



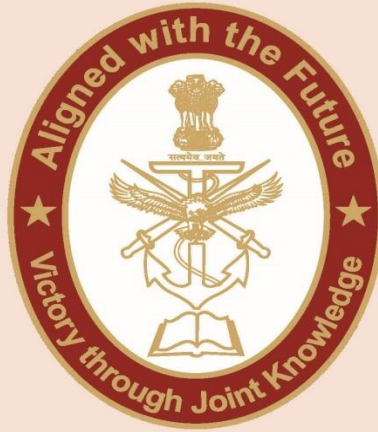
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ISSUE BRIEF

MEASURING THE ISRAELI COUNTER TO THE AIR THREAT AT HAND

LT GEN (DR) VK SAXENA , PVSM, AVSM, VSM (RETD)

CENTRE FOR JOINT WARFARE STUDIES



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HAND**



**Lt Gen (Dr) V K Saxena, PVSM,
AVSM, VSM** is the former Director
General Air Defence, Indian Army.

It is history now that on 07 Oct 2023 at 0630h Israeli time, along with the 'dawn' of the auspicious Sabbath Day marking the culmination of weeklong Israeli festivities of Sukkot, 'dawned' something most ugly, devastating and catastrophic. Hamas (with support from other Palestinians armed groups and external sources) launched a deadly multi-prong terror attack from land and air, firing thousands of rockets into Israel, killing innocent civilians, woman and children, taking hostages and more (203 as per latest report from Israeli Defence Force or IDF) ¹.

The hapless civilians of the Gaza strip (some 2 million populating a tiny strip of 365 Sq km) are now paying the price of the so called operation al Aksa Flood... no water, no food, no electricity, no medical care, nowhere to go but to face the ruin that descends from the air as a determined Israel vows to avenge it all – Operation Iron Swords is on.

²

The entire situation as on date is threatening to explode into a larger West Asia war, especially after the alleged bombing of al-Ahli Arab Hospital in Gaza by Israeli on 17 Oct 2023 (denied by IDF) that killed more than 200 patients (many of these women and children). As of 20 Oct 2023, we are at this juncture:³⁻

- Public support, especially in the Arab world is fast swelling up for the Palestinian cause.
- The hapless innocents in Gaza have nowhere to go as even the Southern Gaza, that was supposed to be a safe zone as called out by Israel has come under air strikes on 19 Oct 2023.
- Egyptian border at Rafa is closed. It is learnt that aid trucks standing at Rafa may be allowed to go in to Gaza any time now.
- Casualties on both sides are devastating (Palestine - 3478 killed, 12065 wounded; Israel- 1400 killed, 3800 injured).
- The zone has become a hot-bed of intense diplomatic activities (details not relevant to the subject, hence not covered).

Out of many topics that are relevant to the current crises, this brief work attempts to find an answer to the following posers:-

- What is the air threat from Hamas?
- How are the defenders poised to counter it?
- Way ahead – a viewpoint

Measuring The Air Threat

Following is stated on the quality and quantity of air threat from Hamas:-

Hamas an acronym for (Harqat al-Muqawama al Islamiya) has amassed a huge pile of air to surface munitions over the years.

As of 2014, Hamas was reported to be in possession of some 6000- 10,000 unguided rockets including long rockets named M 302. Currently the unguided rocket population with Hamas is assessed to be in excess of 30000. Some details about this arsenal are presented:-⁴.

- Short range rockets.

Range 15-20 km. approx. Variety Qassam. These are unguided rockets cast in steel and made indigenously by the Military arm of Hamas (Izz-ad-Din al Qassam).

There are four types of Qassam rockets – Qassam 1,2,3 and 4 weighing 35, 40, 50 and 40-50 kg respectively. Lengths of these vary from 180 to 224 cm (1.8-2.4m) and their ranges are 5, 12, 16 and 16-20 km respectively.

- Other rockets

Medium range rockets - Range up to 45 km. Type- Grad Rockets. These rockets have been mostly smuggled from Iran via Egypt and Syria. Medium long range rockets range up to 80km (alleged to be self-produced by Hamas). Long range rockets - 100-200 km. The exact quantity of holdings, as well as, their source of production of these rockets is not known.

- While most of the rockets, either self-produced or smuggled into Gaza are of unguided variety, there are reports of a small number of these to even have a guidance system⁵.

- There is open-source information of 2021 about the rocket arsenal received by Hamas from Iran and Syria. The rockets received from Iran include (range cited alongside) are Q12-10 km, Q20-20km, S40-40 km and Fazr3 - 43 km, S55-55 km, Fajr - 5 to 75 km, M 75 -75 km, J 80 - 80 km, J 90 – 90 km, A120 -120 km, and R 160-160km). From Syria, Hamas has received M 302 unguided artillery rocket, range 180 km)⁶.

