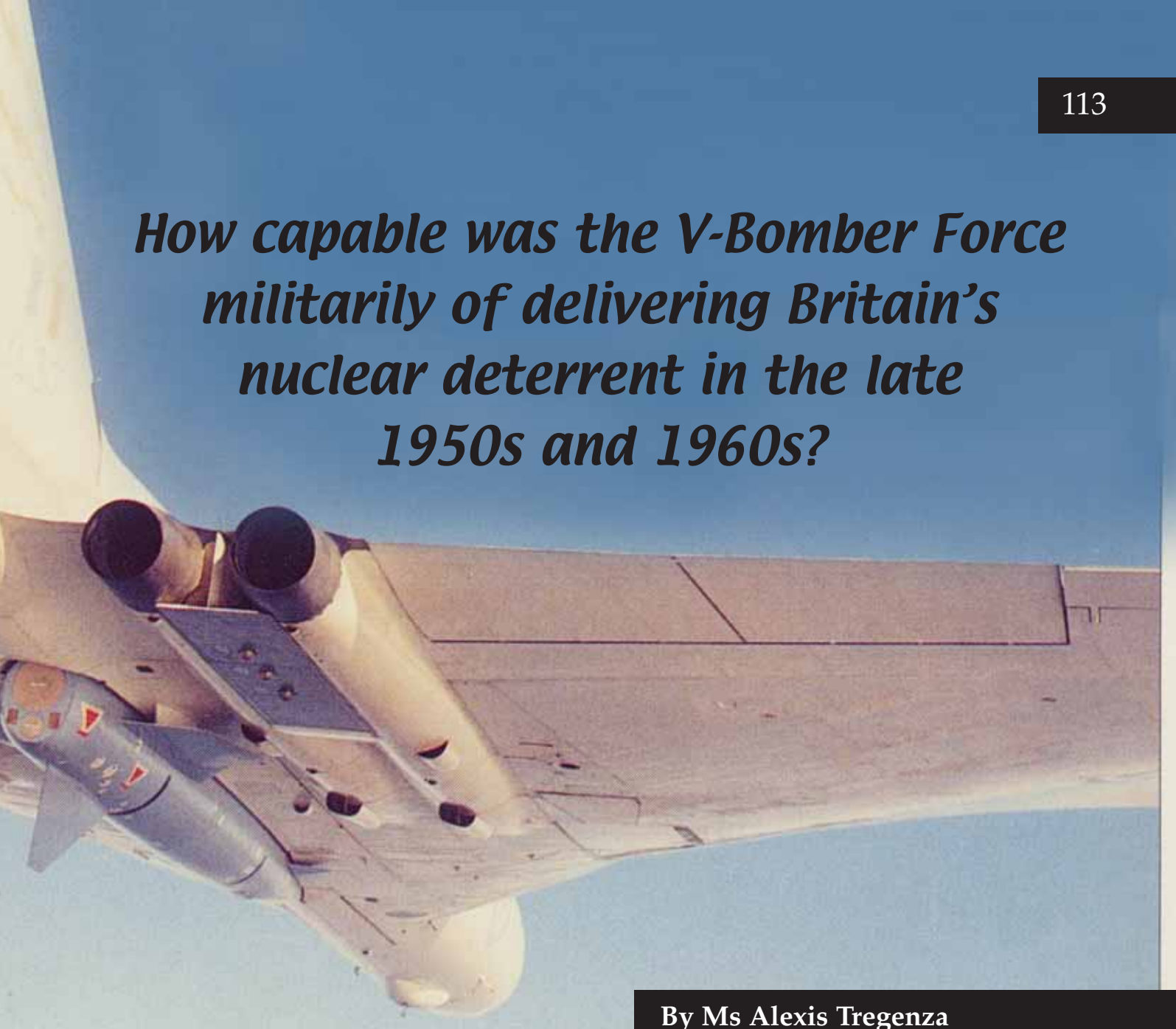
How capable was the V-Bomber Force militarily of delivering Britain's nuclear deterrent in the late 1950s and 1960s?



By Ms Alexis Tregenza

"Then it may be that we shall, by a process of sublime irony, have reached a stage in this story where safety will be the sturdy child of terror, and survival the twin brother of annihilation."
(Winston Spencer Churchill 01/03/55)[1]

In the summer of 1952 the British Joint Chiefs of Staff met to discuss the future of Britain's defence policy. In what became known as the *Global Strategy Paper* the thesis was put forward that nuclear weapons had revolutionized the character of war. Accepting this, the paper went on to argue that the most effective deterrent against Soviet aggression would be recognition by the Soviets that such aggression would bring instantaneous atomic reprisal. It was therefore recommended that the Western powers openly declare that Soviet aggression be punished by nuclear retaliation at the Russian heartland.[2]

This strategy would be at the heart of NATO doctrine for the following 39 years. From the mid 1950s to the end of the 1960s, Britain's primary tool for carrying out this threat was the V-bomber

Britain's V-bomber force was militarily capable in the main of getting in the air in time in the scenario of a Soviet nuclear attack

force, the fleet of three types of bomber: the Vickers Valiant, Avro Vulcan and Handley Page Victor. The purpose of this study will be to examine how capable the V-bomber force was of carrying out this retaliation throughout the time that it was entrusted with carrying Britain's nuclear deterrent.

