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Blue Steel – The V Force’s Stand-off Bomb

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This was a lecture from a speaker whose years in front-line operations, as a navigator in Vulcan and Victor in the Cold War era, ensured that he had much to say, and knew how to combine stories into a well-formatted, enjoyable and very informative presentation.

The thread throughout was a timeline through the period from when the stand-off bomb was conceived, to the day it was rendered un-operational. Information, about the V-bomber fleet and the circumstances associated with landmarks not likely to be forgotten in history, and salient moments in his involvements in the front-line, were mixed seamlessly. It was akin to listening to a story, but on referring to notes it was a deluge of data, knowledge and often as anecdotal as it was engaging.

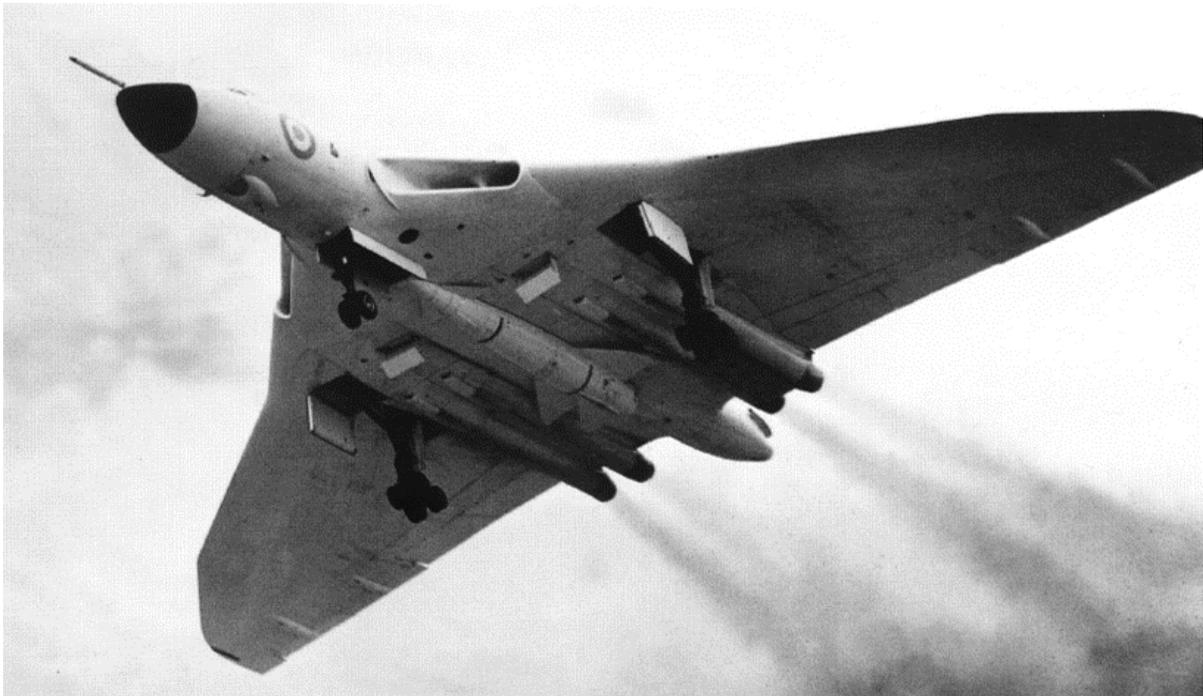


Figure 1. Avro Vulcan B Mk.2 with Blue Steel stand-off bomb

The backdrop was the 'Cold War' (1946-1991) that existed between Warsaw Pact and NATO forces. The events of the period – Berlin Airlift, the US-Soviet Space Race, Cuba missile crisis, and eventually the dismantling of the Berlin Wall – has all been elements relevant to a stand-off between the West and the East, and all associated to a common desire to maintain the belief that each was as equally certain of the other's dedication to a policy often called MAD (Mutually Assured Destruction). Nuclear warheads were being made and used to torment on either side, and the delivery of a bomb by aircraft was the option each could brandish at the other. In Britain an aircraft operational requirement (OR229) was released and assessed by Avro and Handley Page who, respectively, proposed a delta-wing and a swept-wing design: these became the Avro Vulcan and the Handley Page Victor. They were four-engine jets capable of meeting high-speed, long-range and high-altitude mission requirements. In 1950 an additional aircraft, designed to OR231, was

proposed, and this was the Vickers Valiant. It was a lower cost, and consequently less capable, stablemate, but was developed rapidly it became the third V-bomber design, and was the first to enter service. Initially, the aircraft were designed around a large conventional nuclear weapon, and expected to operate as did WW2 bombers, flying out to target, discharging their bomb from on-high, and returning to base again. The weapon specified was the 10,000lb Blue Danube, and 7,000lb Yellow Sun-1 and- 2 (respectively with 600kT and 1.1MT warheads).

