A SHORT HISTORY OF AIR INTERCEPT RADAR AND THE BRITISH NIGHT-FIGHTER, PART TWO, 1945 - 1959, by Ian White

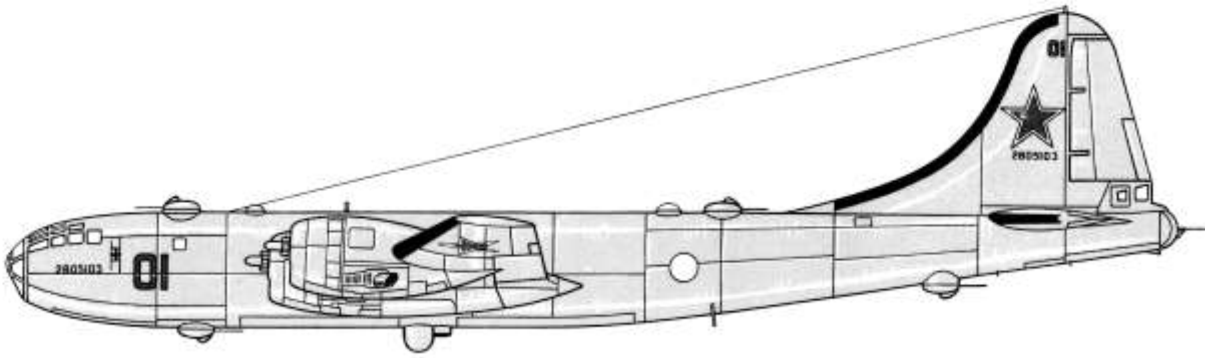
By the time of the end of the Second World War Britain had the best organised and equipped air defence system in the world, bar none and no prospective ‘enemy’ in the foreseeable future. However, unlike that which was built up at the end of the First World War, the system was not dismantled with the coming of peace, but was retained and restructured to meet the demands imposed by new technology and world events. The extent of that restructuring would be heavily dependent on a number of external factors concerning the country’s finances, which even then were in an appalling state, the demobilisation of its Armed Forces and the technological lead achieved by the United States (US) in radar research and design (R&D).

The end of the war also marked the beginning of an equally expensive, but relatively bloodless, slide into the Cold War and the realignment of Europe into Communist and Non-Communist blocks. From the beginning of this period it was apparent that developments in technology would play a significant role in the Cold War, especially in those areas relating to jet-powered aircraft, electronics and nuclear weapons. These in turn would bring about the need to establish a twenty-four, 365 day, fully alert air defence network in peacetime that was in turn supported by high performance jet-fighters fitted with sophisticated radar sets and heavy cannon or guided weapons. This concept was not an insignificant task.

To gain some appreciation of the technological leap that was required, it is worth understanding that at the beginning of the Second World War the air defences had to contend with bombers flying at little more than 250 mph (400 km/hr) - a ground speed of four miles/min (6.5 km/min). However, with the introduction by the *Luftwaffe* of the Arado Ar 234B Blitz jet-reconnaissance-bomber to photographic operations over Britain in November 1944, the defences had to be capable of dealing with intruders flying at very nearly twice those speeds and altitudes in excess of 30,000 feet - the Ar 234B was capable of 435 mph (700 km/hr) at 32,000 feet (9,750 metres) - a ground speed of 7.25 miles/min (11.7 km/min). Incidentally, none of the 234’s sent over Britain were ever intercepted. Therefore, in order to cope with these and better aircraft Fighter Command had to be capable of fielding day and night-fighters with sufficient performance to intercept and destroy them before they released their (potentially) nuclear bombs over Great Britain. Fortunately, until such time as the Soviet Air Force was able to field a jet-bomber, the people of Great Britain were relatively safe from attack.