It shall be assessed in two main parts. Firstly, by examining how vulnerable the V-force was on the ground to a Soviet surprise nuclear attack: namely, was it capable of getting into the air in time, given the brevity of warning Britain had? Secondly, the ability to penetrate Soviet air defences once it had got into the air and deliver its weapons on strategic targets in the USSR shall be considered. These targets were agreed upon between RAF Bomber Command and the Strategic Air Command (SAC) from 1957 onwards.

It is important to point out at this stage that such an examination is hypothetical as thankfully, none of the strategic nuclear weapons on either side in the Cold War period was used. Having accepted this, it does seem possible however, to build a reasonable picture of just how capable Bomber Command's V-bomber force was of carrying out the primary role assigned to it. This shall be done by using a variety of primary and secondary sources.

Further to this, it shall try to demonstrate that Britain's V-bomber force was militarily capable in the main of getting in the air in time in the scenario of a Soviet nuclear attack in sufficient numbers to constitute an effective deterrent and of penetrating Soviet defences to deliver its nuclear weapons. However, it shall also be argued that from the mid-1960s until the decommissioning of the V-force as the carrier of Britain's nuclear deterrent in 1969, advances in Soviet air defence systems and air defence fighters may have caused the attacking V-bombers to suffer such a rate of attrition that Britain's nuclear deterrent capability was seriously challenged.

It is useful at this point to outline why the military capability of the V-force was important. Due to the

We must now turn our attention to the V-bombers on the ground and their ability to get airborne in a 'worst case scenario' in order to credibly carry out the deterrent threat

The V-bombers, Vulcan, Victor and Valiant

human catastrophe that would befall Europe and the Western hemisphere in the event of a nuclear war, it was essential to make any future war as unlikely as possible. This was to be the hinge upon which nuclear deterrence worked. However, for deterrence to work, it is essential that the threat carry credibility otherwise the whole deterrent threat is undermined and therefore the chance of war breaking out increased.[3] For this reason it is also useful to examine the credibility of Britain's nuclear deterrent in this period.

Just how essential it was for Britain to have the capability to carry out its threat to deliver its nuclear arsenal was furthered with the advent of the hydrogen bomb. Whereas large countries such as the USA or USSR might have been able to withstand to a large extent an atomic attack that used lower yield atomic bombs, such as those used against Japan in 1945, the hydrogen bomb as Sir Anthony Eden observed ". . . was to diminish the advantage of physically larger countries. All became equally vulnerable. I had been acutely conscious in the atomic age of our unenviable position in a small and crowded island, but if a continent, and not merely small islands were doomed to destruction, all was equal in the grim reckoning".[4] Nevertheless, the increase in destructive power made Britain even more vulnerable. As a Soviet general said: "There are optimists and pessimists in Britain. The pessimists think five H-bombs will wipe out everyone in Britain, the optimists think it will take eight. We have 200."[5]

Given the huge increase in destructiveness that hydrogen weapons brought, the need for the deterrent to be credible was increased still further. As the Defence White Paper of 1956 stated: "The advent of the hydrogen bomb has enormously strengthened the power of the deterrent and, provided the deterrent is maintained, the likelihood of global war has decreased."[6] Thus, we can see that the greater the destructive power of nuclear weapons, the more vital it was for the nuclear deterrent to be credible in order to prevent war.

It is with this in mind that we must now turn our attention to the V-bombers on the ground and their ability to get airborne in a 'worst case scenario' in order to credibly carry out the deterrent threat.

When looking at the vulnerability of Britain's V-bombers to a sudden Soviet attack, it is necessary to consider a number of factors. Amongst these are the amount of warning time from detection to detonation of the Soviet ICBMs, the state of readiness of the V-bombers, time taken from the alert being received to aircraft becoming airborne and the dispersal of the V-bombers. In addition, a number of scenarios based upon the numbers of weapons and their capabilities at the time should be considered when trying to establish whether the V-force was capable of leaving the ground in time to retaliate and vindicate the capability of Britain's nuclear deterrent. Whether the actual nuclear weapons themselves, carried by the V-bombers affected their ability to get off the ground quickly shall also be examined.

The first raw data to consider is how long it would physically take Soviet missiles to reach Britain from their launch sites to detonating over their targets. In a declassified secret document dating from March 1960, the Minister for Aviation put forward the following argument with regard to the vulnerability of the V-bombers on the ground. This information was compiled from the 'judicial knowledge' of the British Nuclear Deterrent Study Group and the Joint Inter-Service Group for the Study of All-out Warfare. It states the following calculations:

Times of flight of Soviet Ballistic Missiles
1. On normal (minimum energy) trajectories the times of flight
- 650 nm: 8.5 minutes
- 1,000 nm: 11.3 minutes

Radar detection
1. Owing to the curvature of the earth's surface, ground radar cannot pick up missiles (or aircraft) until they rise above the 'radar horizon'. Missiles come within the radar horizon of ground radar in the United Kingdom when they are about 50 to 60 miles above the earth's surface. The time taken by missiles to reach this height is about 2.5 minutes on normal trajectory and three minutes on low trajectory.

