

# MISSILES AND AIRCRAFT – PART 4

Lt C. MEYER

This Article, the last of four concerning the role of air power in the Yom Kippur War, analysis the following:

1. Missile effectiveness — (surface-to-air missiles, air-to-surface missiles, surface-to-surface missiles).
2. Aerial combat and pilot training.
3. Electronic warfare, Precision Guided Munitions and Remotely Piloted Vehicles.
4. The use of satellites for real time intelligence.

## Missile effectiveness

Anyone who concludes from the Yom Kippur War that the aircraft has no future is mistaken. Zeev Schiff.<sup>1</sup>

## Surface-to-air missiles

Why was the 'missile umbrella' so effective in the beginning of the war, yet towards the end of the war, Israeli aircraft were shooting down scores of Arab aircraft? The answer lies in the different situations between the beginning and end of the war. In the desperate early stages, the surprised Israelis were faced with a 'missile umbrella' of massive density and inadequate countermeasures. Towards the end of the war, Sharon's ground forces had created a gap in the air defence system, through which Israeli aircraft streamed. Thus, although the Israeli aircraft loss rate 'decreased from four aircraft lost in 100 sorties in 1967 to one per 100 sorties in 1973'.<sup>2</sup>

1. Actual aircraft losses were more than twice Israeli forces losses in the Six Day War (105 in 1973; 46 in 1967).<sup>3</sup>
2. Israeli losses during the first three days of the war would have been considerably higher than indicated by the overall loss rate of one aircraft per 100 sorties. This loss rate is, however, comparable to United States losses in World War 2.<sup>4</sup>
3. Lower Israeli aircraft losses were sustained during the rest of the war, due to low Israeli losses in air-to-air combat, and improved methods of attacking surface-to-air missile sites using *Standoff* weapons — see note.<sup>5,6</sup>

Another fact which could lead to underestimation of SA-6 effectiveness is that *LONG TRACK* radar,

normally used with the SA-6 missile, was *not* supplied to the Arabs. Two methods of attacking the SA-6 launch vehicle may be invalidated through the use of the *LONG TRACK* radar.

## SA-7 Grail

While few Israeli aircraft were actually shot down by the manportable 'Strela' (popular name of SA-7), many were hit. Most hits caused tailplane damage only.<sup>11</sup> Faster F-4 Phantoms seem to have avoided Strelas, but the slower A-4 Skyhawks appear to have been easily hit.<sup>12</sup> Two main reasons given for the ineffectiveness of the SA-7 were:

1. It was too slow — faster aircraft outflowed it.<sup>13</sup>
2. The warhead was too small. Many aircraft that were hit suffered tailpipe damage only — that is damage to tail.<sup>14</sup>

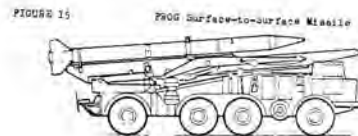


Figure 14: SCUD Surface-to-surface missile used by the Egyptians to bombard Israeli installations in Sinai.

Figure 15: The FROG Surface-to-surface missile used by the Syrians. It has a shorter range than the SCUD.

Figure 16: The AS-16 Kelt is launched from a Tu-16G Badger heavy bomber (Figure 19 and Figure 20). It also bears a superficial resemblance to the SS-N-2a Styx missile (Figure 17).

Figure 17: The SS-N-2a Styx, (used successfully by the Egyptians to sink the Israeli destroyer *Eilat* in the 1967 Six Day War), proved decidedly inferior to the Israeli Gabriel surface-to-surface missile used in 1973 naval battles. Because of its high ballistic flight, the Styx was easily shot down in mid air, whereas the low flying, wave-skimming Gabriel was so efficient that Arab navy vessels were eventually confined to their ports!