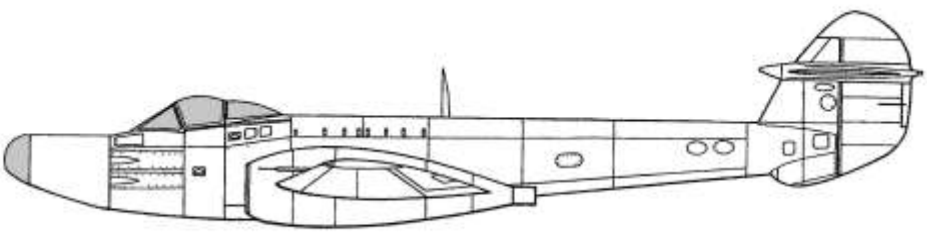
The poor state of the Treasury and the technological lead handed to the US in many areas of weapons and radar development, but more particularly of mass production in the electronics industry, found post-war Britain unable to compete in any meaningful way with its cousin across the Atlantic. With no immediate threat to its airspace and with the Soviet Union as yet unable to deploy nuclear weapons until the early/middle 1950s and then in very small numbers (less than a dozen), the British Government, and through it, the Air Ministry, adopted the *status quo* and opted to soldier on with the de Havilland Mosquito and its AI Mk.10 radar - note that from 1946 onwards aircraft and radar designations were altered to Arabic numbering. At the end of the European War the RAF rapidly demobilised its squadrons and returned its airmen to civilian life. By August 1945 the night air defence of Great Britain was reduced to six stations and eight squadrons; Nos.23 & 141 at Wittering, Nos.25 & 29 at West Malling, No.85 at Tangmere, No.151 at West Zoyland, No.264 at Linton-on-Ouse & No.307 (Polish) at Horsham St Faith. All were equipped with either the Mosquito NF.30 or the 36, with No.25 Squadron operating a mixture of both.

Although small by comparison to its wartime establishment the defence was adequate, since during the Second World War the Soviet Union had neglected the development of strategic bombers. Apart from a small number of four-engined Petlyakov Pe 8 bombers, the Soviet Red Air Force concentrated on the construction of tactical bombers to support the Red Army in its field operations. However, when the US Army Air Forces (USAAF) inadvertantly Soviet Union with a number of Boeing B-29 Superfortress in the latter stages of the Pacific War, the Soviet aircraft industry reverse-engineered the design and produced them as the Tupolev Tu-4 (NATO codename *Bull*) in the late 1940s. These aircraft heralded a significant improvement in the Red Air Force’s capability, both in terms of performance and their ability to carry a nuclear weapon.



(Mike Keep)
Tupelov Tu-4 Bull strategic nuclear bomber, circa early 1950s - a copy of the Boeing B-29A.

The Tu-4's speed of 360 mph (580 km/hr) at 32,800 feet (10,000 metres) was only slightly inferior to that of the Mosquito NF.30, forcing the Air Ministry to look again at the night defences and introduce a more powerful jet night-fighter into RAF service. Fortunately, for the RAF the Air Ministry was not starting from scratch. As has already been mentioned in Part One, Britain was given access to supplies of American 6cm radar technology in 1943 in the form of the self-contained AN/APS-4 with which to equip the Royal Navy's Firefly night-fighters. Although short on range the APS-4 was small enough to be fitted into the nose of a jet-fighter. During September 1945 a Gloster Meteor F.3, EE348, was delivered to the Central Radar Establishment (CRE) for the installation of an APS-4 in its nose, forward of the main wheel attachment frame, to produce what was probably the ugliest aircraft in the Air Ministry's inventory.



(The Author)
Gloster Meteor EE348 with an AN/APS-4 radar mounted in an experimental installation in the extreme nose.

Although not intended to form the basis of an operational night-fighter, EE348, was employed on a series of trials during 1946 to provide radar ranging information for single-seat fighters, where the radar data was fed into a computing gyro-gunsight. The following year in March 1947 the Air Ministry released Specification F.44/46 which called for the development of a fighter capable of intercepting an enemy aircraft flying at 40,000 feet (12,190 metres) and at a maximum speed of 550 mph (855 km/hr). In order to comply with the specification the F.44/46 fighter was required to reach a top speed of 605 mph (520 knots/975 km/hr) at an altitude of 25,000 feet (7,620 metres) and engage its target with four 30mm cannon. The aircraft was also required to have an endurance of two hours with a crew of two; pilot and navigator/radio (nav/rad). In response to this requirement the de Havilland Company proposed its D.H.110 naval fighter, later the Sea Vixen, and Glosters their P.228 derivative of the Meteor that would eventually metamorphose into the Gloster G.A.5 and then into the Javelin. To cut a very long and complex story short, by March 1948 the Air Ministry had ordered prototypes of the D.H.110 and the G.A.5 for evaluation. However, with the loss of the D.H.110 prototype in 1952, the G.A.5 emerged as the RAF's favourite to fulfil the night-fighter requirement.

(Armstrong Whitworth Aircraft Ltd)

Gloster Meteor NF.11 WD597 fitted with AI Mk.10. The two upturned ‘T’ aerials underneath the rear fuselage are the transmitter and receive aerials of the aircraft’s radar altimeter. Note the cannon outboard of the engine nacelles and the crew enclosed in a heavily framed canopy. The bulge under the nose radome accommodates the lower hinge mechanism of the AI scanner.