The mission profile was changed as the Soviet Union’s surface-to-air missile (SAM) programme was monitored: the SAM-1 (Gould) and SAM-2 (Guideline) – names are NATO designations – were being installed around some 400 cities in the Soviet Union. These missiles were well capable of reaching the altitudes to be used by NATO bombers. Methods of delivering a nuclear bomb from outside the sizeable zone neutralised by the SAMs were studied at Farnborough and a report of potential design solutions completed in 1953 led to the issuing of a missile requirement (OR1132) in 1954. The contract was let to Avro, thus creating the Avro Weapons Research Department (AWRD) where studies commenced on the stand-off missile that was to become known as Blue Steel.

The specification called for a rocket-propelled weapon that could be released 100-150n.m. from the target at a height of 50,000ft, cruise at Mach 2.5+, have a low radar cross-section (RCS) signature, and would have an on target error of not more than 500 yards (relating to a 150 n.m. range operation). It was expected to convey a Green Grass (600kT) nuclear fusion warhead, and to be compatible with all V-bomber force aircraft. The design, as revealed in August 1955, was a 48inch (1.22m) diameter missile that was 35ft (10.67m) long, weighed around 15,000lb, and was powered by a Stentor (Hydrogen Peroxide and Kerosene fuel) rocket motor that delivered 26,000lb thrust. It was semi-recessed in the bomb bay of both Victor and Vulcan, was of canard configuration, used a double-skin stainless steel structure and had a folding lower fin to provide ground clearance on take-off and landing. The missile was integrated with the Valiant but only for trials purposes, as the type was withdrawn from service prior to the weapon entering service.

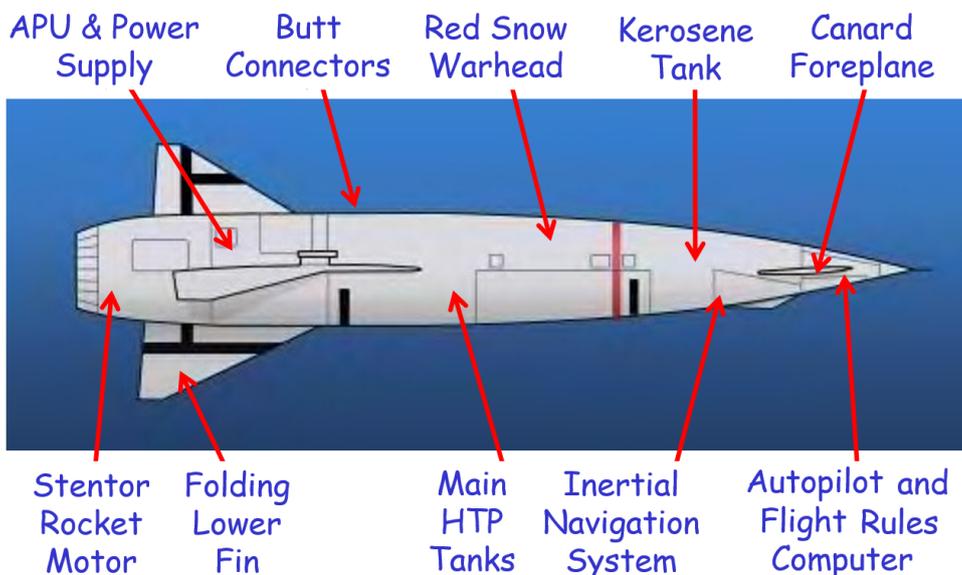
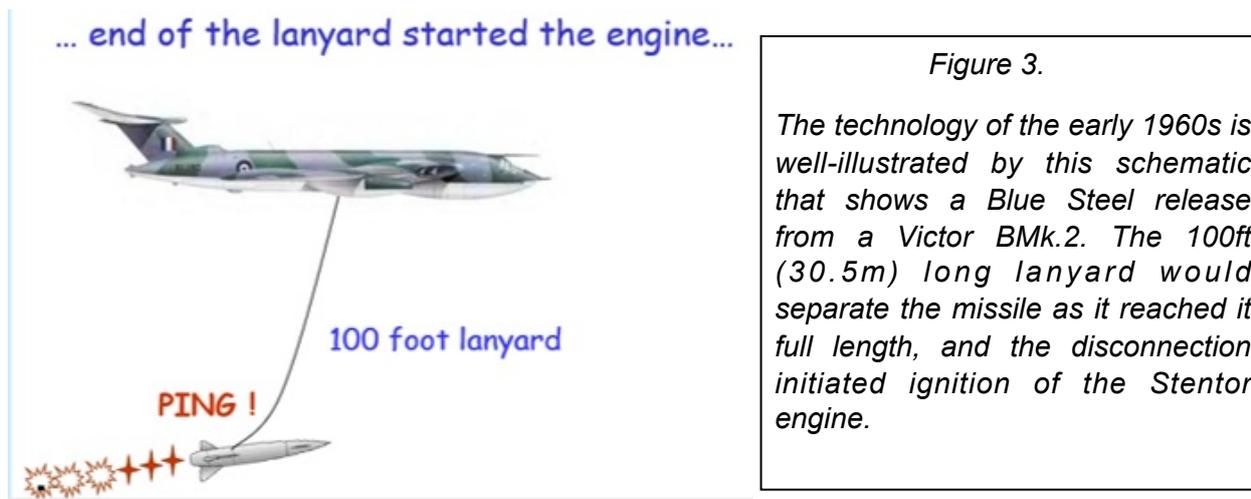