- There are reports of rocket manufacturing factories in Hamas controlled Gaza. One such facility was struck on 13 Oct 2023 by Israeli Defence Forces (IDF)⁷.

- Open sources reported on 13 Oct 2023 that Hamas is now at the cusp of making a transition from unguided rockets to GPS guided drones and missiles. Hamas has been sharing the videos of how it makes rockets using the water pipes⁸

- Hamas with help from Hezbollah and Iranian support has been able to sneak in critical arms shipments either coming in from Libya or transiting via Sudan⁹.

- A naval Commando base belonging to Hamas has also been identified off the coast of Gaza with many meters of tunnels extending into the sea. Weapons for Hamas in sealed capsules have been dropped off this coast in the sea in sealed capsules to be recovered through these tunnels¹⁰.
- Talking of tunnels, there are also reports of rockets and missiles being shipped from Iran via Port Sudan and later trucked across Egypt and smuggled into Gaza through a labyrinth of narrow tunnels located underneath the Sinai Peninsula¹¹.
- In the 11 days of Gaza conflict in 2008, Palestinians fired some 4300+ rockets from Gaza. ¹² . As per one report, Hamas fires 137 rockets at on the cities of Ashkelon and Ashdod in a space of just 5 minutes. ¹³. At this point in time, the max range of Hamas rockets were around 40 kms. By 2021 this range increased to 180-230 km at the far end.¹⁴
- Though estimates vary, it is by far the consensus that an upward of 4500 rockets were fired by Hamas in the opening hours of the conflict on 07 Oct 2023.

Some Reflection On Hamas Arsenal

Following points are made:-

- Hamas has grown from a mere protest group to a mini army with a huge stockpile of arsenal.
- It's teeth have been built graduating up from its own crude capability on the DIY route mainly by Iran, Syria and the Hezbollah from Lebanon.
- The largely unguided rocket arsenal stands at the cusp of transitions into guided weaponry including precision guided weapons.
- The current throughput capability of launching rockets and missiles stands at 30000+ and is poised to increase in the future.

- The indigenous rocket making capability of the jihadi group is only likely to become better with more weapon making facilities.

Countering The Threat

The author has had the privilege to have interacted with several air defence experts of IDF during the years 2008-2012 which essentially marks the development and deployment of the Iron Dome System – the weapon pitched in the forefront for dealing with the rocket threat from Hamas.

In fact, the Iron Dome was also on offer to the Indian Defence Forces during our pursuit to acquire a Short Range Surface to Air Missile (SRSAM) system for our Forces (hence the chance to have interacted).

Some factual details about the system are briefly stated:-

- Iron Dome is an SRSAM system designed to shoot down such threats as rockets, artillery and mortar fire rounds. Such a capability goes by the acronym C-RAM or Counter Rocket, Artillery and Mortar (C-RAM) system
- The Original Equipment Manufacturer (OEM) of the system is Rafael Advanced Defense Systems and Israel Aerospace Industries (IAI). Rafael is a major defence technology company in the field of weapons and military technology.
- Rafael's muscle of indigenously developed arsenal is impressive. Some signature products include air-to-air missiles (Shafir), anti-tank missiles (Spike), submarine-launched cruise missiles (Popeye), laser missile defence system (Iron Beam), active protection system (Trophy) and more.
- Israel has multi-layered air defence system of which Iron Dome is one part. The other weapons in the fire arm include the Spyder SRSAM system, Barak 8 Medium Range SAM (MRSAM) system, Arrow, David's Sling and Iron Beam system (covered later).

Keeping the terror threat in mind, Iron dome has been specifically optimized to take on the C-RAM role. Like any air defence system, Iron Dome is configured on three verticals, viz, the Sensors, the Shooters and the Battle Management Command And Control (BMC2) system. A word about each is presented:-

Sensors

As the name suggests this component of the weapon system is responsible for the detection and identification of the threat. For doing this task Iron Dome has the following resource:-^{15, 16}

- A three dimensional (3D) multi mission radar named EL/M 2084. This sensor is built by Elta a subsidiary of the State run Israeli Aerospace Industry. This is very precise radar working in the frequency range of 2-4 Ghz (most suitable for C-RAM role).
- EL/M 2084 is an Active Electronically Scanned Array Radar (AESA) which means that the radar beams can be steered electronically across the radar span without moving the antenna. This permits fast beam switching to detects small rocket threats spread widely across the horizon.
- Capability wise, the radar has a surveillance range of nearly 475 Km and a detection range of 100 km. It can keep in its surveillance pan some 1100 targets and can detect (locate) 200 of them at the same time.
- In its range and altitude the radar generates an Air Situation Picture (ASP) which is fed to the BMC2 system.