In order to bridge the gap until the Javelin entered service, the Air Ministry raised an interim night-fighter specification, F.24/48, in February 1949 that called for a Meteor-based, jet-powered, night-fighter equipped with four 20mm cannon and AI Mk.10 radar. Gloster responded by proposing a development of their trainer version of the Meteor day-fighter, the T.Mk.7, that featured an extended nose to accommodate the radar scanner and the electronics boxes. With the company heavily committed to the production of single-seat Meteors, the development of the night-fighter was sub-contracted to Armstrong Whitworth Aircraft Ltd (AWA), at Bagington, near Coventry. AWA stretched the T.7’s fuselage by 48-inches (1.22 metres) to accommodate the radar, whilst the long span wings of the photographic reconnaissance version replaced the day-fighter’s short mainplanes, with the four 20mm Hispano cannon being displaced from the nose and mounted outboard of the engine nacelles. The pilot and nav/rad were accommodated under a heavily framed canopy, with the radar’s indicating unit being placed directly in front of the nav/rad. The two Rolls Royce (R-R) Derwent turbo-jets gave the NF.11 a respectable maximum speed of 545 mph (880 km/hr) at 30,000 feet (9,145 metres) and a service ceiling of 43,000 feet (13,105 metres); both more than enough to catch the Tu-4. The NF.11 entered squadron service with No.29 Squadron at Tangmere on the 20th August 1951.

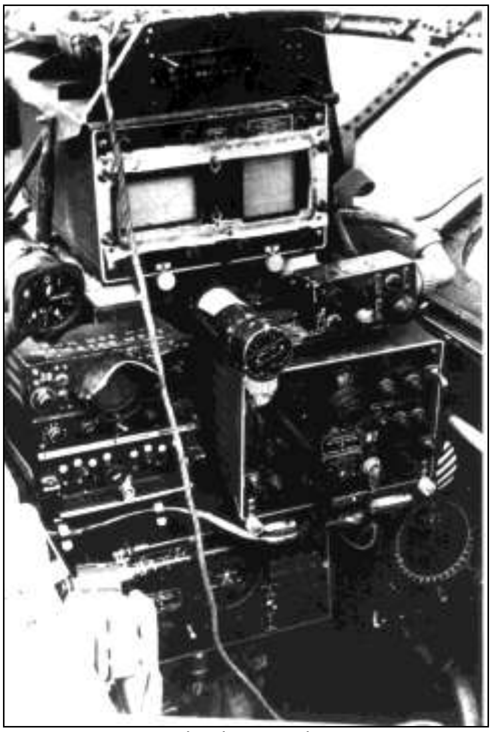
The Meteor was always considered an interim development pending the availability of the all-singing, all-dancing, all-weather Javelin that was to be fitted with a British radar. However, two problems arose to scupper this concept within the upper echelons of the Air Ministry and Fighter Command. First, the procurement and development of the Javelin became a protracted affair that delayed its entry to service until February 1956 and the deployment of the finite missile-armed version until July 1958, and second, the radar failed to perform as specified.

At the beginning of the development of centimetric radar in the summer of 1941, Dr Bernard Lovell (later Professor Sir Bernard Lovell) and Dr F.C ‘Freddie’ Williams began the design of a ‘lock-follow’ mechanism that would enable the radar operator to place and electronic gate over a target return and allow the set to follow the target automatically. This development diverged from AIS (see Part One) when Dr Lovell was transferred to work on Bomber Command’s H2S mapping radar, but was continued as AI Mk.IX under the leadership of Dr A.C.Downing.