However, it would be more topical to ask: how would aircraft, attempt to give ground support fire against the SA-9 Gaskin? The SA-9 albeit vehicle mounted, is mobile, and is said to be faster and possess a larger warhead. This could make it far more lethal to low-flying aircraft.<sup>15</sup> It remains to be seen how defending forces would fare against an attacking Soviet (or Soviet-trained), force with SA-6, SA-8, SA-9 and ZSU-23-4 vehicles advancing with the attacking tank force, especially as 'ZSU-23-4 and SA-6 weapons carriers are included in the *outcome* of battle at the expense of tanks and self-propelled artillery'.<sup>16</sup>

### Surface-to-surface and air-to-surface missiles

The Yom Kippur War saw the first tactical military use of surface-to-surface missiles since World War Two.<sup>17</sup> Sixteen Syrian operated FROG (Free Range Over Ground),<sup>18</sup> rockets came crashing down onto Northern Israeli targets, each carrying a 450 kg high explosive warhead.<sup>19</sup>

SCUD surface-to-surface missiles supplied to Egypt were apparently considered a substitute for a medium range bomber force by the Soviets.<sup>20</sup> SCUD is of longer range than the FROG-7 used by the Syrians.<sup>21</sup> What is notable is that both the FROG and SCUD (several SCUDS were reported fired against Israeli targets in Sinai),<sup>22</sup> can be fitted with nuclear warheads.<sup>23</sup>

In the early stages of the war, an Israeli pilot on patrol noticed a distinct ball of fire in the sky, heading in the direction of Tel Aviv. The 'fireball' was easily shot down — it proved to be a 'Kelt' AS-5 air-to-surface missile. Altogether, approximately twenty-five 'Kelts' were launched against Israel from the TU-16G 'Badger' aircraft. However, only five managed to penetrate the Israeli defences, hitting two radar sites and a supply depot.<sup>24</sup>

It is interesting to note a desire expressed recently in an artillery journal for a rocket system that can "destroy the impetus of the enemy's attack before he can come to grips".<sup>25</sup> The optimum range quoted for such a system would be 'at least' 30 km. The Soviet FROG-7 missile's range, as quoted by James, is given as 60 km.<sup>26</sup>

### Aerial combat and pilot training

*The pilots of Israel are the apple of the nation's eye. Moshe Dayan*<sup>27</sup>

In the huge, swirling air battles that developed

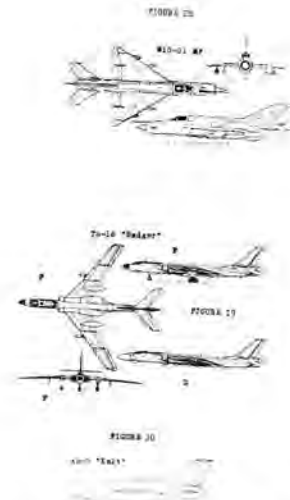


Figure 18: The figure shows a MiG-21 MF, although the version used in the October 1973 War is said to have been the MiG-21 PF, (R. Bonds, (Editor), *The Soviet War Machine*, Hamlyn, London 1976, p 95).

The MiG-21 was one of the main types of fighter aircraft used by the Arabs. It utilised the Soviet AA-2, (K-13), Atoll air-to-air missile against Israeli aircraft, (Phantoms and Mirages), that were armed with Israeli Shafrirs (Figure 22), and American Sidewinders, (Figure 23).

Figure 19: Figure 19 shows Tupolev Tu-16 Badger F, (side, plan and front views — marked F on sketch), and the side view of the Badger D, (marked D on sketch). The actual Tu-16 involved in launching Kelt AS-5 (Figure 20) air-to-surface missile was the Tu-16 Badger G similar in general appearance to the Badger F.

Figure 20: AS-5 Kelt, launched from Tu-16 Badger G. See also Figure 16.

above the Israeli breakthrough at Deversoir, (after the Israeli crossing of the Suez Canal), superior Israeli pilot training proved its worth.

