Battle royal between SCUDS AND PATRIOTS

In the Gulf war a small battle was fought between the aged, primitive Scud and the most modern Patriot missles. The Scuds did some damage but mostly they were beaten in their tracks. Here is how and why. ■ **by D. P. Sabharwal**

Karl Von Clausewitz, the 19th century Prussian war theorist, wrote in 1831, "No one starts a war, or rather no one in his senses should do so, without first being clear in his mind what he intends to achieve by that war and how he intends to achieve it."

It seems Saddam Hussein is a keen follower of Clausewitz, for, he knows what he wants. According to a military analyst, Saddam has probably known all along that he cannot hope to achieve a military victory in the Gulf war. Instead, he hopes to extract a political victory out of the jaws of defeat, which means staying alive, at the helm of a still reasonably strong Iraq, as the greatest Arab hero of modern times, who stood up to the mighty West, dared to hit Israel and scared the wits out of the rich monarchs who had thus far dominated the Arab world.

It appears that like Clausewitz, Saddam too knows that war is a conflict of wills, "a test of moral and physical forces by means of the latter." His every response to the US war strategy has so far been politico-psychological rather than military. A few of his actions falling under political strategy have been setting oil facilities on fire, releasing oil into the Gulf and issuing warnings about terrorist action around the world.

On the psychological front his prominent acts have been showing stone-faced US prisoners of war on television, oblique hints at using chemical/biological weapons and, above all, lobbing militarily useless Scud missiles into civilian areas of Tel Aviv and Haifa.

No doubt Saddam Hussein has succeeded in striking a blow against the morale of the Israelis by creating fear and panic in their minds. This is evident from all the pictures appearing in newspapers as well as on television where every Israeli citizen is shown donning gas masks as soon as a Scud missile raid warning is sounded.

Another well-established fact is that Scuds have caused hardly any damage militarily, but have resulted in a lot of psychological damage. After the first surprise attack by 8 Scud missiles on the second day of the war and the second unexpected attack by 11 more Scuds the next day on Israel's cities, no deaths were reported.

However, the attacks caused so much panic that 900 uninjured Israelis were hospitalised because of the psychological after-effects of the attack. In addition, the Israelis were disturbed because, for the first time, they had lost the power of giving a fitting reply to the Arabs.

It was to overcome and arrest this fear, panic and anguish among the Israelis that almost overnight the USA moved the Patriot missile batteries into Israel. However, the US appreciation that only the most up-to-date Patriots could cope with the ageing Russian Scud, no more deployed and used by the Russians themselves, was not at all complimentary to Israel's air-defence or to the US weapons with which it was equipped.



Patriot Missiles in launchers—Ready to be fired.

But as the war progressed, it became clear that even the most advanced Patriot missile system could not eliminate the threat posed by the almost primitive Scud missiles. Ever since Patriots were air-lifted to Israel, Iraq has attacked Israel with Scuds on more than 10 occasions. And during this period, Patriots engaged and destroyed only 36 of 56 Scuds fired at