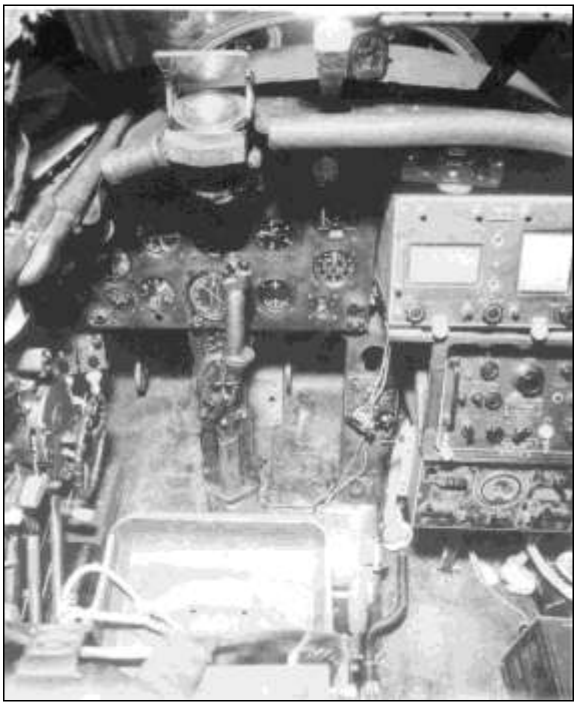
(Crown Copyright)
De Havilland Mosquito NF.XIII fitted with the prototype AI Mk.IXB in a modified radome. This picture was probably taken at RAF Defford.

The prototype of this 9 cm radar was first tested in a specially adapted Beaufighter, but when exposed to *Window* (chaff) jamming during a series of flights in November 1942, it locked itself to the *Window* cloud and lost the target. At this juncture the Air Ministry was in two minds whether to proceed with the development and production of AI Mk.IX or go with the American SCR-720B radar which performed better in the face of *Window* jamming. Downing was sure he could fix the problem and was given a stay of execution to modify the locking circuits and conduct further tests. Tragically, on the 23rd December 1942 the AI Mk.IX Beaufighter with Downing on board was accidentally shot down by a Spitfire and he and his pilot were killed. With the prototype lost and no replacement in sight, the Air Ministry took the pragmatic decision and opted to proceed with the procurement of SCR-720B as the RAF's next AI radar (see Part One, pages 68 & 69).

Although displaced by the SCR-720B set, work on AI Mk.IX continued at a slower pace with a variety of versions being proposed that linked the lock-follow facility to the windscreen projection of the radar picture and produced firing calculations for the fighter's gyro-gunsight. However, again to cut a very long story short, the version with windscreen projection and gyro-gunsight solutions was submitted to the Central Fighter Establishment (CFE) in 1944 and 1945. Under testing this was found to be superior to SCR-720B/AI Mk.X at medium and high altitudes, but failed to gain their approval as it did not work well at the lower levels and proved very complex in operation. A second trial at CFE in February 1948 buried AI Mk.9 for ever, when it was discovered that its low-level performance remained inferior to that of SCR-720B/AI Mk.X and its lock-follow facility proved unreliable. The following year the programme was cancelled. With AI Mk.IX removed from the equation and the country in general having little in the way of foreign exchange to buy equipment from abroad (meaning America), the Air Ministry and the night-fighter designers had little alternative but to soldier on with AI Mk.10.



(Ted Hootton)
The Indicating Unit for AI Mk.10 in the Meteor NF.11, 12 & 13, showing the heavily framed cockpit canopy and generally cluttered nature of the nav/rad's station.

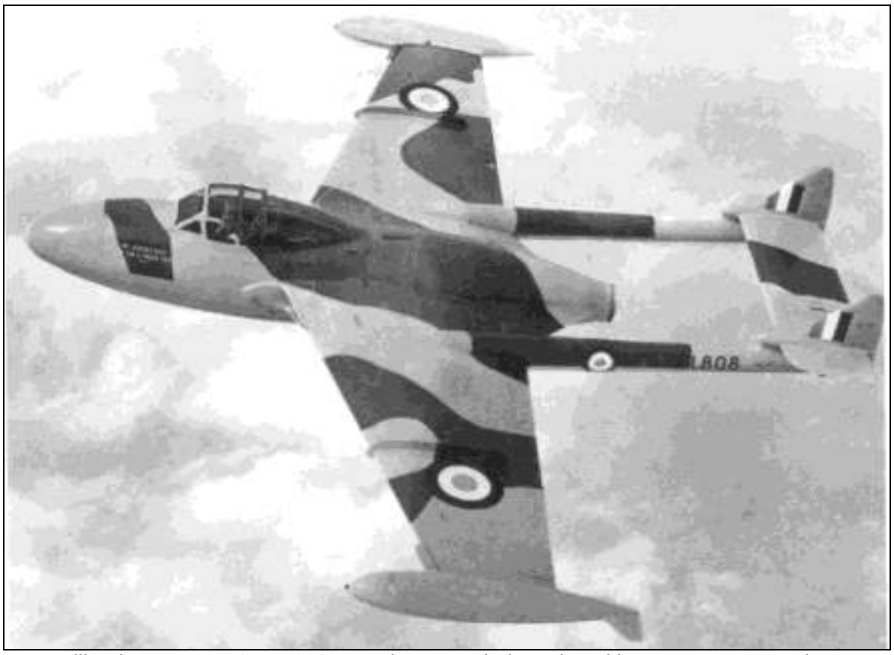


(Ken Wright)
The Indicating Unit of AI Mk.10 in the right hand side of the Vampire NF.10's cockpit, with the pilot's seat, flying controls and gunsight on the left. That of the Venom NF series was very similar.