*I was leading eight Mirages over the canal bridgehead when we jumped 20 MIG-21s. We shot down eight on the first attack and then broke off . . . I bounced them again and shot down two more. They just didn't seem to have a clear idea what to do.*<sup>28</sup>

Scores of Arab aircraft were shot from the skies.<sup>29</sup> The Shafrir was apparently the most effective air-to-air missile of the October War — due to its large warhead, it caused aircraft it hit to explode immediately.<sup>30</sup> Other air-to-air missiles used, the American Sidewinder, and the Russian K-13 Atoll were said to cause aircraft fire rather than explosions — if they hit the target.<sup>31</sup> New techniques used for air-to-air fighting (at low altitude and very low speeds), are mentioned by the International Editor of *Flight International*, Mark Lambert.<sup>32</sup> Some sources regard the development of a new air-to-air missile as important.<sup>33</sup> An interesting, unconventional, new

use of air-to-air missiles, (as *anti-tank* missiles by ground forces), is alleged in a recent publication.

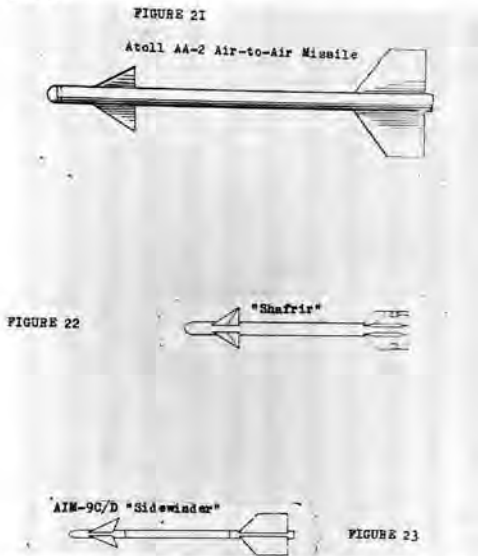


Figure 21: Soviet designed AA-2 Air-to-Air missile, homing on infra-red (i.e. heat) radiation. In the text, this missile is also referred to as the K-13 Atoll. K-13 is said to be the Soviet designation for this missile.

As mentioned above, the line drawing makes it appear considerably larger than the other missiles shown, (Shafir, Figure 22, and Sidewinder, Figure 23), whereas they are all of comparable size. (Pretty, Ronald, (Editor), Jane's Pocket Book of Missiles, MacDonald and Jane's Ltd, 1975, p 30, 215 and 222).

Figure 22 Shafir. Like the above mentioned Atoll, the Shafir also homes on heat emitted from an enemy aircraft. The Shafir is Israeli designed and manufactured.

Figure 23: AIM-9 C/D Sidewinder. The Sidewinder was used by the Israelis (together with the Shafir), in air-to-air combat in the Yom Kippur War. The illustration given is that of the newer model AIM-9 C/D Sidewinder. The AIM-9D Sidewinder homes on heat emissions from aircraft, as do the Atoll and Shafir. An earlier model Sidewinder, the AIM-9C, homes on an enemy aircraft using semi-active radar. An earlier model Sidewinder, the AIM-9B uses infra-red (heat-seeking) homing, (as does the AIM-9D). Precisely which (Sidewinder was used in the fighting is not clear, but it was probably the AIM-9D.)

### Electronic warfare

One lesson of the October War was that an ounce of ECM is worth a pound of additional aircraft, in the presence of dense and sophisticated air defences. Luttwak and Horowitz.<sup>34</sup>

The importance of Electronic Warfare and Electronic Counter Measures was rudely brought home to the Israelis when they lost fifty aircraft in three days.<sup>35</sup> Electronic Counter Measures were then not available to jam the SA-6 'Gainful' missile.

It has been said that the Yom Kippur War showed the importance of electronics in warfare.<sup>36</sup> The war has also shown the importance of being able to keep abreast of technological developments<sup>37</sup> — despite their initial failures, the Israelis managed to recover from near defeat — thanks to the Arabs' overdependence on their initial technological advantages. The Egyptian strategy had been so totally structured around the initial electronic superiority of their missiles, that once the 'missile umbrella' was pierced, there was no technological device at hand to make the Israelis disappear.