The Russians would need to fire at only three aiming points. With six MT rockets (two aimed at each of these points), they could almost certainly wipe out the whole V-bomber force

2. From the point of pick-up by ground radar, the remaining times of flight of Soviet missiles fired at the UK would therefore be:

- 650 nm: 6 minutes
- 1,000 nm (normal trajectory): 9 minutes
- 1,000 nm (low ttrajectory): 3 minutes [7]

In the event of high international tension, the V-bombers were to be dispersed to 36 airfields in groups of four to minimize the chances of a handful of rockets destroying the entire V-bomber force on their 6 main airbases. A note by the Minister of Aviation of March 1960 pointed out:

"Our operational plans provide for the dispersal of the V-bomber force among 36 airfields in times of crisis. But it requires from 24 to 48 hours to complete this redeployment. Thus in the event of a surprise attack, out of the blue, our V-bombers would be caught on their six main bases. These are sited so close together that the Russians would need to fire at only three aiming points. With six MT rockets (two aimed at each of these points), they could almost certainly wipe out the whole V-bomber force." [8]

The document then goes on to assert:
6) Assuming that the bombers had been dispersed, but that the aircrews were not kept continuously in their aircraft, the Russians could, with about 50 rockets, destroy virtually the whole dispersal airfields, many of which are close to one another.

7) . . . even if a very high state of readiness can be achieved, it would still be possible for the Russians to eliminate 80% of our V-bomber force with about 250 rockets.

8) That would leave us only about 20 aircraft. With the Russian defences concentrated upon them, very few would get through; a threat on this extremely reduced scale would not constitute any appreciable deterrent.

10. It must also be remembered that this whole system depends upon a single warning station at Fylingdales, which could be jammed by a small number of aircraft flying 100 miles or more away over the North Sea.[9]

So, we are left with the raw arithmetic of early warning times being picked up by radar vs the time taken for the V-bomber crews to scramble and get airborne, armed with nuclear weapons. The arguments presented above at first glance appear quite convincing in proving the vulnerability of the V-bomber force on the ground.

However, in the scenario portrayed, the argument is made that so few V-bombers would get airborne after the initial pre-emptive strike, that the force would not constitute any appreciable deterrent. The estimated time of arrival (ETA) for a Soviet missile from first detection to detonation was on average 4.5 minutes. It is also the case that the above scenarios overlook some significant factors that would more than likely pre-empt a nuclear strike by the Soviets. As Andrew Brookes has argued:

". . . Whitehall reasoned that it was safe to assume that a third world war would result only from a period of escalating international tension. As diplomatic relations deteriorated and Soviet preparations for war became evident, bomber crews would have been recalled from leave and servicing personnel detailed to work round the clock to produce as many serviceable aircraft as possible."[10]

Once international relations were at a high state of tension, the V-bombers would be dispersed to their 36 separate airfields in groups of four. The 26 dispersal airfields ranged from RAF Lossiemouth in northern Scotland to RAF Aldergrove in Northern Ireland to St Mawgan in Cornwall. Added to the 10 main airbases in Lincolnshire and East Anglia, these constituted the 36 dispersal airfields.

In response to the Minister of Aviation's report, the defence board produced a detailed brief: D.F.B. (60)5 which effectively deconstructs the arguments put forward by the Minister of Aviation and presents an alternative version of events to counter it. On the subject of the strategic warning not being received and the force knocked out by three-megaton rockets, it argues: "On the subject of strategic warning, however, the British Nuclear Deterrence Study Group concluded in its last report that':

"The current Joint Intelligence Committee assessment is that we should get strategic warning of at least 24 hours before any heavy Soviet attack on this country. There is therefore no need to maintain our deterrent forces constantly at maximum readiness in order to guard against a "bolt from the blue attack".[11]

With regard to the Minister of Aviation's claim that even if the force were dispersed and at readiness, most of it could still be destroyed by about 250 three-megaton missiles, it concludes. Apart from the fact that this calculation ignores the additional warning time which would be gained by the dispersed bases to the West of the country and in Northern Ireland, the contention that such an attack is feasible has been answered by the Minister of Aviation himself. In his paper of 19 February referring to an attack with about 300 rockets on this country he says:

"It is inconceivable that the Russians would believe they could safely attack Britain on this massive scale without immediately provoking annihilating retaliation from the Americans."[12]

This last point is most important. Given the cohesion within NATO and the resolve to retaliate against a Soviet nuclear attack, the Soviet leaders would be ". . . most unlikely to risk annihilating retaliation from the Americans . . .'[13] Although as I have argued earlier, hydrogen weapons were a great leveler in terms of reducing the importance of the geographic size of a country, the US — unlike Britain at the time — had underground ICBM sites, nuclear bombers (primarily B-52s) on constant airborne alert and the first Polaris-armed submarines were beginning to come on stream.

From 1964, France too had an effective nuclear deterrent triad that relied upon a combination of

The US and NATO would have had a very substantial retaliatory capacity in the event of a surprise attack. Such a consideration on the Soviet side for a surprise nuclear attack would have to be weighed very carefully

USS John Marshall (SSBN 611)

Since peace so largely depends upon the deterrent force of nuclear retaliation, it is essential that a would-be aggressor should not be allowed to think he could readily knock out the bomber bases in Britain before their aircraft could take off from them

supersonic bombers (the Mirage IVA), ICBMs stored in underground silos and ballistic missile submarines.[14] All of these forces would have ensured that the US and NATO would have had a very substantial retaliatory capacity in the event of a surprise attack. Such a consideration on the Soviet side for a surprise nuclear attack would have to be weighed very carefully. This caution would have contributed towards deterrence and therefore the continued survival and viability of the V-bomber force.