VIDE ANGLE VIEW

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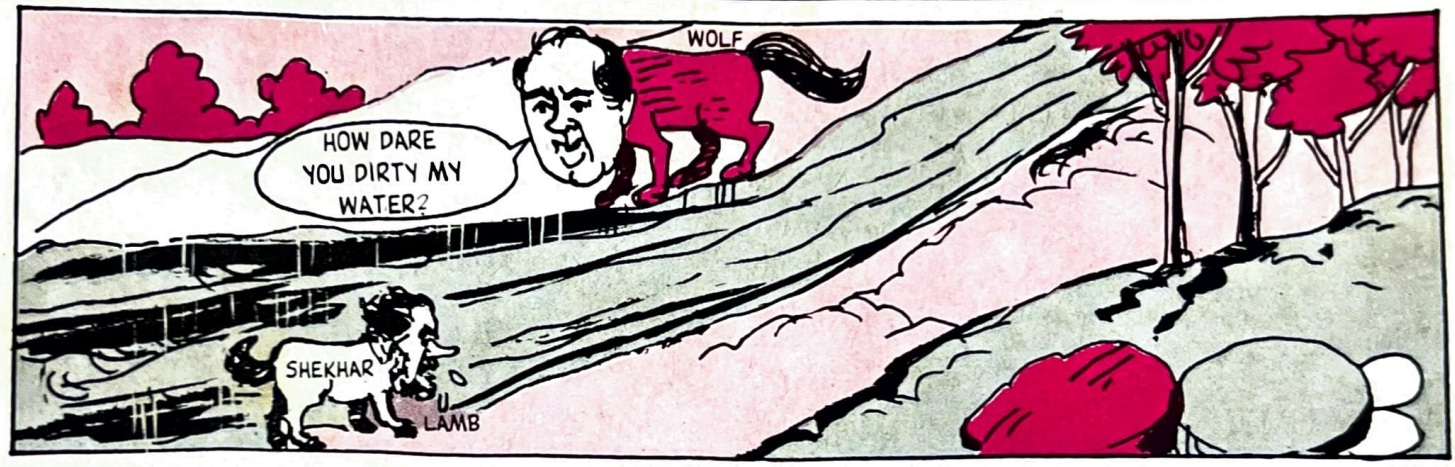
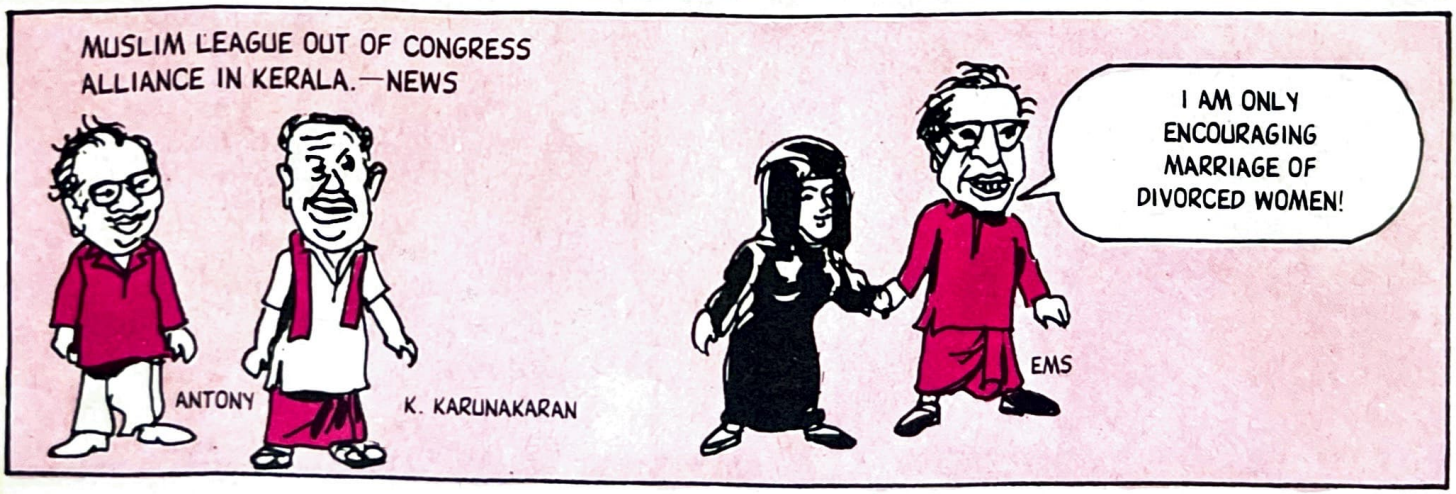
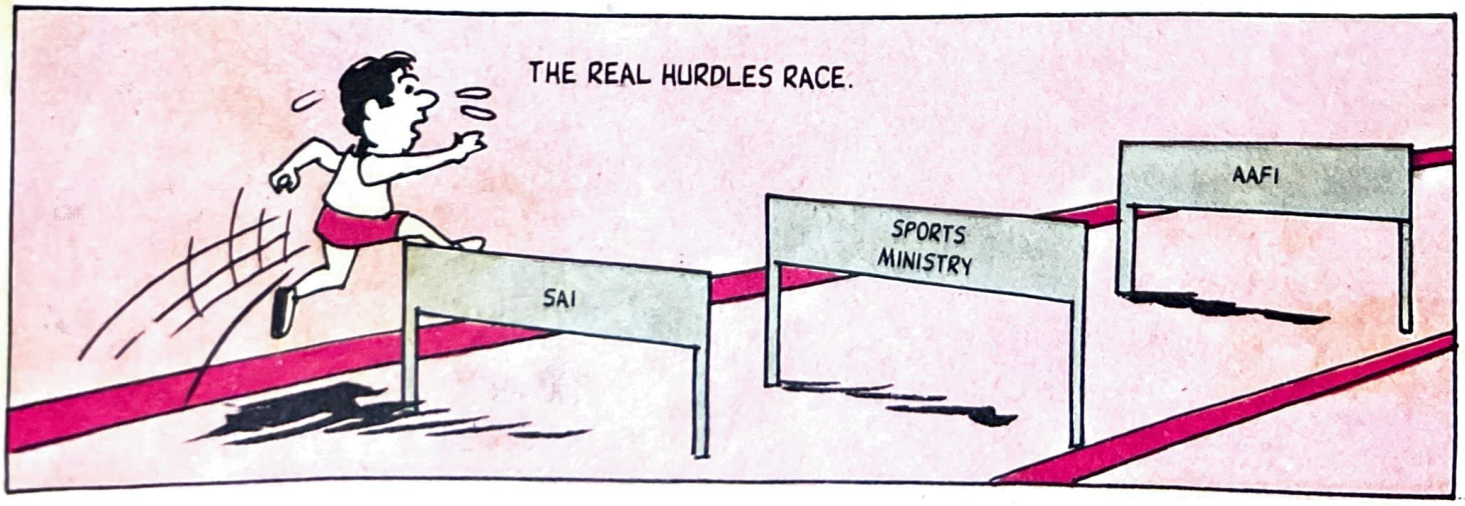