The more dependent a weapon system is on sophisticated guidance and electronic homing systems, the more vulnerable it is said to be once those same electronic systems have been overcome by advances in enemy technology.<sup>38</sup>

In the wake of the Yom Kippur War, many sources have suggested that the Remotely Piloted Vehicle should be the answer to an Israeli fighter pilot's prayer. A target drone was used experimentally by the Israelis, drawing the fire of 32 surface-to-air missiles and still returning,<sup>39</sup> but it is as yet unresolved as how effective a RPV would be.<sup>40</sup> It would also be pure speculation to regard the RPV as a substitute for the fighter aircraft. While the initial massive use of RPV's might be spectacularly successful, enemy breakthroughs in jamming them could result in a powerful weapon being rendered useless instantly. It is also not mentioned in current general literature how the electronic communications (including those of RPV's) would fare if nuclear weapons were to be used.<sup>41</sup> It would appear, however, that the Israelis consider the American Lance surface-to-surface missiles, (capable of dispensing cluster bombs), a good proposition.<sup>42</sup>

### Satellites

The next war will be won by the military organisation with the most efficient photographic reconnaissance. Col-Gen Baron von Fritsch<sup>3</sup> Former C-in-C, Wehrmacht forces, late 1930's.

The idea of an all-seeing magic eye over the battlefield, telling commanders what was happening while it was happening, has been dreamed of for centuries. While the above quote may seem soubly inappropriate, (out of date, and photographic reconnaissance alone did not win the Yom Kippur War), it should be remembered that prompt satellite intelligence was immensely



useful for the political manoeuvring that accompanied the war. It was the Russian threat of direct military intervention if the Israelis did not stop their advance that stopped the *IDF* — a threat, using satellite information, obtained more results than two Arab war machines could then do. No fewer than twelve Soviet satellites were said to have been launched over the Middle East at the time of the conflict.<sup>44</sup>

Technology has come a long way since the first observation balloon was used by Brevel-Captain Coutelle during the battle of Fleurus on 26 June 1794.<sup>45</sup> Yet the current role of the most modern spy-in-the-sky is essentially the same — supplying information that can be of use to an army while the conflict is in progress. It is significant that after the war the Israelis have taken a new look at 'real-time' intelligence<sup>46</sup> — intelligence obtained about the fighting during the fighting.

### Summary and conclusions

At the beginning of the first Article, four viewpoints were stated:

1. The role played by air power was important.
2. Control of air space over battlefield areas, (either by possessing it by aircraft or denying it by an air defence system), was vital.
3. Newer, more advanced weapons obtained by the Israelis towards the end of the conflict caused the outcome of the war to change decisively in their favour.
4. Arab ground operations were greatly influenced by their preoccupation with using a 'missile umbrella' to control the air.<sup>47</sup>

Before drawing generalized conclusions from the Yom Kippur War as regards aircraft and missiles, it is important to recognize the limitations of such a procedure. Historically, Israel's air doctrine has been one of defence through offence. This has been dictated by Israel's slender manpower reserves, small geographical size: and the need to fight and win a war before obliteration by the Arabs or international intervention can occur.<sup>48</sup> (See note). There has also never been any large scale involvement of superpower forces. This last factor has been used by Gen. P. M. Gallois to challenge a widely-held interpretation of the Yom Kippur War — newer, more advanced weapons obtained by the Israelis towards the end of the conflict caused the outcome of the war to change decisively in their favour — thus, these same weapons will be equally effective under different circumstances in Europe.