(Ken Wright)
Vampire NF.10, Meteor F.8 and Meteor NF.11 of No.151 Squadron circa 1954 when the Vampire was giving way to the Meteor NF.11.

When the Cold War went 'hot' during the period of the Berlin Airlift and the outbreak of the Korean War in 1950, the need for fighters of all types quickly outstripped Gloster's and AWA's capacity to produce sufficient aircraft to fulfil Fighter Command's expansion and modernisation plans. It had always been the RAF's policy that night-fighters be twin engined, partly for reasons of safety and partly because the extra power was needed to provide these heavy aircraft with a reasonable performance. However, despite the Air Ministry's bias in this regard, the de Havilland Company began work on a night-fighter based around their single-engined Vampire day-fighter, which they proposed to sell to foreign air forces. Equipped with AI.10 and fitted with a Mosquito-style front fuselage that accommodated a two-man crew, the radar and four 20mm cannon. The resultant 'Vampire Night-Fighter' took to the air for the first time on the 28th August 1949. The Company was immediately successful in securing an order from the Egyptian Government for twelve aircraft, but these were subsequently embargoed by the British Government due to political problems in the Middle East. With the aircraft unlikely to be delivered to the Egyptian Air Force 'any time soon', the embargoed aircraft were taken over by the Air Ministry to fulfil the pressing need for jet night-fighters. The first of what was eventually re-titled the Vampire NF.Mk.10, were delivered to the RAF in July 1951 and allocated to No.151 Squadron in February the following year.

Although faster than the Meteor at altitude, having a superior ceiling and being a good gun-platform, the Vampire suffered a few disadvantages, namely; no ejection seats, a cockpit that was difficult to get out of in an emergency and a low slung fuselage which made the loading and arming of the guns a difficult operation. Overall, the Vampire was viewed by the crews as a death trap that was responsible for the loss of several crews and, notably, two experienced squadron commanders. The Vampire NF.10's service in Fighter Command was short lived. Only Nos.23, 25 & 151 Squadrons were equipped and their aircraft were quickly replaced by Meteors and Venoms in 1954.



De Havilland Venom NF.2, WL808, was the exampled employed by A&AEE, Boscombe Down, to trial the Venom night-fighter concept. This aircraft was then transferred to the Central Fighter Establishment for further trials, before passing to No.253 Squadron at Waterbeach as an operational fighter.

