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PL-15(E) Air-to-Air Missile

Between 7 and 10 May 2025, an armed conflict ensued between Pakistan and India, with both parties engaging in substantial aerial bombardment of each other's military infrastructure. It was during this conflict that the Chinese-made PL-15(E) air-to-air missile was reportedly used for the first time in combat. In this article, the authors provide a comprehensive account of the Chinese missile, accompanied by a comparative analysis with other missiles.

Keywords: PL-15(E), air-to-air missile

1. Introduction

Jammu and Kashmir have been a site of ongoing conflict between India and Pakistan since the independence of both countries in 1947. The status of the region was the catalyst for the first Indo-Pakistani War in 1947, which culminated in a ceasefire brokered by the United Nations. Consequently, the region was divided into areas under the control of India and Pakistan. However, both parties consider this arrangement to be provisional. The status of Kashmir was a major contributing factor to the war that broke out between the two sides in 1965 and 1971. However, these wars came to an end with the restoration of the status quo.

The Kargil War, which took place from May to July 1999 in the Kargil district of the disputed Kashmir region along the Line of Control separating the Pakistani and Indian-administered parts of Kashmir, is a significant example of this dynamic. The region of Kargil is now incorporated into the Ladakh Union Territory. The war was fought at high altitude, at approximately 5,000 metres, under extreme conditions. The conflict in question involved two nuclear-military powers engaged in a conventional war against each other. Kargil has frequently been the site of border clashes between the two countries, and the Kargil War was the largest and deadliest such clash. The immediate cause of the conflict was a border incident in which Pakistani soldiers, disguised as Kashmiri rebels, infiltrated Indian territory and attacked military targets. In the early stages of the conflict, the Pakistani government attributed responsibility for the clashes exclusively to local rebels. However, it subsequently acknowledged the involvement of Pakistani soldiers. The Indian armed forces, specifically the army and air force, have demonstrated their capacity to thwart external aggression. In this instance, they have successfully neutralised the threat posed by Pakistani forces, thereby securing the area. Subsequent to mounting pressure from the international community, Pakistan withdrew its remaining troops from Indian territory in July 1999, thereby restoring the status quo ante bellum [1], [2].

2. Four-day conflict in May 2025

Between 7 and 10 May 2025, an armed conflict ensued between Pakistan and India. In this conflict both parties inflicted significant damage on each other's military installations. However, India's military intervention primarily targeted terrorist infrastructure, as indicated by public communications. Following the facilitation of dialogue between the two nuclear-armed states by the United States, both countries realised that continuing their hostility would have consequences – both for themselves and for the region – that would be difficult to predict. Consequently, on 10 May, the armed conflict was brought to a halt in its entirety.

On 22 April 2025, armed individuals discharged firearms at civilians in the contested region of Kashmir, which is under Indian administration. According to the latest police reports, at least 20 people lost their lives in the attack [3]. This event marked the genesis of the four-day conflict, a situation that had been preceded by decades of problems and disputes. The Indian government's reprisal measures were initiated on the night of 7 May.

In a move that was both swift and unexpected, India instigated a robust military offensive against Pakistan in the early hours of Wednesday morning. This response was a direct act of retaliation for the attack that had occurred in Kashmir a fortnight prior. Concerns have been raised that the recent armed conflict between the two nuclear-armed adversaries, which has not been witnessed for over two decades, may potentially result in an escalation into a more extensive war. There is limited open-source confirmation that both parties are resolute in their commitment to pursue novel military acquisitions, whilst concomitantly severing their economic and trade ties to a considerable extent. This text was composed by HVG360 on 7 May 2025 [4].