*In their haste to saw off the branch on which they are precariously perched, European strategists have attempted to draw a parallel between the Yom Kippur War of 1973 and their own strategic and tactical situation. In 1973, at the eleventh hour, the United States, provided some PGM's to their Israeli allies, who used them to great effect. But there is no parallel. In the Middle East wars the superpowers were only indirectly involved . . . In other words, the Soviets would not expose themselves to PGM's or any other defensive weapon on the NATO side.*<sup>52</sup>

Thus, even though the Israelis have been said to use *PGM's* successfully, it does not follow that *PGM's* would be the deciding factor of a future conflict, especially if larger forces are involved for a longer time.

The role played by air power was undoubtedly important. Without it, Sharon's much vaunted crossing of the Suez Canal would have failed, and with it the most important Israeli war initiative. However, especially in the initial stages of the war, the ability of the Egyptians to protect their ground troops from attack by aircraft proved decisive. Thus, control of the air space over the battlefield is still vital. The question of whether this may be achieved through an air defence system or the aircraft is subject to circumstances and the 'state of the art' of current technology.

While Arab ground operations were said to have been greatly influenced by their preoccupation with a 'missile umbrella' to control the air, this does not mean to say that future operations of this nature using Soviet trained forces will involve a similar situation: especially as Soviet military doctrine emphasizes mobility. A future war could see far greater emphasis on mobile surface-to-air missile systems,<sup>53</sup> used in conjunction with armour.

While the Yom Kippur War did not show the aircraft to be obsolete, it did show that it will have to be used more carefully in future, and in closer co-operation with other weapons and arms.<sup>54</sup> Ground support may also prove more difficult — while the SA-7 'Grail' missile proved relatively ineffective, the newer SA-9 'Gaskin' could prove extremely effective. Although missiles and aircraft have become ever more sophisticated and electronic warfare more demanding, it is not machines that win wars, but the man behind the machine.

Summarising; there is no clear advantage in the air battle between defence and attack, between jammer and jammed. Technology advances on both these sides, and effectiveness is certainly a

result of the resources devoted to the evolution and deployment of equipment. But, as was said at the outset, secrecy, surprise and sharp wits can be as important as the hardware.<sup>55</sup>

**FIGURE 24**

Figure 2. Typical Soviet army area battlefield missile air defenses. Showing area and vehicle-mounted launchers common to all of these units provide dense coverage from the front lines throughout the army area.