BMC2 System

- This system built by the Israeli software company mPrest analyses the detected threat, identifies it as to Friend and Foe (IFF- implying own/enemy) and prioritises the same based on immediacy of impact and comparative lethality. Based on the selected threat to be engaged (the criteria is to take on those rockets that are headed to a vulnerable point or a population centre or any other key area), the BMC2 system calculates the future position of the threat (impact point) and launches and guides the interceptors towards the same.

Shooters

- The teeth of the system are the Tamir interceptor missiles. It is a supersonic missile capable of flying at a speed of 2.2 Mach.
- The missile is 3 m long and carries a blast fragmentation warhead with a proximity fuse.
- It is designed to destroy the C-RAM threat fired from a distance of 4-70 km. The action to upgrade this range to 250 km is already underway. The same was reported to have commenced sometimes in 2021.

Issues With Iron Dome

Issue 1: Gaps - Fait Accompli

Following points are stated

- A typical fire unit of Iron Dome consists of the following¹⁷:-
 - o 1x Detection and tracking radar EL/M 2084.
 - o 1x BMC2 system.
 - o 3-4 missiles firing launchers each having 20 missiles.
- Unlike a typical air defence fire unit where the sensors shooters and BMC2 systems are deployed together as one compact unit, the launchers of the Iron Dome are deployed in a scattered manner connected to the sensor and the BMC2 with a secure wireless communication.
- In this manner one fire unit is capable of covering a large swath of area roughly around 150sq km. ¹⁸. Considering the Israeli border with Gaza of 51 km long and that with Southern Lebanon about 120 km and with West bank walled barricade of 708 km the deployment of launchers is far stretched out with wide gaps in between.
- As per open source, IDF has at least 10 Iron Dome fire units. By the scale of 3-4 launchers and 20 missiles on each, the total quantum of missiles works out to some 600-800¹⁹.

- With this quantum, and keeping in mind the borders (corresponding air space) to be protected, Iron Dome even with scattered deployments can cover only a few really threatened areas at best. Further in the current Hamas-Israeli conflict if Hezbollah is to open the second front from Southern Lebanon, Iron Dome deployment will be further stretched.

Besides Iron Dome, Israel has other options as well. These are briefly presented.

Iron Beam system

Way back in 2014, Israel unveiled a directed energy (laser kill weapon system). Some details:- ^{20,21}

- The weapon is based on the concept of destroying incoming rockets and missiles by inflicting laser beams on the threat. Owing to their high intensity, coherence and direction-ability, these beams are capable of defeating the rocket and missile threat in multiple ways as under:-
 - Detonating the warhead on board dumb rockets or cripple the electronics and electromagnetics if the weapons are carrying any (guided rockets and missiles).
 - Burning holes on the body and control surfaces of the threat rockets and missiles putting them off course and thus rendering them in-effective.
- Latest reports indicate that the power of laser beams (fibre laser) in the Iron Beam could have reached in the region of 100-150 KW pushing up its erstwhile kill range from 7 to 10 km.
- A typical Iron Beam fire unit (Battery) consists of the following:-
 - An search and track radar of the type EL/M 2084M.
 - A BMC2 unit with functions as explained above.
 - 2x Laser kill systems.
- In Feb 2022, the Prime Minister of Israel had stated that the system will get operationally deployed in the field in an year's time which means that some fire units of the systems are already operationally deployed.

- This leads us to the reports emerging a few days back showing the Iron Dome systems firing laser beams on to the incoming rockets. The veracity of its actual deployment is not corroborated.
- Even if true a few systems of Iron Beam will not alter the gap situation in any manner.

Issue 2: Too Many

Sample the following from recent histories of the wars where the C-RAM threat played in a very big way:-

- During Operation Protective Edge (Jul 2014) Hamas along with Islamic Jihad fired a total of 4564 rockets. Out of these some 735 were successfully intercepted by the Iron Dome²². Even if 90 % of the rockets engaged got successfully destroyed (success rate 90%) then the total addressed rockets works out to $735 \times 100/90 = 817$ rockets.
- As stated, Iron Dome's trajectory prediction software assesses the impact point of each threat under track and directs missiles only on to those that are headed to people/utilities/buildings/infra/targets of value. Assuming that even 50% of the rockets fired were correctly headed $735/2282$ (50% of 4564) is an interception score that is far from comfortable.
- In the intense rocket attacks that broke out in May 2021 (6-21 May) due to eviction of 4 Palestine families from East Jerusalem, Hamas with other groups (details not covered) fired some 4369 rockets. As per Israeli assessment only a third of these (1456) were threat rockets (such low % unlikely). Even if true and granting 90% success rate to Iron Dome, the possible interception could at best be 1310. Balance struck hard on targets and many more in other areas.²³.
- Cut to the current crises, an estimated 4500+ rockets were fired in the initial days of the attack. Going by the previous logic of only a third of it as correctly

headed and being intercepted at 90% success rate, still a 150-200 still struck their targets with many more (incorrectly headed) in other areas.