The Indian retaliatory strikes, designated “Operation Sindoor” were executed on the night of 7 May. The operation targeted nine alleged terrorist strongholds, which were struck by Air Force aircraft. The operation was conducted by units stationed at three air bases. This preliminary categorisation encompassed three distinct types of aircraft; however, subsequent analysis revealed the presence of a fourth category. The launch of the Scalp EG¹ cruise missile against targets in northern Pakistan was conducted from a single air base by Rafale EH aircraft. The cruise missiles were launched from their own designated airspace, situated approximately 100–120 km from the Pakistani border. The Russian-manufactured Su-30MKI fighter jets were observed taking off in formation from the other air base. Furthermore, these aircraft were also observed launching BrahMos-A missiles from a considerable distance, targeting locations in central and southern Pakistan. The third group departed from an air base and conducted its mission in Kashmir itself. The group's composition also included Rafale EH fighter jets, which were equipped with AASM Hammer guided glide bombs. These bombs can be deployed from a distance of 50–70 km from the target. Subsequent revelations indicated that this formation comprised MiG-29 aircraft as well. In addition to these strike formations, Pakistan was also subjected to kamikaze drone attacks; however, these will not be discussed in this paper.

In response to the detected strike formations, the Pakistani Air Force also initiated the deployment of its fighter jets, specifically the Chinese-manufactured JF-17A Block 3 fighter aircraft (Figure 1), which are equipped with Chinese-produced PL-15 radar-guided missiles. The Chinese-manufactured J-10C fighter jets also participated in the operation, which constituted

¹ This weapon is analogous to the Storm Shadow missile in the French military arsenal.

the primary focus of the news reports. Evidence of the use of the PL-15 missile was found in the form of missile debris discovered in Punjab [7], [8]. Further circumstantial evidence for the deployment of the PL-15 missile is provided by the discovery of an intact PL-15E missile in the Hoshiarpur area that failed to detonate by the Indian army. This event presented Indian experts with the opportunity to study the technology of the missile.

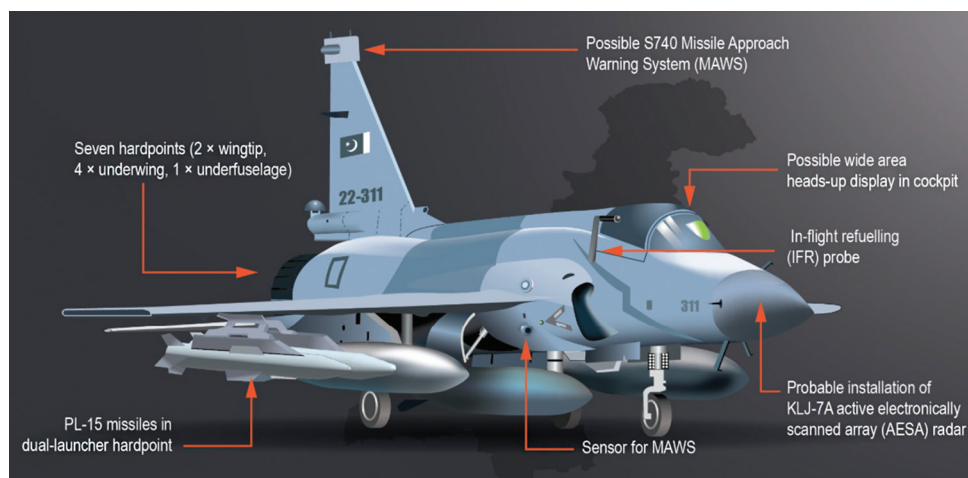


Figure 1.
JF-17 Block III [36]

According to Pakistani claims, five aircraft were destroyed, including three Rafales, one Su-30, and one MiG-29. It appears that India has not formally recognised these losses. On 9 May, an Indian Kashmiri government official acknowledged the loss of at least three aircraft and the hospitalisation of three pilots. The available reports indicate that at least one Rafale aircraft was destroyed, with a high probability of additional aircraft being destroyed as well, including one MiG-29 and one Su-30. The wreckage of these aircraft could be identified.

As reported in the news, it appears that the third strike formation suffered these losses. The probable rationale for this occurrence can be attributed to the necessity for the formation to approach the targets in closer proximity, a consequence of the drop/launch distance of the glide bombs. This strategic manoeuvre enabled the Pakistani aircraft to successfully intercept the Indian aircraft [5], [6]. The hostilities continued for several days. However, the present article will not delve into the intricacies of the conflict, as this would not contribute to a comprehensive understanding of the focal point of the PL-15(E) missile.