Saudi Arabia and Israel.

The remaining 20 Scud missiles exploded on ground causing modest to extensive damage. Now how many of these 20 missiles were not engaged and how many could not be engaged at all, is a moot point. The fact has emerged loud and clear that the Patriot shield created as a defence against Scud attacks and claimed to be almost perfect and invincible has gaping holes.

As the battle royal between Scuds and Patriots continues between Iraq and multinational forces led by the USA, let us look at these missiles more closely and learn how each one is outwitting and outmanoeuvring the other.

Scud missile

The Scud is a Soviet-designed medium range surface-to-surface guided missile designated as SS-1 but code-named Scud by NATO. The earlier version of the missile had a range of less than 180 km, but Scud-B, held by Iraq, has an extended range of up to 300 km.



Patriot missile leaving its launcher on firing.

However, the modified version of the Scud-B missile named Al-Hussain, and Al-Abbas developed in Iraq with the help of technology and technicians from companies in Germany, France and the USA can reach targets up to a distance of 400 km.

Experts believe that the original Scud missiles supplied by Moscow, and the initial improved models turned out by Iraqi factories having low range, were largely used up in the Iran-Iraq war that ended in 1988. In all probability, the missiles that struck Israel were made in Iraq and belong to higher-range category.

The Scud missile, or for that matter any guided missile, is in effect a pilotless aircraft. It is controlled throughout the flight and is guided all the way to the target. It has a long cylindrical body with a pointed nose and looks like a sharpened pencil.

In its rear portion is the liquid propulsion system, analogous to an engine. The liquid fuel contained inside the missile, on burning, generates gases at high pressure and temperature. These gases are then ejected out of the missile at very high velocity propelling the missile forward.

In the forward section of the missile is placed the warhead and fuse. The warhead contains a few kilograms of "high explosive" which is detonated by the fuse either on impact with the ground or in close proximity with the ground. The damage is caused due to blast and high velocity fragmentations of the missile.

During the flight to the target which is hundreds of miles away, a missile is likely to deviate from the desired or programmed path due to gravitational forces and changes in atmospheric conditions such as wind. To ensure that the missile stays on the desired course, a control and guidance system is required which is located in the middle portion of the missile, behind warhead and ahead of the propulsion system or so, called engine.