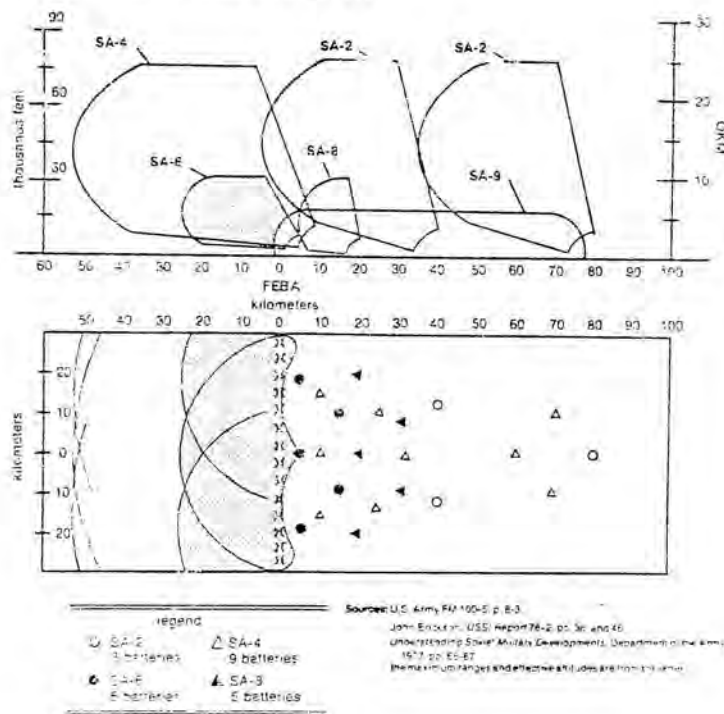


Figure 24: The sketch shows the composition of a typical Soviet Army missile umbrella. The different areas represented show zones in which an aircraft is vulnerable to a particular surface-to-air missile. Thus, according to the sketch, an aircraft is within range of a SA-9 missile up to approximately 5 000 m, and vulnerable to SA-6 and SA-8 missiles up to ca 10 000 m. The SA-4, (not discussed in this article), is shown to be effective up to ca 24 000 m, and the SA-2 effective up to 25 000 m. The areas in the sketch showing the limits at which a particular missile can intercept an aircraft are called missile envelopes. Although some missiles shown in the sketch are not known to have been used in the 1973 October War, they could well be used in a missile umbrella, would be on the right half of the Figure, about to attack forces in the left half. A Soviet army could be expected to include ZSU-23-4 Shilkas and SA-9's in its armoured and motorised rifle regiments.

## Foot-notes

Descriptions of the illustrations given in the text follow the references. As with the previous Article, numerous explanatory notes have been included. The reader is referred to illustrations in the previous Article — (Figures 1 to 13).

1. Z. Schiff: The Israeli Air Force (Air Force Magazine, vol 59(8), Aug 1976), p. 38.
2. J. Viksne: The Yom Kippur War in Retrospect, part 2—technology (Army Journal, no 324, May 1976 p 32).
3. *Ibid*, p 32.
4. *Ibid*, p 32.
5. *Ibid*, p 32.

*NOTE*: In the last week of the war Israel received the radar homing Shrike missile, the electro-optically guided Maverick and television guided Walleye and Rockeye which allowed the IAF to attack anti-aircraft sites with an improved margin of safety. *Ibid*, p 31.

The Shrike is a missile that homes on a radar source. The Walleye is a glide bomb, Maverick projects a constant TV image of its target to its airborne controller. Rockeye is a cluster bomb. The World Missile Directory maintains that a newer version of the Maverick will allow a SA-6 radar van to be attacked from ca 22,5 km range compared with the present 10-13 km. D. Richardson: World Missiles Directory (*Flight International*, 14 May 1977, p 1333).

*NOTE*: A complete system generally consists of a radar vehicle and 6-8 launching vehicles... supported by long range electronic search equipment, usually the LONG TRACK radar of the SA-4 Ganef.<sup>6</sup>

Two separate radars are involved in the SA-6, the acquisition radar, (usually the LONG TRACK used with the SA-4 system, which provides advance long range warning of approaching aircraft), and the target and acquisition radar, (the STRAIGHT FLUSH, used to direct the missile onto the target).<sup>7</sup>

The first method of defence against the SA-6 was a steep, nearly vertical dive on the missile launcher, following an approach at high altitude. As mentioned earlier, this approach was said to be successful against SA-6 launch vehicles, (the missile's flight trajectory just after launch was said to be low). However, aircraft following this pattern of attack were unable to pull out of their dives before entering the lethal range of the ZSU-23-4.<sup>8</sup> The second method of attack included jinking, (violent and unexpected changes of course), and adapting the flight profile to avoid areas known to be within the radius of action of SA-6 batteries.<sup>9</sup> However, Armies and Weapons state further: A good deal of success which attended these tactics was due to the fact that the search radar normally used, the LONG TRACK, had not been supplied to the Arab countries. Such methods could obviously not be expected to meet with the same success against the air defence systems of the WARSAW PACT countries.<sup>10</sup>

6. E. Po: SA-6 Gainful (*Armies and Weapons*, vol 4, 15 May — 15 June 1977, p 57.)
7. *Ibid*, pp 60-61.
8. *Ibid*, p 56.
9. *Ibid*, pp 56-57.
10. *Ibid*, p 57.
11. P. Borgart: The Vulnerability of the Manned Airborne Weapon System, Part 3: Influence on Tactics and Strategy, (*International Defense Review*, vol 6, 1977, p 1064).
12. D. Richardson, *op cit*, p 1345.
13. G. Tobin: The Viability of Offensive air support in the next Decade (*International Defense Review*, vol 3/1976, p 363).
14. D. Richardson, *op cit*, p 1345.
15. J. Viksne, *op cit*, p 32.
16. G. Tobin, *op cit*, p 362.