In the days following the air battle on 7 May, several claims pertaining to Pakistani losses were published in the Indian media. It was reported that the Pakistani Air Force suffered the loss of one F-16, two JF-17A fighter jets, and one ZDK-03 Karakoram Eagle air surveillance and control aircraft. It appears that neither country has officially corroborated these claims. This is a customary component of information warfare, intended to compensate for losses suffered and to influence public opinion in their respective countries.

It is the considered opinion of the Pakistani Air Force that the J-10C aircraft launched the PL-15(E) missile from 200 km. This would also imply that the Indian Air Force (IAF) miscalculated

the missile's maximum launch range, which was set at 150 kilometres. Consequently, IAF pilots undertook their missions with a false sense of security, as they had been operating under the assumption of this maximum range. The 200 km launch distance would be the second-longest recorded, surpassed in length only by the Su-57 fighter jet of the Russian Air Force, which achieved a launch distance of 217 km when firing an R-37M missile at a Ukrainian Su-27 aircraft [32], [33], [34], [35].

2.1. *The fundamental question*

Prior to the presentation of the PL-15 missile, it is imperative to pose a rather complex question. While we are unable to provide a definitive response, the question may offer some insight into the subject of air combat.

There are several versions of the Rafale combat aircraft:

- Rafale A is a technology demonstration aircraft that first flew in 1986;
- Rafale B is a two-seat version that was constructed for the French Air and Space Force. The production of the vehicle totalled 157 units;
- Rafale C is a single-seat version of the Rafale B, with a production run of 302 units;
- Rafale M is analogous to the Rafale C version, except for the reinforcement of the wing structure and the incorporation of an arresting hook for carrier landings. The total number of units manufactured was 48;
- Rafale N aka Rafale BM is a two-seater version that was designed for the navy. The project did not proceed to series production;
- Rafale R is a variant of the Rafale aircraft that has been specifically adapted for reconnaissance missions. The project did not proceed to series production;
- Rafale DM is a two-seater version that was manufactured for the Egyptian Air Force;
- Rafale EM is a single-seater version that was manufactured for the Egyptian Air Force;
- Rafale DH is a two-seater version that has been manufactured for the Indian Air Force;
- Rafale EH is a single-seater version that has been manufactured for the Indian Air Force;
- Rafale DQ is a two-seater version that was manufactured for the Qatari Air Force;
- Rafale EQ is a single-seater version that was manufactured for the Qatari Air Force;
- Rafale DG is a two-seater version that was manufactured for the Hellenic Air Force;
- Rafale EG is a single-seater version that was manufactured for the Hellenic Air Force;
- and the following early versions: F1 Standard, F2 Standard, F3 Standard, F3-R Standard, F4 Standard, F4.1 Standard, F4.2 Standard and F5 Standard. We will not elaborate further on these [9].

As is evident from the above list, the object was produced in several variants. The primary inquiry concerns to the identification of the equipment installed in the Indian Rafale EH variant. This is of particular significance, as the aircraft may have been equipped with an older radar system, which possesses a detection range that is less extensive than that of a more contemporary system. It appears that the latter option is considerably more expensive. It is imperative to ascertain which air-to-air missile (AAM) integration the Indian customer

requested. For instance, regardless of the sophistication of the aircraft, the employment of an AIM-9L-I1 air-to-air missile on board a modern aircraft does not guarantee a favourable outcome in the event of engagement with an aircraft equipped with an IRIS-T missile. The missile in question belongs to a different generation, with a completely different launch range and targeting capability. The central question pertains to the armament of the aircraft during the mission. Specifically, it is necessary to ascertain whether air-to-air missiles were mounted on the aircraft, or whether it was only equipped with glide bombs. The aforementioned news [9] reports did not address these questions, and it is likely that they did not possess any information regarding the matter [9].

In the absence of this information, it is not possible to state with any degree of certainty that the Rafale, widely regarded as the world's most advanced fighter jet, exhibited substandard performance. In such cases, it is imperative to also examine the level of training of the pilots. A plethora of unanswered questions have emerged in the aftermath of the mid-air collision.