A Scud missile has 4 cruciform tail control surfaces, which control the angular motion of the missile in all 3 directions on receiving commands from the guidance system.

Fitted with a radio command guidance system, the Scud missile is tracked throughout its flight by a ground-based radar which computes its velocity and position.

This information is fed to a computing unit which compares the actual position of the missile with the desired position at that point of time.

Scud missiles are known to have been launched from a mobile launcher, which is a 8-wheeled vehicle. During transportation, the missile is in a horizontal position. However, prior to launch, the missile is brought to the upright position by means of hydraulically activated rams fitted on the vehicle.

The original launchers were capable of carrying 1 missile each but Iraq has modified launchers which carry 2 missiles. Accompanying a set of launchers are command/control vehicles and a meteorological unit which carries a weather radar.

The radar collects data which is used to obtain information about upper atmosphere required for ballistic computations regarding the flight path of the missile prior to its launch. This helps minimise the deviation of the missile from its programmed path.

Patriot missile

The US army's MIM-104 Patriot missile is a surface-to-surface battlefield missile basically designed and developed for use against enemy aircraft. In size it is less than half of Scud-B. It can engage targets from a distance of a few hundred metres to about 70 km up to an altitude of 24 km.

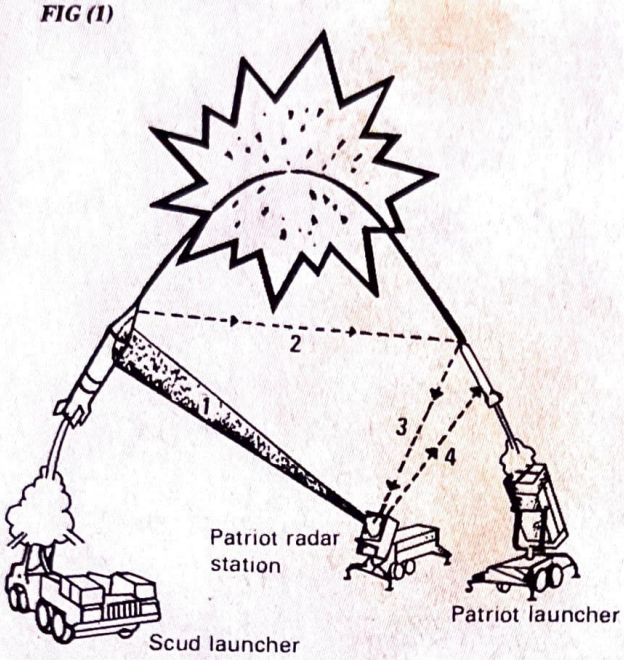
After its propellant (fuel) is completely burnt, it achieves a speed of about 6 Mach (6 times the speed of sound) which works out to more than 7,000 kilometres per hour. The missile warhead weighs 70-80 kg and is activated by a proximity fuse. The whole missile then explodes with large fragments, thus destroying the target.

The Patriot has an improved version designated as PAC-2 meant to be used against missiles such as the Scud. It has a better fuse and warhead which enables it to destroy incoming tactical ballistic missiles which are much smaller in size.

The missile is mounted within a sealed canister which acts both as a shipping and storage container and as a launch tube. At launch, the missile blasts away the canister rear cover and flies through the forward fibreglass cover. 4 canisters are mounted on a launcher.

The Patriot consists of 5 sections: radome, guidance system, warhead, propulsion and control surfaces. The ogive-shaped radome protects the electronic components of the guidance section. The missile has a multiple guidance system in-

FIG (1)



Patriot Vs Scud

1. Patriot radar picks up and illuminates Scud after being informed of its launch by geostationary satellite.
2. A part of reflected energy is picked up by Patriot missile.
3. Patriot missile sends the data collected from Scud to radar set which communicates it to the computers where course corrections for Patriot missile are computed.
4. Course correction commands are transmitted to Patriot missile, which eventually explodes in the vicinity of Scud thus destroying it.

cluding semi-active homing. In this the target is tracked and illuminated by a radar beam from the transmitter on ground.