Having accepted the relative unlikelihood of an unannounced Soviet first strike due to NATO's retaliatory capacity, how well prepared the V-bomber force was to cope with a 'worst-case' scenario and deliver Britain's nuclear retaliatory capability must now be considered.

On 30 August 1963, a 'no notice' alert exercise was put into practice to see how quickly and what proportion of the V-bomber force could become operationally ready and in how much time. 65 aircraft participated and all were loaded with live nuclear weapons. The results were as follows:

2 hours	19 aircraft	29%
4 hours	37 aircraft	57%
6 hours	57 aircraft	88%
8 hours	64 aircraft	98%[15]

Although the above record may appear relatively poor, it should be remembered that in time of international crisis, the serviceability of aircraft would be improved and aircraft kept at a higher state of readiness.

There also followed improvements in the early warning time and in the time taken for the V-bombers to get off the ground. The Missile Infra-red Detection and Surveillance System (MIDAS) promised to increase the detection time of missiles from when they were in the air, back to the time from when they were launched. This, on average, increased detection time from 4.5 minutes to 6 minutes, giving V-bomber crews a vital extra 90 seconds. MIDAS was able to do this because it was a space-based system that was not limited by the curvature of the earth. It was estimated that there should be a 95% chance that at least one satellite would see any launching.[16]

With the early warning system thus improved, improvements also followed in the take-off times of the V-bombers. As the 1957 Defence White Paper stated: "Since peace so largely depends upon the deterrent force of nuclear retaliation, it is essential that a would-be aggressor should not be allowed to think he could readily knock out the bomber bases in Britain before their aircraft could take off from them. The defence of the bomber air-fields is therefore an essential part of the deterrent and is a feasible task."[17]

Although take-off times from the six main V-bomber airbases could be kept to a minimum time of 140 seconds — provided the aircraft were armed and serviceable — this was not the case from the 36 dispersal airfields where conditions were more primitive. This delay served to under-mine the credibility of the deterrent. Air Chief Marshal Sir Harry Broadhurst, Commander in Chief of Bomber Command, insisted that the V-bomber crews had to get their scramble times down to Fighter Command Levels.

Improvements at the dispersal fields, pushed through by Air Chief Marshal Broadhurst, included the building of Operational Readiness Platforms (ORPs) leading straight to the runway threshold, permanent crew accommodation in the form of special caravans positioned close to the aircraft and temporary command posts with efficient lines of communication.[18] With these improvements in place, the ability of the V-bombers to get airborne quickly from the dispersal fields was proven, and thereby the deterrent made more feasible militarily.

In addition, a procedure was devised for the Vickers Valiant to enable it to start all four engines at the same time[19] and for the Vulcan and Victor

A Blue Steel armed Vulcan B2 of No 617 Squadron

Both the Mk 2 Vulcan and Victor had the capability to start their engines simultaneously, thus cutting down on the time taken from the order to scramble to the V-bombers becoming airborne

Mk 1, Squadron Leader Dixon — an engineering staff officer at Bomber Command — designed the 'Simsmart' trolley that enabled an aircraft crew chief to start all four engines simultaneously while the crew were strapping in.[20]

Both the Mk 2 Vulcan and Victor had the capability to start their engines simultaneously, thus cutting down on the time taken from the order to scramble to the V-bombers becoming airborne and therefore adding to the airborne deterrent credibility.

In 1962, the state of readiness of the V-bomber force was improved still further with the inauguration of the Quick Reaction Alert (QRA) plan that involved one aircraft from each V-bomber squadron (there were 20 in all by 1961)[21] being maintained in armed condition and at a later date on operational readiness platforms at the end of the runway, ready to scramble at a moment's notice.[22] V-bombers at QRA readiness were able to scramble in 90 seconds[23], a time comparable to the pilots of Fighter Command during the Battle of Britain in 1940. However, one must ask the question: 'Was one V-bomber from each squadron at 90 seconds readiness sufficient to effectively enforce Britain's nuclear deterrent?'

Once again, it must be remembered that in time of international crisis, many more V-bombers would be brought up to QRA status thereby making for a sizeable force to act as a deterrent. Thus, even in the 'worst case scenario' of a sudden and massive Soviet strike without warning which, as has been argued, was fairly unlikely, the V-bomber force could still scramble 20 nuclear bombers in 90 seconds. Although this may not have had the deterrent impact of nuclear armed bombers on airborne alert 24 hours a day as was the case with the USAF, the take-off time was still entirely feasible to allow a minimum of 20 nuclear armed V-bombers to become airborne minutes before Soviet ICBMs aimed at Britain would hit their targets.

Coupled with the nuclear deterrent capacities of the USA and from 1964, France, it would seem that the only scenario in which only 20 V-bombers alone would be launched against the USSR would be if the Soviets launched a sudden nuclear strike

A Valiant of No 214 Squadron being towed past the Bloodhound site at RAF Marham

There was the deployment of 'Bloodhound' surface-to-air-missiles at each V-bomber base that were proven to be dependable and could lock on to jamming signals from hostile aircraft as a means of guidance

against Britain and Britain alone was at war with the USSR. Given the basis on which NATO operated and still operates[24], the chances of this seem very remote. However, the UK had an independent nuclear deterrent, which was intended to operate independently of NATO if required, although operating outside of NATO would diminish its chances against Soviet defences significantly.