3. PL-15 air-to-air missile

Since the 2000s, China has made significant progress in the field of medium- and long-range air-to-air missiles. In the wake of earlier copies/licenses of the Russian R-27 and R-77, for example, the PL-11 and PL-12, the latest 5th generation, domestically developed PL-15 and PL-12 missiles now feature active radar homing and an operational range of 70–100 km. The integration of these components into the J-10A/B, J-11B, and JF-17 aircraft variants is indicative of their technological sophistication and functional versatility.

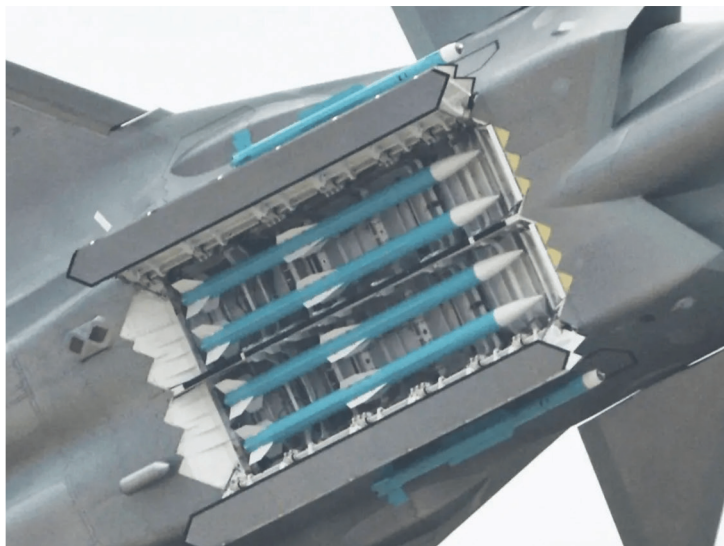


Figure 2.

PL-15 missiles in the internal weapon bay of aircraft J-20 [11]

The PL-15 missile is China's most advanced long-range missile, with integration into the J-11B aircraft commencing after 2015. In 2017, it was integrated into the J-10C and J-16 aircraft and subsequently became the basic air-to-air missile of the J-20. The PL-15 represents a substantial enhancement over its predecessors. Its dimensions are 4.0 m in length, 203 mm in diameter, and its mass is 210 kg. Its range is estimated to be approximately 200 kilometres. The export version, designated PL-15E, has a range that is limited to 145 km. The aircraft employs a dual-pulse solid rocket motor, a design that ensures both high terminal velocity and range. The seeker is an AESA radar. Consequently, the PL-15 offers robust jamming protection and enhanced target acquisition sensitivity. According to Western sources, the PL-15 has a range of more than 200 km, which exceeds that of the AIM-120D, thus prompting the U.S. to commit to developing the AIM-260. It is estimated by Janes that the range of the missile is 300 km. However, this estimate may be slightly higher than the actual range of the missile [13]. It is also possible to integrate the PL-15 into the internal weapon bays of the J-20 aircraft, with a capacity of four. The launch aircraft can be the Chengdu J-20 (which has an internal weapons bay), J-10C, J-16, J-11B/D fighters, and those offered for export, e.g. Pakistan's J-10CE aircraft have also received PL-15E missiles. The upgraded version (possibly PL-15A) may further increase the „No-Escape Zone” through optimisation of the engine and software [10], [11], [37].

3.1. Technical data on the PL-15 air-to-air missile

The subsequent section will present the primary technical characteristics and structural parameters of the PL-15 air-to-air missile:

- Type: BVRAAM – Beyond Visual Range Air-to-Air Missile
- Engine: two-stage solid-fuel rocket engine capable of reaching five times the speed of sound (For more information on rocket engines, see publications [17], [18], [19], [20], [21], [22].)
- Length: 3996 mm
- Diameter: 203 mm
- Mass: ≤ 210 kg
- Operational range:
 - Export version (PL-15E): officially 145 km, but according to some sources it can reach up to 170–180 km;
 - PL-15: over 200 km.
- Guidance system: AESA – Active Electronically Scanned Array, two-way data link during the mid-flight phase and active radar homing during the final phase.
- Warhead: Highly effective, fragmentation warhead. Laser and/or active radar proximity fuse, enabling the warhead to be deployed at the optimum location and time to achieve maximum destructive capability. No specific weight data is available for the warhead, but estimates suggest it may weigh approximately 40 kg [14].

