was 26% on average, as it was during the 1973 war. There is no tank that can match up to this dramatic lifesaving criterion.

The Merkava Mk.3's fighting compartment is totally "dry." All accessories, ancillaries and supporting systems are electrically operated, devoid of any hydraulic fluids or other inflammable elements. The fire hazard from exploding ammunition is also eliminated by stowage in special heat resistant ammunition containers in the rear compartment.

With the power train located forward, there is ample space in the rear, which can be used for ammunition stowage as well as to carry infantry over dangerous ground, and to evacuate wounded, even on stretchers, where immediate MED-EVAC lifesaving activities can be effected en route.

A quite unique facility is the possibility of installing, in the field, in every tank configuration, additional communications

equipment in order to convert the tank into a command vehicle. There already exist, as standard equipment, all the necessary connection boxes for radio or staff aids, so that within minutes the tank can be converted without any further work. Experience has clearly shown that special command vehicles that can be recognized by the enemy become prime targets.

The Mk.4 version of the Merkava, which is in its final stages of development, will retain the IMI 120mm smoothbore gun and not, as speculated, a larger caliber main armament, such as a 140mm barrel. However, refitted for the use of advanced technology ammunition with enhanced penetration capability, the gun's recoil system has been redesigned and based on compressed gas rather than the traditional heavy coil spring system previously used. For additional enhancement of first-round hit probability, a new thermal sleeve is fitted to the gun barrel, increasing its effect by 80%, according to field tests. The Merkava Mk.4, due to become operational soon, will be powered by a new 1500-hp engine, which has already passed the 10,000 km running field test in a prototype version. Further improvements are on the way, but so far kept under a tight lid of security; however, according to experts, they should represent a new stepping stone in unique tank design, fitting General Tal's concept of advanced technology concepts for the 21st century.

### Notes

<sup>1</sup>See R.M. Ogorkiewicz, *Technology of Tanks*, Janes IG, London.

<sup>2</sup>Ibid.



Using the auto-tracking sight, the Merkava gunner can engage helicopters. In this test, a helicopter UAV is seen here just before and just after being hit.

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