Britain also had the ability to defend its own airspace which would also improve the likelihood of a substantial number of V-bombers being able to get off the ground. From 1957 onwards, Fighter Command concentrated its efforts on protecting the bomber bases in order to buy the V-force time to get on its way.[25] Soviet medium and long- range bombers would have been vulnerable to these interceptors (primarily English Electric Lightnings from 1960 onwards). In addition, there was the deployment of 'Bloodhound' surface-to-air-missiles at each V-bomber base that were proven to be dependable and could lock on to jamming signals from hostile aircraft as a means of guidance.[26]

In considering the ability of the V-bombers to leave the ground in time to threaten a significant retaliatory capability, it is worth taking time to consider the nuclear weapons that the V-bombers carried and in particular, two which could have seriously affected the ability of the V-force to get significant numbers of bombers into the air.

Blue Danube, the RAF's first atomic weapon, even if rather large for a weapon with a yield of 20 KT[27] was fairly straightforward to handle and deliver. However, its successor, Violet Club, Britain's first hydrogen weapon in order to give Britain an early megaton capability was questionable in terms of its operability. Described as a 'rather delicate weapon'[28], Violet Club was so unstable, it has recently emerged that the bombs could have exploded by accident.[29] The bombs also took a long time to arm. A memo by Group Captain Tait warned that that the arming of specially modified Vulcans designed to carry the bomb would take at least 20 minutes.[30] Such 'fragility' and instability coupled with the time it took to arm the Vulcans, could have seriously undermined the ability of the V-bombers assigned to be armed with Violet Club to get airborne. This in turn meant that the V-force did not have a completely viable operational hydrogen bomb until the 'Yellow Sun' came into service in 1960.

A Blue Steel missile being refuelled with high test peroxide (HTP), RAF Scampton

Like Violet Club, although to a lesser extent, in the event of a sudden attack, serious problems could have arisen in getting a significant number of V-bombers armed with the Blue Steel missile airborne

Its successor, the 'Blue Steel' stand off missile may also have hindered take-off time of the V-bombers due to the fact that its fuel was a mixture of kerosene and hydrogen peroxide, a highly combustible mix.[31] Liquid-fuelled rockets of any kind require a lot of preparation time before being hoisted into the bomb bay and being made ready for service. The Blue Steel had to be filled with propellant in the preparation building and then taken to the aircraft on a low loader with the fuel mix and temperature kept under constant surveillance.[32] Like Violet Club, although to a lesser extent, in the event of a sudden attack, serious problems could have arisen in getting a significant number of V-bombers armed with the Blue Steel missile and airborne. However, this must be tempered with the argument made earlier that a Soviet surprise attack was fairly unlikely and that in times of high international tension, more V-bombers would be brought to operational readiness.

The picture that emerges with regard to the ability of a significant number of V-bombers to become airborne in the event of a Soviet attack is mixed, but overall it seems enough would have become airborne to effectively carry Britain's nuclear deterrent. Although there would have been little warning time from detection to detonation, systems such as MIDAS were developed to increase warning time. There were also efforts to decrease the amount of time the V-bombers took to get airborne such as practice 'scrambles' carried out by aircrews and systems to allow the V-bombers to start all four engines at once. Dispersal of the force was also important in increasing the chances of the V-force despite the destructiveness of hydrogen weapons on a country as small as Britain.

Greater efforts were also made to increase operational readiness both at the V-bombers' main airbases and at their dispersal airfields, especially with the introduction of 'QRA' readiness. Most important of all, I have argued the chances of a sudden, unannounced Soviet strike were fairly unlikely because of the capability of NATO to carry out a massive reprisal. The more likely scenario of an escalation in tension (such as the Cuban missile crisis) leading to war would allow a far greater number of V-bombers to become combat ready and prepared for war. This would allow time for the loading of the more complex weapons such as Violet Club or Blue Steel.

A No 55 Squadron Victor B1A being refuelled by a Valiant of No 90 Squadron

Flight refueling will give the V-bombers tactical freedom en-route to the target. It will also increase the radius of action of the force

"Today, shooting wars are won or lost before they start. If they are fought at all, they would be fought principally to confirm which side had won at the outset." (General Curtis LeMay April 1956[33])

Having established that a significant number of V-bombers would be able to get into the air in the event of a Soviet nuclear attack, we must now turn our attention to the question of whether the V-bombers would be able to break through the Soviet defences and deliver their weapons. This ability was vital in order to vindicate the threat of the deterrent. This shall be done by looking at several important areas and weighing up the likelihood of whether these factors combined, indicate that there was a good chance that the V-bombers would be able to get through and deliver their weapons.

These areas shall include routing of the bombers, navigation, targeting, Soviet air defences, V-bomber counters to these defences and V-bomber development to try and stay ahead of these defences. It shall also be argued that although the V-bombers would seem to be quite effective during the late 1950s and early 1960s, by the mid to late 1960s, there was a growing likelihood, given the improvements in Soviet air defences, that prohibitive numbers of V-bombers would be brought down over Soviet air space before they could reach their targets.

In examining the capability of the V-bombers in the scenario of a retaliatory strike on the Soviet Union, the first area to be considered will be the routing of the bombers. Once in the air, the V-bombers would have to take a route towards their target that would give them the maximum possible chance of reaching their target without being brought down. This, influenced by NATO Intelligence about Soviet air defences, would dictate the routes to be taken. There was a further problem in the ranges that the respective V-bomber types were capable of.