3.2. Integration and platforms

The PL-15(E) missile has been integrated into several Chinese and exported fighter aircraft, including:

- Chinese types: J-10C, J-16, J-20, J-35
- Export versions: JF-17 Block III, J-10CE
- The most recent iteration of the missile, debuted at the 2024 Zhuhai Airshow, incorporates retractable rear fins. This configuration enables the J-20 and J-35 stealth fighters to carry a maximum of six PL-15(E) missiles within their internal weapon bays, representing an augmentation from the previous capacity of four missiles.

3.3. Combat application and analysis

The PL-15E missile was first used in combat in May 2025 during air battles between India and Pakistan. It is highly probable that Pakistan's J-10C fighter jets utilised PL-15E missiles in their engagement with Indian Rafale jets. In the aftermath of the confrontation, fragments of PL-15E missiles were discovered on Indian soil, thereby substantiating their deployment [15].

3.4. PL-15 vs. PL-15E hidden differences

Despite the export version (PL-15E) having an officially limited range of approximately 145 km, it is likely that its actual capabilities extend to 170–180 km, while the Chinese PL-15 variant has a launch range of more than 200 km according to most sources. The primary distinction between these two categories is found in the management of the engine and the optimisation of the flight path. It is hypothesised that the PL-15 variant incorporates more sophisticated combat algorithms and electronics, thereby enabling enhanced target approach accuracy and improved targeting, particularly in a BVR (Beyond Visual Range) environment [11], [13].

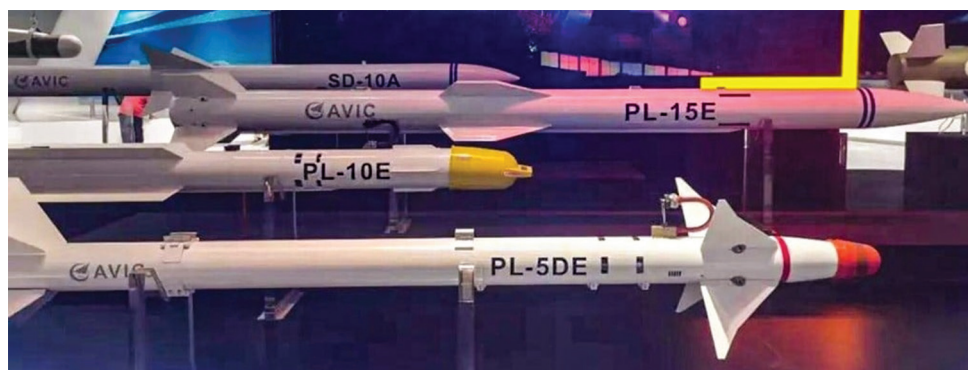


Figure 3.

PL-15E missile (The difference in size between this missile and the PL-5E, which is an AIM-9-sized missile, is clearly visible.) [12], [27]

3.5. Possible further developments

As asserted by the International Institute for Strategic Studies (IISS) [23], the PL-15 missile is undergoing further development. It is acknowledged that the development of a more compact version is underway, with the objective of enhancing its compatibility with aircraft equipped with internal weapon bays. This initiative is being undertaken while maintaining the existing combat and technical specifications.

The article refers to the new missile as the PL-16.

The text also refers to a PL-17 missile, which is reported to have a launch range of 400 kilometres. The article also mentions that this missile may have either active or passive radar. The latter would be a version that can be used against radars, such as the Russian Kh-31 or the U.S.-made AGM-88 HARM (High-speed Anti-Radiation Missile) missile [23].