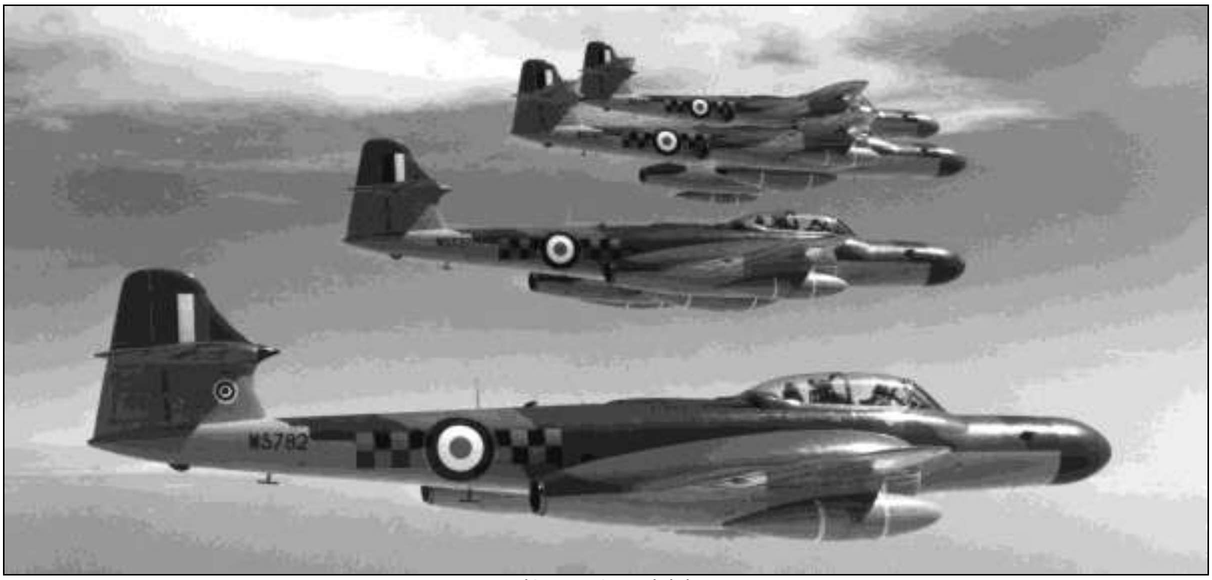
Despite the hostility shown towards the Vampire night-fighter, the de Havilland Company persevered with the single-engined night-fighter concept in the belief they could build a better aircraft based around the more powerful Venom airframe. Although initially showing little enthusiasm for the project, the Air Ministry was eventually brought around to de Havilland's thinking when it was proposed to graft the forward fuselage of the Vampire NF.10 to the slightly swept wings and rear fuselage of the Venom. The prototype Venom night-fighter flew for the first time on the 22nd August 1950 and when it was tested by the pilots at the Aeroplane & Armament Experimental Establishment (A&AEE), Boscombe Down, it was found to handle reasonably well, despite a tendency towards longitudinal instability and an unsatisfactory rate-of-roll for a fighter. However, such was the RAF's desperation to acquire night-fighters, the Air Ministry went ahead and accepted the aircraft for squadron service in November 1953, pending a series of modifications to eradicate its shortcomings. The fully modified version, designated Venom NF.Mk.2A, complete with redesigned tail surfaces and frameless canopy, but no ejection seats, entered service during the summer of 1954.

Although viewed as 'dubious' by its crews, the Venom NF.2A was in many ways a good night-fighter. It proved capable of outperforming the Meteor and was more than a match for the Tu-4 that was then (the early 1950s) equipping the majority of the Soviet Air Force's long-range bomber regiments. However, by the middle of the decade the Soviet aircraft industry was beginning to test a whole series of jet-bombers, whose performance was likely to outstrip the UK night-fighter force. As was mentioned earlier, it was the intention that the Javelin take over the all-weather, day and night-fighter role in the early/mid-1950s - its original in-service date was 1953 -and allowing the Meteors and Venoms to be retired. By 1950 the wartime AI Mk.10 radar was reaching the end of its useful life and with the delays in the Javelin programme steadily moving to the right, yet another interim night-fighter had to be found. With work progressing on developing the Javelin's AI Mk.17 radar, the decision was taken to purchase an off-the-shelf equipment from the United States and fit it into the Meteor and another version of the Venom.

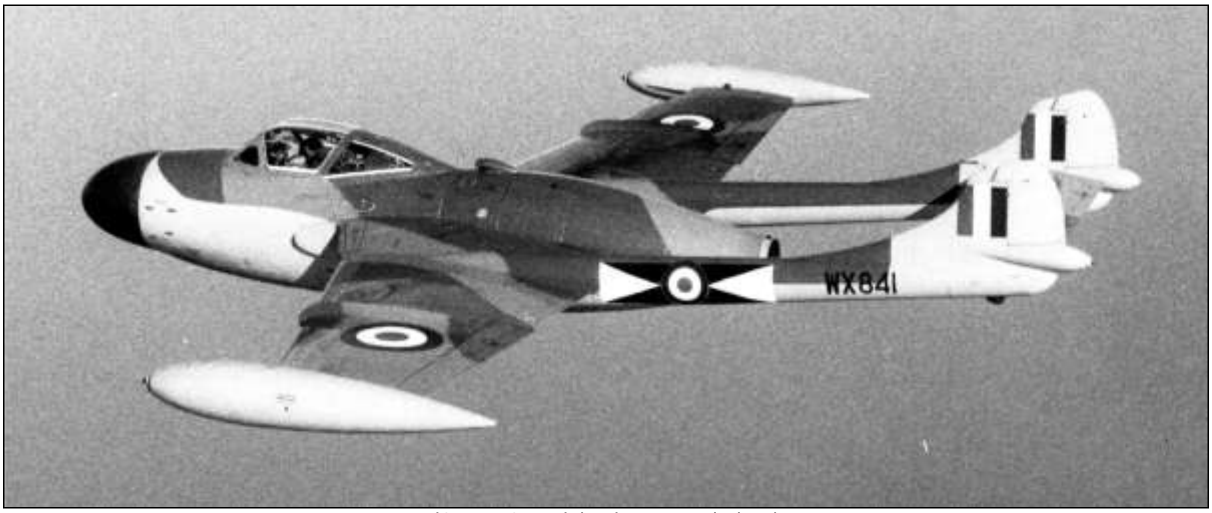
(Crown Copyright)
Gloster Meteor NF.12, WS697, 'N' of No.25 Squadron circa July 1958 to April 1959.