This reflected signal is received by the missile and enables it to lock on to the target. Propulsion is provided by solid fuel and control of the missile by 4 tail surfaces actuated by hydraulic cylinders on receipt of signals from the guidance system located in the forward section of the missile.

Difficult task

The game of launching a Patriot missile against a fast-moving target like a Scud and destroying it subsequently is a fairly difficult task and demands a more complex system in addition to the launcher carrying missiles. These elements are shown in Figure 1.

The electrical power plant is the source of power for the system. It has 2 turbine generating sets which produce 150 kw of electricity.

The antenna mast set provides UHF communication between various stations. There are 7 antennas which can be extended to a height of 30 metres to obtain a line of sight communications. The orientation of each antenna can be remotely controlled.

The radar set, consisting of multi-function, phased array, can perform all the functions usually performed by many different radar sets: search and detection, acquisition, tracking of target(s) and Patriot missile(s) and target illumination and missile guidance. During operations the radar set is unmanned since it is monitored and controlled remotely from the engagement control station.

The engagement control station is the hub-centre of the Patriot missile system. It is accommodated within an air-conditioned shelter which offers nuclear-biological-chemical-warfare protection in addition to electro-magnetic pulse hardening. This shelter is mounted on the truck itself. (See Figure 2.)

Now, have you ever considered the possibility of hitting a large flying bird with a stone? Well, theoretically it might be a distinct possibility, but practically it is almost impossible. Now this scenario is with a bird flying at slow speed and presenting to the eye a somewhat reasonably large cross-sectioned area.

Imagine, the object to be hit is flying at an extremely high speed and is projecting an extremely small cross-sectioned area, similar to that of a pencil. The problem gets further compounded when the attacking object itself is travelling very fast.

Let us now translate this problem to Scud and Patriot missiles. Say, a Scud has been launched from Iraq and is approaching Israel at a speed of around 2,000 kmph. Now, before a Patriot is launched to destroy the Scud, it is necessary first of all to know that a Scud has been launched.

It is difficult, no doubt, since it could have been launched from anywhere in North-West Iraq, spanning thousands of square kilometres. Then one has to know the precise direction in which it is travelling.

The next requirement is to estimate the Scud's position after a given period of time—the time required for the Patriot, travelling in excess of 5,000 kmph—to reach and hit it. No easy task either because an error of even one second will result in the 2 missiles being more than 2 kilometres away from each other.

Sequence of events

Having painted that gloomy picture, let me admit that in today's "hi-tech" world, all this is not difficult at all. The sequence of events following a Scud missile launch from Iraq is, invariably, something like this:

- As soon as a Scud missile is launched, it becomes known to the 2 US satellites positioned along the Equator above the Indian Ocean in geostationary orbit (about 36,000 km above the surface of the earth, where a satellite's position with respect to earth always remains the same).

These satellites, through 3-metre-long infra-red telescopes, pick up the intense heat from the Scuds (that is generated in the form of red hot gases coming out of it) and relay the same information directly to American Commanders as well as to Patriot missile locations in the Gulf through US mobile defence satellite communication terminals. A decision to fire a Patriot is then taken.

- The radar set of Patriot missile system searches the incoming Scud with the help of signals received from the satellites and illuminates it with radar beam. The radar set then sends a coded signal to Patriot to aim its seeker towards the Scud.

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Battle royal between Scuds and Patriots

(Continued from page 14)

- The seeker in Patriot missile acquires the reflected radar energy of the beam (with which the ground radar is tracking and illuminating the target).
- The seeker in Patriot missile sends the signals it receives to the ground radar set. The "raw data" signals are then transferred to the computers in the engagement control station, where they are elaborated and filtered from electronic-counterpressure inputs (jamming elements). This information is combined with the absolute position of the Scud and the Patriot as well as the velocity of Scud missile to work out changes in the course of Patriot.
- The course correction commands are then transmitted to the Patriot missile.

These steps are continuously repeated till the Patriot warhead, armed with a proximity fuse, explodes into 700 shrapnels as it nears the Scud, destroying it in mid-air. Thus, with a Patriot system in operation, there are up to 5 radar beams "in the air."