*NOTE*: Large scale maneuvers recently held in Syria indicate that both the mobility of the SAM-6 batteries and the quantity of quad-mounted 23 mm guns have been significantly improved to provide an offensive tank thrust with even heavier air defense. R. Hotz: Israeli Air Force Faces New Arab Arms (*Aviation Week and Space Technology*, vol 102, no 10, Mar 10, 1975). A second new weapon, the SA-7 Strella short-range tactical infra-red guided missile, was introduced and had a high initial kill rate against low, slow aircraft such as transports, gunships and helicopters. The initial loss rates to the Strella generated an accelerated interest in infra-red countermeasures. Immediate actions included the use of flare devices to act as decoys. Helicopter and gunship crews fired Very signaling pistols in the direction of the approaching SA-7s with good results. Paint with low reflecting qualities was used to repaint many of the aircraft, and some infra-red suppression devices were installed. Speed was also a factor in defeating the Strella. Aircraft travelling at high speeds were relatively immune, and the only jets lost or damaged by this weapon were caught at slow speeds.

*Note*: Strella is misspelled here — the correct spelling is Strela (Lake, Rear Admiral J. S., USN (Retired), and Hartman, Lt-Commander R. V., USN (Retired), 'Air Electronic Warfare', *US Naval Institute Proceedings*, Oct 76, p 47.)