Figure 2. Blue Steel - configuration of major items

The Ministry of Supply production contract was released on 4 May 1956. In January 1959, the initial warhead guidance system having suffered an unacceptable proportion of failures, a major change

was an amendment that specified the Red Snow warhead (a US-derivative armament that was rated at 1.1MT).



Meanwhile, 17 practice missiles and 50 full-size missiles were acquired and taken to Australia where an RAF team was formed at Woomera in 1957 in preparation of trials that took place from 1961. We were presented with considerable information on the progress made in trials, which were not achieving good success rates initially, Starting from October 1962 the UK-based in-service fleet received 40 modified aircraft, and 16 training and 53 operational missiles were delivered to Squadrons. The modified aircraft had up-graded engines, modified bomb-bay doors, and equipment improvements that included a new Inertial Navigation System (INS) and a Ground Position Indicator (GPI-Mk6). We were shown the instrument panels used by the three crew members that managed navigation, communications and many of the tactical tasks associated with the operation of weapons. Many modern 'digital' systems engineer deserves to hear the pros and cons of 1950s/60s analogue technology: its ingenuity and issues nowadays a few line of computer code.



Figure 4. Using the Ground Position indicator (GPI-Mk6) the crew navigator provided accurate target coordinate data necessary for the autonomous missile guidance system

As Soviet missile capabilities improved there was increasing risk associated to maintaining the high-level delivery procedures, and in the mid-60s the V-bomber fleet (the Valiant had been withdrawn –

only Vulcan and Victor remained in service) began to perform low-level flight profiles. The aircraft were recognisable as they had their upper surfaces painted with RAF camouflage, but this put more pressure on the crew, to navigate and maintain a profile that was inconspicuous to SAM and other defences used by the enemy. The aircraft had to fly closer to the target (within 45nm), release the weapon and the Blue Steel then flew a high altitude profile and reached the target within 2 minutes of being released.