This allows the Patriot missile to follow the most efficient track to the Scud missile. With the help of the ground-based, large, more powerful and sophisticated computers housed in the engagement control station, missile accuracy is extremely high.

Destruction of Scud launchers

Ever since the first Scud missile landed in Israel, Allied air forces have made all-out efforts to locate and destroy static Scud-launching sites as well as mobile launchers. But the fact that even on the 27th day of the Gulf war Iraq was able to pound Israel with yet another Scud, proves beyond doubt that all mobile launchers have not been located and destroyed.

This is because even with the most sophisticated spy satellites, it is not possible to pinpoint the exact location of the Scud launcher.

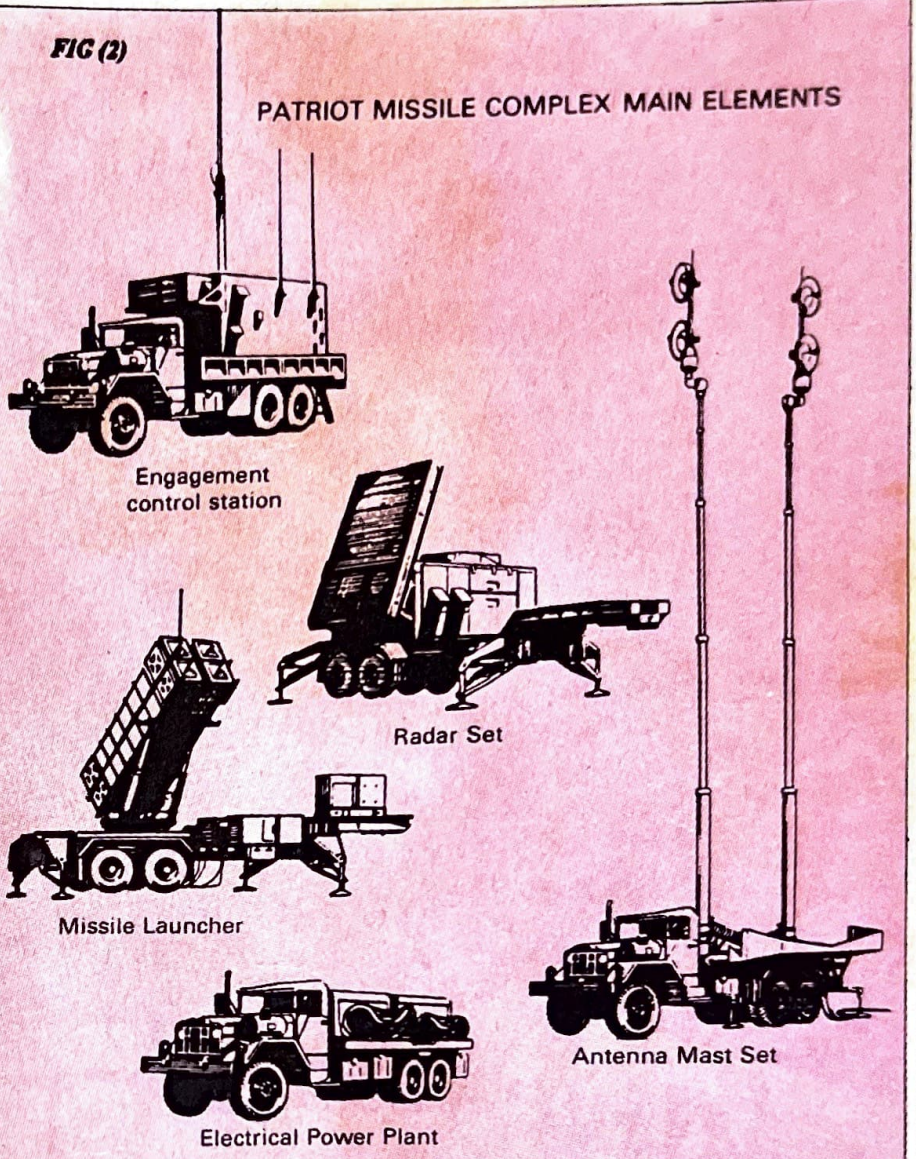
Both in theory and practice, as soon as a Scud is launched, it is picked up by the geostationary satellites as mentioned earlier. The satellites also record the coordinates of the launch site on their digital map and relay this data to earth. The information is then used to identify the site in Iraq for an air strike.