4. Geopolitical significance

The PL-15E is not merely a technical device; it is also an element of China's geopolitical strategy. By offering modern BVRAAM missiles to countries such as Pakistan, it challenges the dominance of Western arms exports. The PL-15E provides nations without access to Western technology with the opportunity to acquire advanced air superiority capabilities. This is of particular significance in regions where air superiority plays a strategic role, such as the South China Sea, South Asia, and the Middle East.

In the aftermath of the conflict, India declared its intention to procure additional Meteor missiles to augment its existing inventory. Moreover, drawing upon the technological intelligence gleaned from the wreckage of the PL-15E, India has initiated the development of its own Astra Mark 1 missiles. The Astra Mark 2 is projected to have a range of 110 to 160 kilometres [34].

5. Comparisons with similar missiles

In this study, a comparative analysis is conducted on the U.S.-made AIM-120, the Russian R-77 and the European-made Meteor missiles, and the Chinese PL-15(E). The reliability of the comparison is contingent upon the quality of the open-source data.

5.1. AIM-120 AMRAAM (USA)

The development of the AIM-120 (Figure 4) commenced in the 1980s, and the system entered service in 1992 on USAF F-16D fighter aircraft. The product has been produced in numerous variants and continues to be produced to the present day: AIM-120A, -B, -C, -C1–C8, -D, -D1–D3. The A and B variants have now reached the end of their designated life cycle. Despite the absence of precise data, it is evident that the most prevalent variants at present are those

that predate C4. It is important to note that there may be significant differences between the missiles, as the manufacturer is constantly developing them. The range of the AIM-120C series is estimated to be in the range of 100–120 km, while the range of the D version is estimated to be 160–180 km. During the developmental process, the missile underwent a series of modifications, a phenomenon that can be attributed to the significant advancements in electronics, computing technology, and miniaturisation that have occurred since the 1980s. Contemporary iterations of the aircraft are equipped with an AESA seeker and, commencing with the C version, possess a reduced wingspan, thus allowing them to be accommodated within the internal weapon bays of fighter aircraft [24], [25], [26].

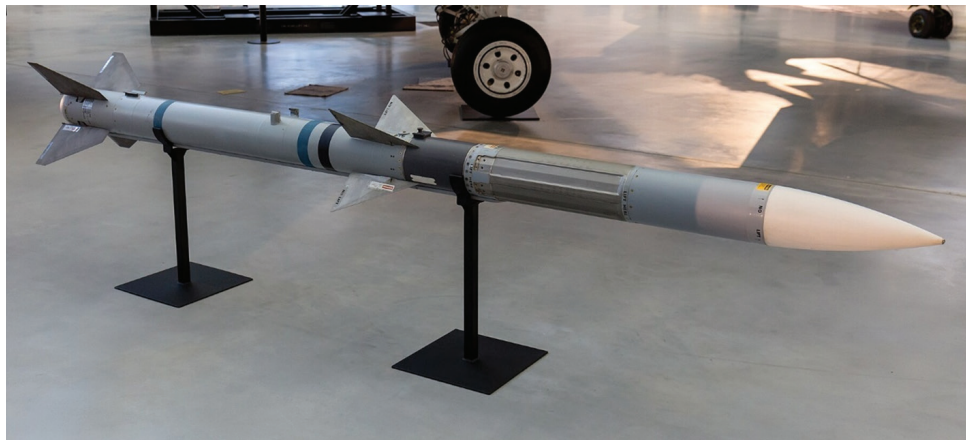


Figure 4.
AIM-120 missile [28]

5.2. Meteor (MBDA METEOR) (Europe)

The initial reports concerning the development of the missile were published in military and aviation periodicals during the early 2000s. The system configuration process was initiated in 2012, and the system has since been implemented in multiple countries. Further information regarding the missile can be found in publication [16].

A distinctive attribute of the missile under consideration is that its second stage of propulsion is constituted by a solid-fuel, controllable ramjet engine, a feature that is discernible from the presence of two air intakes situated in the lower portion of the missile. The principal benefit of this engine is that it preserves the rocket's kinetic energy throughout its flight, thereby resulting in a significantly larger "no escape zone" in comparison to that of analogous rockets. The rocket's seeker is AESA radar (Figure 5) [16].