The chosen radar was the Westinghouse AN/APS-57 that was modified with a British strobe unit and a variable PRF. Designated AI Mk.21 in UK service (it was also used in the Royal Navy's de Havilland Sea Venom), the new radar had a range that varied between nine and twenty-five miles (14.5 & 40 km), depending on altitude, compared to the ten to twelve miles (16 - 19.3 km) for AI Mk.10. It also boasted an air-to-surface (ASV) mode. Overall, APS-57 had more operating modes than AI Mk.10, better definition, a limited lock-follow facility and IFF and navigation beacon functions. Unfortunately, the APS-57 came with more electronic boxes, which in turn required a further stretch of the Meteor's nose to accommodate them, the installation of up-rated Derwent engines of 3,800-lb st to lift the greater weight and a slightly redesigned fin of greater area to restore the longituinal stability. Overall, its performance was broadly similar to that of the Meteor NF.11. The first of the resultant Meteor NF.12 flew for the first time on the 21st April 1953 and entered service in January 1954.

Often referred to as the 'Queen of the Skies' by its crews, the Meteor NF.14 was the last of a long line of Gloster night-fighters. A cleaned-up version of the Mk.12, the Meteor 14 was broadly comparable in performance terms to that of the NF.11 and the NF.12. So by the end of the line for the twin-engined, jet night-fighter, it was only the performance of the radars that distinguished the original NF.11 from the definitive Mk.14! Deliveries to Fighter Command began in 1954, where it was regarded by pilots as 'fun to fly', but was in reality hopelessly outclassed by contemporary bombers such as the English Electric Canberra and the American Boeing B-47 Stratojet, with which it exercised on a regular basis.



(Crown Copyright)
This well known photograph shows four of No.85 Squadron's Gloster Meteor NF.14s with WS782 & WS737 in the foreground. Note the 'T' aerials of the radar altimeter under the rear fuselage and the VHF comms radio aerial above the fuselage roundel.



(Crown Copyright via Roger Lindsay)
De Havilland Venom NF.3, WX841, of No.141 Squadron, circa June 1955 to March 1957.

Amazingly, given the problematical development of the Vampire and Venom and the aircrew's aversion to flying over the North Sea on one engine, the Ministry of Supply (MoS) approved yet another version of the de Havilland fighter, the Venom NF.3. Whilst very similar to the Mk.2A, the new model had the APS-57 radar, which was being funded by the United States under the terms of the Mutual Defence Aid Programme, and Ghost Mk.104 engines of 4,950-lb thrust to boost the rate-of-climb and the operational ceiling. However, with its predicted life being somewhat short, the NF.3 was not fitted with ejection seats, although they were considered. The Mk.3 entered service in June 1954 - at about the same time as the Meteor 14 - but was withdrawn by the end of 1957.

(Gloster Aircraft Co Ltd)
Gloster Javelin FAW.4, XA631. This photograph was probably taken on the pan at Gloster's Morton Valance airfield. XA631 was ordered as an FAW.1, but advanced down the production line and converted to FAW.4 standard, whence it was retained by the manufacture for operational reliability trials. According to the records it did not enter RAF service.

The long awaited introduction of the Javelin occurred during February 1956 and marked the beginning of the end for the dedicated night-fighter and the transition of Fighter Command to an all-weather force. From the mid-1950s the Meteor and Venom squadrons were converted to all-weather working as both types began to disappear from Britain's skies. By June 1959 the UK's air defence units were fully equipped with Javelins, the Venoms had passed to the maintenance units (MU) for scrapping and the remaining Meteor NF.11s (the oldest of the type) flown to the RAF in Germany to act as temporary equipment pending the introduction of the Javelin in the Federal Republic. The last of these survived until June 1960, when they too were transferred to the scrap yards. It fell to the Far East to see out the night-fighter, when No.60 Squadron based at Tengah, Singapore, traded its Meteor 14s for Javelins in August 1961. Ironically, by the time the Javelin was being built in reasonable numbers and in improved variants with missile armament, its replacement in the form of the English Electric Lightning was already undergoing operational testing and would enter Fighter Command service the same month as No.60 Squadron's Meteors were retired!