So far so good, but there is always the proverbial "slip between the cup and the lip" and even after knowing the coordinates of the mobile launcher site, it is not possible to destroy it everytime—for 2 reasons.

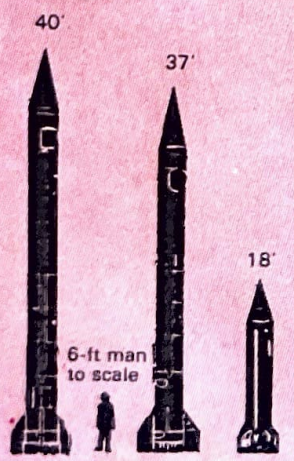
First, the accuracy of the information

FIG (2)

PATRIOT MISSILE COMPLEX MAIN ELEMENTS



SCUD AND PATRIOT—HOW THEY STAND



	PATRIOT	SCUD-B	AL-HUSSEIN
Height (m)	5.31	11.25	12.20
Dia (m)	0.41	0.92	0.85
Weight (Kg)	1,000	6,300	7,000
Warhead (Kg)	60-70	450	~
Range (Km)	Upto 70	300-600	>650

supplied by satellite is limited to within 5.5 km, which amounts to too large an area on ground to be combed to identify the launchers. Secondly, by the time the aircraft can get airborne and reach the site (it could be anything from 45 minutes to 2 hours) these mobile launchers can be pushed back to their hiding place.

This explains as to how Iraq is in a position to launch repeatedly and at will send missiles to Israel as well as Saudi Arabia.

Patriot failures in Israel

After the second Scud missile attack on Israel on the third day of the Gulf war, the USA provided Patriots to Israel alongwith American crew and a training unit because till then no Israelis were trained and capable of handling this complicated weapon system.

However, within the next few days, many more Scuds landed in Tel Aviv. And it happened in spite of Patriot missiles being fired to intercept and destroy the Scuds in mid-air. Israeli officials were quick in warning the public that the Patriot system would not provide an impenetrable barrier against the Iraqi attacks.

It was also mentioned that there was a large hole in the umbrella of Patriot anti-missile missiles, which was meant to protect the Tel Aviv region from a rain of deadly Scud missiles.

What are the exact reasons as to why and how a "Patriot streaking towards the incoming Scud" has missed the target on more than one occasion? It is only accusations by the 2 concerned parties that are being reported.

Pentagon officials say that the fault lies with the Israelis, who were reportedly responsible for all strategic decisions concerning the systems operation. Israeli experts, on the other hand, insist that it is independent operational factors which are responsible for the Patriot's failure.

Whatever the reason, Israel is really sore that Scuds are still landing on its territory. Its anger is in fact swelling after watching the amazing success of the Patriots in Saudi Arabia. Over there, hit rate of Scuds is really high.

This could be because the Saudi crew manning the Patriot missile battery have, in fact, improved upon the system. On 8 February, a Patriot destroyed a Scud over Riyadh, leaving only minor debris that fell on a parking lot, whereas in the past, debris from intercepted Scuds had killed several people and injured dozens in Saudi Arabia and Israel.

This was achieved by adjusting the system's computer software to get cleaner kills of Scud missiles. The adjustments were done to alter the engagement parameters—the altitude, range and angle of attack so as to hit the Scud's warhead head-on.

The ultimate winner

In the ongoing Gulf war, a small battle is being fought between the aged, old and primitive Scuds and the most modern state-of-art Patriot missiles. In spite of all the odds against it, the Scud has stood up to the challenge till date. Whether it will do so in the coming days is difficult to say.

During World War II General Patton had said, "Wars may be fought with weapons, but are won by men." Coming days are going to prove this saying yet again because prior to the Gulf war, not many Patriots were fired and tested in the anti-missile role. But now, with each firing, a lot of new information and data is coming up which is being used to optimise the Patriot for killing the Scud. But it is only time—in near future—that will tell as to who is the eventual winner in this battle royal between the Scud and the Patriot missiles. □□



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