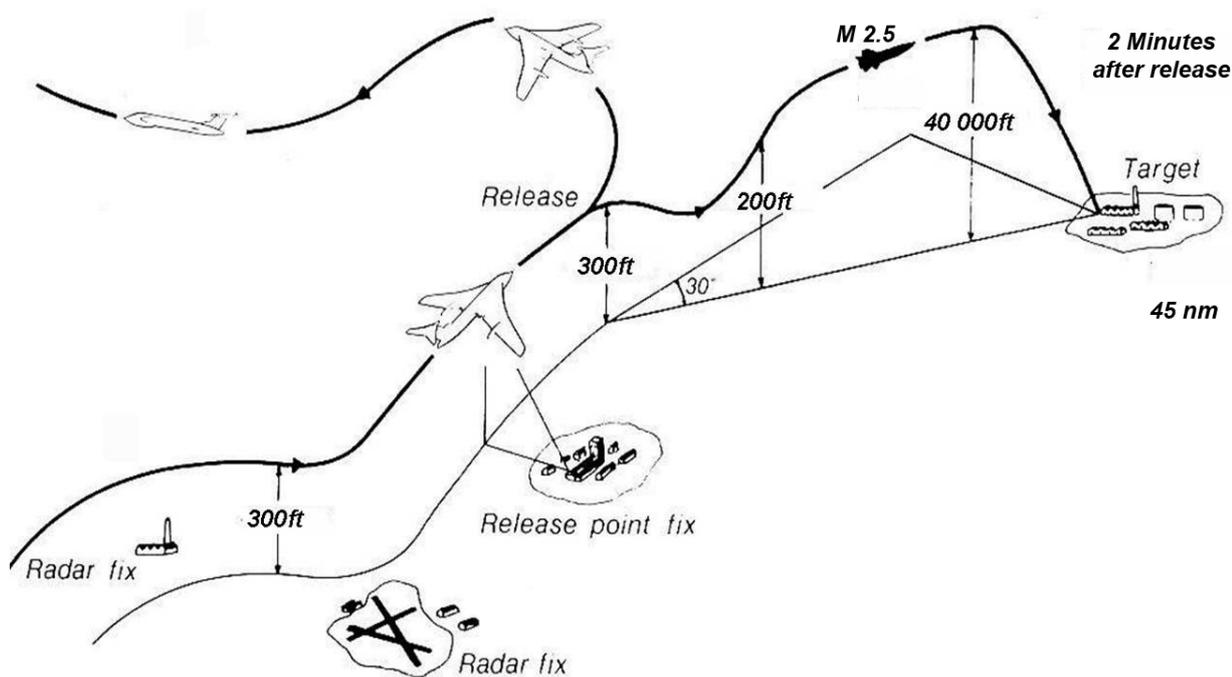


Figure 5. This schematic diagram shows the typical profile and the salient fixes that were used to locate and attack a target when the aircraft was at low-level.

Both Vulcan and Victor flight crews comprised a five-place team, with pilot and co-pilot on the flight deck, and navigator radar, navigator plotter and air electronics officer (AEO) at rearward-facing consoles across the rear pressure bulkhead. The speaker, being a navigator, talked through the controversial crew escape systems. Each of the two pilots had ejection seats, but the other three crew members – rear-facing at their consoles behind the cockpit had to bail-out, and that was easier said than done. He cited reports that in some accidents, when all crew members were lost, it was believed that the flight-deck crew decided to stay with the rest of the crew.

There was consideration of each of the three rear cabin crew having an ejection seat each fitted. Each seat was to be bespoke to the position, requiring a coordinated process whereby each operator, in turn, had to move and rotate their seat to orientate them (with the assistance of inflatable cushions) to be ejected in sequence through a single roof-hatch on the fuselage centreline. This proposition was not adopted, and the procedure adopted to escape from the Victor was described with some mirth. It relied on a knotted-rope that stretched from the right-hand wall to the door on the left-hand side. The crew members could leave their seats, in sequence, inch along the rope using the knots to 'navigate' – as this could be in darkness, or even chaotic circumstances, and on reaching the door, they could bail-out downwards). (The door hinged at the top and had side panels fore and aft - a necessity to prevent those bailing out being buffeted on

leaving the aircraft, and to minimise the possibility of the unimaginable fate of being sucked into the engines intake). He did not describe the process of escaping from a Vulcan, but it has been described by some crews as certainly neither better nor easier.



Figure 6. A Blue Steel missile being unloaded from a cradle on the back of a lorry that could transfer the ready-to-use weapon onto the trailer unit on which it could be towed beneath the aircraft on dispersal. It was stressed that Blue Steel was carried with a warhead in peacetime, but rarely, and under very specific conditions.

The Blue Steel story did not continue until the end of the cold war. The service life was threatened as early as 1960 when a withering defence budget pronounced by Harold Watkinson claimed it was better to replace airborne delivery of nuclear warheads with submarine-based launch platforms. It did not happen overnight. The Woomera based trials were only just beginning, but as reported above when in-service operations commenced in 1962, the combination of aircraft and the up-dated weapon was edging ever closer to providing an acceptable level of performance. The transfer of the UK nuclear deterrent capability from air to sea was underway by the end of the decade.

In the interim period, the speaker outlined how the Blue Steel force was active and using Radar Bomb Scoring Units (RBSUs), of which five were in use in Britain (located near London, in East Anglia, Glasgow, Newcastle and Manchester). The aircraft were also flying more missions using the low-altitude profile described. Such manoeuvres as were necessary could not be practiced at all the RNSUs in the UK, as there was too much population relatively close to the some units. These units monitored the aircraft as if they were a defending site, and gathered information from each operation that was invaluable to assessing likely vulnerability to potential responses.

There had been some belief that the US Skybolt missile would suit UK needs, and trials were conducted, from which it was concluded that the Vulcan was the better of the two V-bombers to carry the missile mainly because the Victor was a better platform to replace the Valiant as the much

needed tanker aircraft having much less turbulence behind it. The Government decision to adopt a nuclear-powered submarine based deterrent was already gaining favour, and although Skybolt trials continued, with dummy loads, no purchase was to follow. The submarine-launched Polaris was by then close to entering service, and the US abandoned Skybolt in late-1962.

This was a presentation that was so wide-ranging that all, bar the most secure, of all practical aspects of the Blue Steel, as a weapon and deterrent, were integrated in the material presented. The speaker had been at the centre of operations and while he was candid in his recollections, there was a sincere message too. It reminded those who can recall the breadth and depth of the 'Cold War' years what such confrontations entail, and for those who have only read about it, this offered a clear insight into the most chilling peace-time operations undertaken as routine by UK airborne forces.

There were around 180 attendees, and the overall satisfaction was vividly expressed in their applause, and desire to offer personal thanks as the session concluded. The branch could not have wished for a better anecdote to the helping of AGM formalities that had to precede these reminiscences.

Lecture notes by Mike Hirst