17. D. Richardson: Scud: the rocket that went to war (*Flight International*, no 3551, vol 3, 2 April 1977, p 814).
18. *Jane's Weapons Systems 1978*, (ed: Pretty), London, 1978, p 423.
19. J. Viksne, *op cit*, p 21.
20. C. Herzog: *The War of Atonement*, London, 1975, p 25.
21. *NOTE*: *Jane's Weapon Systems 1978* gives the range of the FROG-7 as 60 km (p 424). The SCUD-Bis given a range of 280 km, and a SCUD-A a maximum range of 130 km, according to Richardson.
22. D. Richardson: Scud: the rocket that went to war (*Flight International*, no 3557, vol 3, 2 April 1977, p 815).
23. *Ibid*, p 814.
24. *Jane's Weapon Systems 1978*, (ed: Pretty), p 423.
25. *Jane's Weapon Systems 1977*, (ed: Pretty), p 50.
26. Viksne, Lt Col J., *op cit*, p 22.
27. TLM: The Importance of Artillery (*Journal of the Royal Artillery*, vol 105, March 1978, p 4-5).
28. D. Richardson, *op cit*, p 815.
29. Z. Schiff, *op cit*, p 35.
30. R. Hotz: Israeli Air Force Faces New Arab Arms, (*Aviation Week and Space Technology*, vol 102, no 10, March 10, 1975, p 17).
31. J. Viksne, *op cit*, p 32.
32. R. Hotz: Israeli Air Force Faces New Arab Arms, (*Aviation Week and Space Technology*, vol 102, no 10, Mar 10, 1975, pp 16-17).
33. P. Borgart: The Vulnerability of the Manned Airborne Weapon System Part 3: Influence on Tactics and Strategy, (*International Defense Review*, vol 6/1977, p 1064); *NOTE*: Problems were experienced with the Soviet K-13 Atol missile, with obtaining a lock on its target.
34. R. Hotz: Egypt Plans Modernized Air Arm, (*Aviation Week and Space Technology*, vol 102, no 10, 10 March 1975, p 18).
35. M. Lambert: How Good is the MIG-21? (*US Naval Institute Proceedings*, vol 102, Jan 1976, p 98).
36. R. Hotz: Israeli Air Force Faces New Arab Arms, (*Aviation Week and Space Technology*, vol 102, no 10, p 17).
37. *NOTE*: *Missile war in Beirut*. Over the past month, Second-hand Matra air-to-air missiles, made in France, have reached the Christian forces in Lebanon in large quantities. According to informed sources, these missiles have been adapted by the suppliers for use as ground-to-ground missiles. They are so powerful that, used in surface combat, they can flatten heavy fortifications and knock out tanks. The Christians have deployed them in positions that would threaten part of the Syrian force of 200 tanks if it were to be sent into against the Christian suburbs of Beirut. . . . The people who adapted the Matra, by contrast, left intact the precise homing device of the original model, so that its accuracy could help to compensate the Christians for their numerical inferiority to the Syrian force that surrounds them. (*Foreign Report*, 27 September 1978, p 7).
38. E. Luttwak and Horowitz: *The Israeli Army*, London 1975, p 350.
39. J. Viksne, *op cit*, p 31.
40. *Ibid*, p 39.
41. I. Cohen: Israeli revamps her forces (*Armed Forces*, vol 1(3), Jan 76, p 19).
42. *Ibid*, p 19.
43. *Aviation Week and space Technology*, 27 Jan 1975, p 127. *NOTE*: A Remotely Piloted Vehicle is a pilotless jet aircraft controlled (Remotely Piloted) by a distant pilot. A RPV differs from a drone in that a drone is usually preprogrammed while a RPV involves a pilot piloting the vehicle through remote control.<sup>42</sup> Possible ways of using RPVs against surface-to-air missile sites are:
  - a. Large scale use of small, expendable RPVs to saturate enemy defences.
  - b. To use RPVs to attack SAM sites — delivering bombs or missiles.
44. D. Parry: Remotely Piloted Vehicles (*Defence Africa*, vol 4, no 1, Nov 77, p 49).
45. *NOTE*: They (the Soviets) recognize that high altitude bursts of nuclear weapons can knock out, over great areas, the communications and electronics of an enemy which has not sufficiently shielded or grounded his electronic gear against the electromagnetic effects inherent to this type of attack.
46. W. J. Ruhe: The framework of electronics in war (*Signal*, vol 32(7), Apr 78, pp 11).
47. D. Richardson: World Missiles Directory, (*Flight International*, vol 3, no 3557, 14 May 1977, p 1332); I. Cohen. Israel Rebuilds her Army (*Army*, vol 25, no 6, June 1975, pp 22-23).
48. J. W. R. Taylor, *A History of Aerial Warfare*, London, p 8.

44. J. Viksne, *op cit*, p 24.

45. J. W. R. Taylor, *op cit*, p 11.

46. Z. Schiff, *op cit*, p 38.

47. *Pointers*, 1978 Doctrine — 2, Missiles and Aircraft, No 2 f 1, p 1.

48. Z. Schiff, *op cit*, p 34.

*NOTE:* There has been no large scale involvement of American or Soviet forces in the Middle East wars. There has, however, been evidence of Cuban tank crews being used on the Golan Heights against the Israelis after the Yom Kippur War — before being sent to Angola.<sup>49</sup> Some Soviet and North Korean pilots are also said to have been used on occasion to pilot Egyptian aircraft,<sup>50</sup> and some American pilots are said to have been used by the Israelis towards the end of the Yom Kippur War.<sup>51</sup>

49. *Foreign Report*, 15 Mar 78, pp 5-6.

50. *Foreign Report*, 8 Mar 78, p 5;

Z. Schiff, *op cit*, p 36.

51. R. Hotz: Egypt Plans Modernized Air Arm (*Aviation Week and Space Technology*, 30 Jun 75, p 15).

52. P. M. Gallois: Soviet Military Doctrine and European Defence (*Conflict Studies*, no 96, June 78, p 8).

53. R. Hotz, Robert: Israeli Air Force Faces New Arab Arms, (*Aviation Week and Space Technology*, 10 Mar 75, p 15).

54. Z. Schiff, *op cit*, p 38.

55. *Jane's Weapon Systems 1977*, p 99.