It requires no explanation to deduce that vis-à-vis the sheer quantum of rockets being fired, Iron Dome and now Iron Beam, given their very finite number of launchers will fall way short to neutralise the threat that faces the nation. Just to add, that this huge stockpile was from one front, what if Hezbollah opens up from North or threat develops from the West Bank?

Issue 3 Cost Skewedness

Much is appearing these days in the open source on the comparative end-to-end cost of an interception from an Iron Dome or Iron Beam vis-à-vis, the cost of a typically unguided Hamas rocket. Figures in the region of \$50,000²⁴ for an Iron Dome interception and \$2000²⁵ for an Iron beam shot (all costs covered) are being quoted (Cost of one Iron Dome Fire unit is quoted between 500- 1000 million \$). What about the cost of a Qassam rocket? A paltry 300-800²⁶ \$.

What do these figures indicate? Probably the following:-

- In a typical air attack-air defence duel, the cost of attack (threat) should be generally matched or bettered by the 'cost of kill' (air defence). This disregards the subjective argument that the cost of kill should be measured not on what is destroyed but what is protected?
- Argument notwithstanding, if the cost of kill remains skewed for long periods, the attacker will get to have the last laugh by having succeeded in inflicting disproportionate costs on the defender and crippling him in the long run.

Other Air Defence Systems

As stated, the other major air defence systems which Israel has in its arsenal are Arrow and David Sling and a few short range and medium range weapons such as the Spyder SRSAM, Barak MRSAM etc. A word about each:-

- Arrow family of air defence systems are big guns that are meant to destroy enemy's ballistic missiles in the endo, as well as, exo atmospheric regions. These form a part of the Israeli Ballistic Missile Defence (BMD) shield as an

important component of their Integrated Air Defence System (IADS). This weapon is nowhere suited to taking on the C-RAM threat.

- The interceptors, Arrow, Arrow 2 and arrow 3 are hypersonic missiles (speeds in excess of Mach 5) which guided by a huge Long Range Surveillance Radar named Green Pine (the Indian LRSR serving its indigenous BMD system Programme AD is codenamed Sword Fish. The same is inspired by the Green Pine LRSR of Israel).
- The other major system called David's Sling is also in a different class of weapon. This system with interceptors in the hypersonic domain has a huge operational range of 250 km. It is designed to intercept latest generation strike aircrafts, tactical ballistic missiles, cruise missiles and medium to long range guided rockets. The system is not designed for the C- RAM threat.
- The other short and medium range air defence weapons and SAMs mentioned earlier (Spyder SRSAM and Barak MRSAM) are also not suitable for a C-RAM role (further details not covered)

That leaves the Iron Dome now being joined with Iron Beam to tackle the instant threat at hand.

Some Alternate Solutions

It is the sense of the author that besides the current fire arm comprising of the Iron Dome and now the Iron Beam, Israel will require a mass kill C-RAM solution that is effective as well as cost viable.

While there is no single or a magic answer to this requirement, multiple options could be tried. One alternative solution is to deploy high rate of fire air defence guns that have the capability of saturating the target kill zone with a preponderance of fire achieving a high percentage of kill on the unguided rocket vehicles merely on account of the volume of 'low-cost' fire delivered.

Today, the towed air defence guns have a rate of fire capability starting from a mere 300 rounds per minute (rpm) to 6000+ rpm (ZU 23 -2 – 1600-2000 rpm, GAU Avenger

30 mm Gatling rotary cannon – 7200 rpm, M 134 GAU-17 20 mm Gatling gun - 2000-6000 rpm).

In addition, there are emerging trends of revamping the fuses of high rpm rounds with proximity sensors that hugely increases the kill zone of small projectiles. Technology is also very much available for revamping the warhead content of the projectiles. In this, the single warhead is replaced with many a small fragments that is spewed in a centrifuge destroying/damaging multiple threats in its beat.

There is also experimentation going on of using an unmanned vehicle – a kind of hardened drone executing a limited Electromagnetic Pulse (EMP) attack in the target area. This solution will however be most effective where the threat vehicles are carrying on board some degree of electronics or electromagnetics or even GPS based satellite communication circuitry. What about the threat that is fully dumb? A herd of unguided rockets cast in steel? Of course, the impact will be doubtful.

Then there is a swarm drone idea of getting a low-cost swarm ready with the capability of being deployed in the threat area at a moment's notice. The idea is to kill the waves of incoming rockets by achieving a catastrophic collision. A tall order need.

Of course, no order is tall enough to deter an air defence warrior whose nation is suffering disproportionate costs and taking on huge collaterals. That all these actions and more are in various stages of development is only to state the obvious.

DISCLAIMER

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Endnotes

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