For the Valiant, its combat radius was limited to 1,250 nm miles, whereas the Victor Mk2 had the longest range with a radius of action of 2,050 nm miles.[34] Combat radii was boosted however with the introduction of mid-air refueling. The RAF concluded: "Although we do not know to what extent flight refueling will be required in war, it

appears likely that we would require more tankers than will be available from the Valiant tanker force from 1960 onwards".[35] However, the fact that a tanker force was available at all would extend the range of the V-bombers that were able to refuel safely in mid-air. As another RAF document observed: "Flight refueling will give the V-bombers tactical freedom en-route to the target. It will also increase the radius of action of the force".[36]

Having 'topped up', the V-bombers would then proceed to their targets. As an RAF document of 1961 pointed out:

"The ranges will vary for the various marks and types according to the weapon load. If direct routes were flown from the 'V' bases in the UK, most of the targets in Russia we wish to attack would be within range, bombers being allocated to various targets according to their radii of action. However, the direct routes cross the satellite countries in Europe and the greatest distances over Russian territory and, therefore, involve the longest crossing of the Russian air defence system. It is essential now, and as the Russian defence system improves, it will be vital, to route our bombers tactically so they proceed as far as possible outside the perimeter of the Russian defence system to points from which targets are reached by the shortest penetration. This involves flying round Northern Norway and South-East Europe which increases considerably the distance to be flown."[37]

It was concluded therefore, that the V-bombers should take a longer route in order to avoid Soviet defences not just to the North but also to the South.

"Some of the distant targets can be reached from Cyprus, and the direct routes from Cyprus to some of these targets are themselves the shortest penetration routes, but planned facilities in Cyprus provide for one squadron of V-bombers only because of its vulnerability and the expense of overseas deployment."[38]

Hence, we can see that a small number of V-bombers deployed from Cyprus, along with those flying on a northerly route from the 36 dispersed airfields and all heading for different targets, would present the Soviets with a widely scattered force, converging on their various targets from different directions. The wide dispersal of the V-bomber bases and their wide scattering *en route* to target increased the chances of greater numbers of bombers getting through to their targets. There remains the question however, of the targets themselves.

Once the V-force became fully operational in 1957, Bomber Command — as part of NATO — went about coordinating its targeting with SAC. At the initial meetings to discuss targeting between Bomber Command and the Strategic Air Command (SAC), it was discovered that there was much duplication of targeting.[39] This would have undermined the effectiveness of the NATO deterrent in general. The solution was a combined plan in which Bomber Command was allocated 106 targets, including 69 cities of governmental or military significance, 17 Soviet air force airfields with nuclear roles and 20 Soviet air defence system sites. There was also to be full tactical co-ordination by joint planning of routes, the timing of attacks and electronic countermeasures (ECM) tactics.[40] However, right from the outset, the V-force was intended to have the capability as an independent nuclear deterrent for Britain, indeed, this was one of the fundamental reasons for its existence.[41]

Although it is difficult to imagine a scenario in which the British nuclear deterrent would be deployed on its own without the help of its NATO allies, war plans were drawn up for such a situation. In the event of this, Soviet targets were revised to include "131 Soviet cities whose population exceeded 100,000; from these 131 cities, 98 were chosen which lay within about 3,000 km of the UK and they were graded in order of priority according to population, administrative importance, economic importance and transportation".[42]

The high priority given to cities reflected Britain's belief in the viability of this strategy, especially targeting Moscow, otherwise known as the 'Moscow criterion'.[43] There also remained a level of ambiguity in Britain's targeting policy as it was believed that the Soviet leadership might value their own power more than their cities.[44] However, without the 'saturation' that a combined NATO attack

The next problem for the V-bombers as they neared Soviet airspace would be how to navigate to the target and deliver the weapon. An even greater problem would be how to survive the Soviet air defences

would bring and the ECM aids that the involvement of the Americans would bring, it must be concluded that the V-bomber force acting alone would suffer much higher losses.

It is also worth mentioning that Bomber Command was dependent to a significant extent on US space Intelligence and without this, very recent knowledge about Soviet defences would be quite poor.[45] To what extent it is difficult to say, but given that the V-force operated primarily as Britain's nuclear deterrent within NATO, it is more useful to consider its military capability within this context.

The next problem for the V-bombers as they neared Soviet airspace would be how to navigate to the target and deliver the weapon. An even greater problem would be how to survive the Soviet air defences. This will be discussed below.

The nature of the role of the V-bombers meant that from a navigational point of view, they would have to be self-sufficient in finding their way to the target (in much the same way that RAF Bomber Command crews were in the early raids of the Second World War from 1939-41). Although the early Valiants carried navigational aids reliant upon ground beacons, which would have been of little use on a long-range flight into the Soviet Union, all the V-bombers were soon equipped with more up-to-date systems. These included an updated version of the H2S radar, the H2S Mk 9A[46] that helped to map the ground directly below the aircraft.

The earlier model had proved useful to Bomber Command during the Second World War. This information was then fed into the Navigation and Bombing Computer (NBC). The NBC afforded V-bomber crews a degree of help their predecessors did not have. It monitored the aircraft position, track and groundspeed from information fed to it from the H2S Mk 9A and could steer the aircraft and release the bomb if required.[47] From a purely navigational point of view finding the target should not have presented a problem. An RAF document concluded on the subject of navigation, "Tests with the Valiant have shown that navigation to the required accuracy can be achieved in daylight in good weather using maps and dead reckoning. At night or in bad weather, a navigation aid

is essential".[48] As the navigational aids appeared to be satisfactory at high level, the V-bombers would appear to have been able to find their targets.