Throughout its barely twenty years of life, Britain's radar equipped night-fighter force developed the principles and practice of night interception and established night fighting as an indispensable arm of Britain's national defence - a legacy it retains to the present day, albeit with far more sophisticated systems and far fewer aircraft and personnel.

COMPARATIVE PERFORMANCE OF THE PRINCIPLE NIGHT-FIGHTERS, 1946 - 1961

	Mosquito NF.36	Meteor NF.11	Vampire NF.10	Venom NF.3	Meteor NF.14
Powerplant	2 x 1,690-hp R-R Merlin 113/114	2 x 3,600 lb st R-R Derwent 8 turbojets	One 3,350 lb st de Havilland Goblin 3 turbojet	One 4,950 lb st de Havilland Ghost 104 turbojet	2 x 3,800 lb st R-R Derwent 9 turbojets
Loaded Weight	21,600-lbs	22,000-lbs	13,100-lbs	15,800-lbs	21,200-lbs
Max Speed	407 mph at 28,000 ft	579 mph at 9,842 ft	538 mph at 20,000 ft	630 mph at altitude	578 mph at 10,000 ft
Range	1,300 miles	920 miles	1,220 miles	1,000 miles	920 miles
Service Ceiling	39,000 ft	43,000 ft	40,000 ft	49,200 ft	43,000 ft
Armament	4 x 20mm cannon	4 x 20mm cannon	4 x 20mm cannon	4 x 20mm cannon	4 x 20mm cannon
Radar	AI Mk.I0	AI Mk.10	AI Mk.10	AI Mk.21 (AN/APS-57)	AI Mk.21 (AN/APS-57)

RAF NIGHT-FIGHTER SQUADRONS, 1946 - 1961

No.5	Meteor NF.11.
No.11	Meteor NF.11.
No.23	Mosquito NF.30, Vampire NF.10, Venom NF.2 & 2A & Venom NF.3.
No.25	Mosquito NF.30 & 36, Vampire NF.10, Meteor NF.12 & 14.
No.29	Mosquito NF.30 & 36, Meteor NF.11 & 12.
No.33	Venom NF.2A & Meteor NF.14.
No.39	Mosquito NF.36 & Meteor NF.13.
No.46	Meteor NF.12 & 14.
No.60	Meteor NF.14.
No.64	Meteor NF.12 & 14.
No.68	Meteor NF.11.
No.72	Meteor NF.12 & 14.
No.85	Mosquito NF.30 & 36, Meteor NF.11, 12 & 14.
No.87	Meteor NF.11.
No.89	Mosquito NF.19 & Venom NF3.
No.96	Meteor NF.11.
No.125	Meteor NF.11 & Venom NF.3.
No.141	Mosquito NF.36, Meteor NF.11 & Venom NF.3.
No.151	Mosquito NF.30, Vampire NF.10 & Venom NF.3.
No.152	Meteor NF.12 & 14.
No.153	Meteor NF.12 & 14.
No.219	Mosquito NF.30 & 36, Meteor NF.13 & Venom NF.2A.
No.253	Venom NF.2A.
No.255	Mosquito NF.19 & 30.
No.256	Mosquito NF.19 & Meteor NF11.
No.264	Meteor NF.30 & 36, Meteor NF.11, 12 & 14.
No.307	Mosquito NF.30.
No.500	Mosquito NF.19 & 30.
No.502	Mosquito NF.30.
No.504	Mosquito NF.30.
No.605	Mosquito NF.30.
No.608	Mosquito NF.30.
No.609	Mosquito NF.30.
No.616	Mosquito NF.30.

COMPARATIVE PERFORMANCE OF AI Mk.10 & AI Mk.21 (AN/APS-21)

AI	Wavelength	Frequency	Peak Power	Max Range
Mk.10	9.1 cm	3.3 GHz	70 kW	6 miles
Mk.21	3.2 cm	9.4 GHz	200 kW	20 miles

AI	Min Range	Aerial System	Weight	Aircraft
Mk.10	300 ft	Helical scanning parabolic dish	500-lbs	Mosquito NF.30 & 36 Meteor NF.11 & 13 Vampire NF.10 Venom NF.2 & 2A
Mk.21	300 ft	Helical scanning parabolic dish	Not Known	Meteor NF.12 & 14 Venom NF.3