Figure 5.
Meteor missile [16]

5.3. R-77 (Russia)

The air-to-air missile under discussion was developed by the Russian company Vypel during the 1990s (Figure 6). The aircraft's distinguishing feature is its retractable control surfaces, which draw upon technological advancements in the field of space exploration. The seeker of the rocket is equipped with a AESA radar system.



Figure 6.
R-77 missile [29]

5.4. R-37M (Russia)

The R-37M (Figure 7), developed for aircraft such as the MiG-31BM and Su-35, is currently one of the longest-range operational AAMs. It is estimated that the range of the aircraft is up to 400 kilometres, and its speed is approximately Mach 6. This makes it suitable for intercepting high-value targets, including airborne warning and sniper aircraft. The effectiveness of the system is ensured by its radar seeker and data-link mid-course guidance, which enable it to remain effective despite electronic countermeasures.

Its Russian designation is RVV-BD (Ракета Воздух-Воздух Большой Дальности – Long-Range Air-to-Air Missile). The primary function of the system was to counter aerial refuelling, AWACS, and other types of C4ISTAR (Command, Control, Communications, Computers, Intelligence, Surveillance, Target Acquisition, and Reconnaissance) aircraft. The piece was commissioned in 2019. It has been documented that the Su-57 was utilised in the Russo–Ukrainian war, with reports indicating that a Russian Su-57 shot down a Ukrainian Su-27 aircraft from a distance of 217 km [31].



Figure 7.
R-37 (RVV-BD) missile [39]

5.5. AIM-174B Gunslinger (USA)

The AIM-174B (Figure 8) Gunslinger is a very long-range air-to-air missile (AAM) developed by U.S. defence contractor Raytheon and used by the United States Navy (USN) [40].



Figure 8.
F/A-18F with four AIM-174B [40]

5.6. AIM-260 JATM (USA)

The AIM-260 Joint Advanced Tactical Missile is the U.S. response to rapid Asian missile developments. Although details remain classified, its range reportedly surpasses that of the AIM-120D, pushing beyond 200 km. The JATM is designed specifically to counter stealth aircraft and highly manoeuvrable fighters in heavily contested airspace. This is not included in the table because little data is available.

Table 1.
Technical data of missiles [the authors]

Missile type	AIM-120C-5-7	AIM-120D	Meteor	R-77	PL-15E	R-37M	AIM-174B
In service	2003–	2006–	2013–	1994–	2016–	2019–	2021–
Maximum operational range [km]	120	180	200	100	145 200+ (PL-15)	200+	400+
Speed relative to the speed of sound [M]	4	4	4+	4	5+	6	3.5
Length [mm]	3,660	3,660	3,650	3,500	3,996	4,060	4,700
Diameter [mm]	178	178	178	200	203	380	340
Wingspan [mm]	447	447	630	700	–	720	1,570
Mass [kg]	161.5	161.5	185	175	210	510	860
Warhead weight [kg]	20.5	20.5	25	22.5	40	60 ⁵	64
Warhead	HE BF ¹						
Engine	SFR ²		SFR+Ramjet	SFR ²			
Guidance system	INS ³ + update via DataLink + ARH ⁴						INS ³ + ARH ⁴ and SARH ⁶
	¹ HE BF – High explosive blast-fragmentation ² SFR – Solid-Fuel Rocket motor ³ INS – Inertial guidance ⁴ ARH – Active Radar Homing ⁵ conventional or thermonuclear ⁶ SARH – Semi-Active Radar Homing						

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PL-15(E) légiharc-rakéta

2025. május 7. és május 10. között fegyveres konfliktus alakult ki Pakisztán és India között, amelyben mindkét fél komoly csapásokat mért a másik katonai objektumaira. A híradások szerint ebben a konfliktusban alkalmazták először éles bevetésen a kínai gyártású PL-15(E) légiharc-rakétát. A szerzők a cikkben bemutatják a kínai rakétát, és összehasonlítják a hasonló kategóriájú rakétákkal.

Kulcsszavak: PL-15(E), légiharc-rakéta

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