However, once the V-bombers were required to switch to low level attack from 1963 onwards due to the increasing sophistication and therefore threat of Soviet air defences, navigation was to present more of a problem. Problems soon became apparent when low-level trials were carried out by a Valiant in 1956. A document of that year summarizing the problems encountered pointed out that

"map reading was the only means of navigation available . . . A very close link between the second pilot and the navigator was particularly necessary due to the lack of view from the navigator's station. Use of the bomb aimer's position proved fruitless again due to the restricted view".[49]

Although navigational problems at low altitude at first appeared great, measures were introduced to alleviate the problem. In 1961, in operation 'Malvocation' low-level flight trials by a Valiant were carried out from Goose Bay in Canada because the terrain was thought to more closely resemble the vast wastes of the USSR and navigation would be more of a challenge because of the lack of distinctive features in the terrain. Amongst the measures introduced to improve low level navigation were the Decca Type 9033 Roller Map.[50] Installed in the cockpit for the co-pilot to read, it aided navigation considerably as the previous navigation aids were useless at such low altitude and as already mentioned, the navigator couldn't see very well out of the bomb aimer's position. The Decca Type 9033 worked by simply plotting the position of the aircraft on a map which scrolled along. Accurate information such as the aircraft's speed and direction were fed into it via the aircraft's systems and with this information, it would then work out the aircraft's position on the map.[51]

Trials in Canada were judged to be a success. The conclusion drawn from 'Malvocation' was that "Phase 1 has shown that with an experienced crew, the Valiant can be flown in the low level role very successfully".[52] Although the problems of low-level navigation would appear to be solved, there were also other problems to be overcome if the V-bombers were to be used effectively at low-level and be able to carry out their mission. These will be discussed below as part of a wider consideration of the V-bomber's ability to penetrate Soviet defences, get within range of their targets, and deliver their weapons.

In trying to evaluate whether Britain's V-bomber force was capable of carrying out the mission assigned to it, a study of Soviet air defences is vital. As argued earlier, such a study is hypothetical but it is possible to reach a balanced judgment if many of the factors are considered carefully.

With the V-bombers having got this far, they would now come upon the most significant obstacle between themselves and the target — the Soviet air defences themselves. In looking at the Soviet air defences, and the V-bombers ability to penetrate them, it will be necessary to look at several areas. These will include the structure of the Soviet air defence system, the detection systems it employed and the weapons systems it deployed, most significantly, surface-to-air missiles and air defence fighters. It will then be necessary to look at the countermeasures the V-bombers employed to overcome these defences. The last stage will be to consider the delivery system of the V-bombers and their ability to hit their targets, assuming they were able to penetrate the Soviet defences.

The Soviet Air Force of the Anti-Aircraft Defence of the Homeland (*Protivo-Vozduschniya Obarona-Strany* or PVO Strany) ranked third in order of precedence in the Soviet armed forces after the Strategic Rocket Forces and the Ground Forces and became an independent arm in 1954.[53] The Commander-in-Chief of the PVO Strany, who operated directly under the Ministry of Defence in Moscow, had four main elements under his command. These comprised:

i) Radar Troops (*Radioteknicheskie Voiska*)
ii) Anti-Aircraft Artillery Troops (*Zenit-naya Artilleriya*)
iii) Anti-Aircraft Missile Troops (*Zenitno-Raketmye Voiska*)
iv) Fighter Aviation of the Air Force (*Istrebitel'naya Aviatsiya*)[54]

All would have acted interdependently to defend

The high cruising altitude of the V-bombers had been one of the factors that they relied upon in order to be able to get through. With the MiG-19, this was brought into question

Soviet airspace. Having captured a number of German scientists at the end of the Second World War,[55] the Russians used this expertise to build their air defences. The integration of these air defence components would have presented a formidable obstacle to the attacking V-bombers. Given that cities formed such a large part of Bomber Command's targets, these defences seem all the more formidable. I shall now examine the fighter and surface-to-air missile (SAM) elements of the Soviet defences in the context of the V-bombers ability to overcome them.

Although V-bombers were designed to fly close to the speed of sound, none of them was supersonic. Soviet fighters from the MiG-19 onwards entering service in 1955[56] already represented a superiority in speed at the time the first V-bomber — the Valiant — became operational. It was also uncomfortably close to the V-bomber cruising height of 60,000 ft. The high cruising altitude of the V-bombers had been one of the factors that they relied upon in order to be able to get through. With the MiG-19, this was brought into question. As Brookes has pointed out '. . . it was clear that the PVO-Strany would soon be capable of operating in all weathers at the heights and speeds wherein the early V-bombers sought their protection".[57] Furthermore, the radar chain would enable the PVO-Strany command and control to direct their surface to air missiles and fighter interceptors with greater efficiency. Although in 1955 the Russian air defence system was ". . . thought to be comparable to that of the UK in 1939/40 . . ."[58] Bomber Command could also be sure that advances would follow.

Britain therefore, having made a major effort to get the V-force into service, would now have to ensure that it was kept up to date. The advantages of speed and especially height that were relied upon when the designs for the V-bombers were in the

design stage, no longer applied by 1955. Of particular concern (not surprisingly) were the increases in performance of fighters and surface-to-air missiles. The following tables show the performance of Soviet air defence fighters compared to the performance of the V-bombers in speed and altitude.

Chart shows V-Bomber speeds compared to Soviet Interceptor fighters

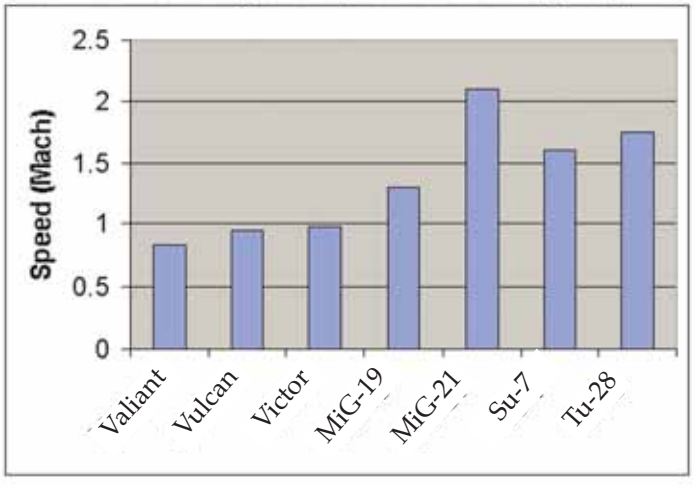
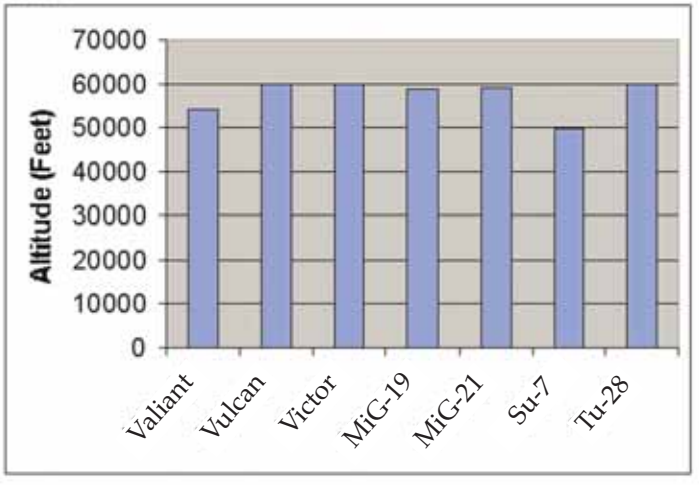


Chart shows the maximum altitudes of V-Bombers compared to Soviet Interceptor fighters



From these charts we can see that all the V-bombers were outclassed by Soviet interceptors in terms of speed. This is not particularly surprising, but perhaps a cause for greater concern is the increase in altitude of Soviet interceptors. Both the MiG-19 and MiG-21 were just below the maximum ceiling of the Vulcan and Victor and the Tupolev-28 (NATO code-name FIDDLER), entering service in 1961, could actually match them for height. The Valiant was outclassed in both speed and height and therefore it must be concluded that it would have suffered heavy losses at the hands of Soviet interceptor fighters.

In 1955 a top secret document trying to predict the vulnerability of the V-bombers by 1960 argued that ". . . the loss rate for Valiants operating by day at high level will be so high that this type of operation is out of the question".[59] This would mean that for high level daylight raids, the V-force would have to rely on Vulcans and Victors. Furthermore:

"It is estimated in J.I.C.(56)8(Final) that by 1960 against aircraft flying at sonic speeds, the Soviet air defence system is likely to be able to provide a reasonably effective defence against deep penetration raids except those made at low level in poor visibility. The fighter force consisting of supersonic day fighters and all-weather fighters may well be receiving into service considerable numbers of a new fighter combining the roles of day interceptor and all-weather fighters. This new fighter maybe armed with air-to-air guided missiles and be capable of speeds up to Mach 2.5 at 70,000ft. Surface-to-air guided weapons will be deployed for the defence of strategic target areas. A.A.A. (anti-aircraft artillery) guns may be retained to provide a deterrent against low level attack and to supplement the guided weapon defences".[60]

If one were to imagine an attack on the USSR by the V-bombers, it seems reasonable to conclude that a percentage of the bombers would have been shot down before they reached their targets. The important question is how high a percentage? The same document estimated that:

"In studying the problem of extending the Valiant operational life it has become apparent that the Vulcans and Victors are also likely to run into serious trouble in 1960. Theoretical assessment gives them a loss rate of 5% per 100n.m. by night. A penetration of Moscow therefore would cost something in the region of 55% of the attacking force."[61]

This would represent an unacceptable rate of loss for any attacking aerial force. However, it is worth remembering that the V-bombers would have had the elements of surprise in terms of where they were approaching from, were very likely be part of a much larger NATO force, thereby increasing the number of targets for the Soviet air defences to cope with, and that in such a scenario, manned bombers would have been preceded by ICBMs, including Britain's Thor missiles loaned by the USA.[62]

The other major threat to the V-bombers apart from fighters were SAMs, especially the SA-2. NATO concern over the use of SAMs increased after Gary Powers' U-2 spyplane was shot down in 1960. Given the height and speed at which the U-2 travelled, it appeared that overnight, the V-bombers had become much more vulnerable to Soviet air defences. However, Gary Powers's aircraft was a lone aircraft flying deep inside Soviet territory. Any V-bomber attack would take place with tens of aircraft attacking simultaneously and in the case of a NATO attack, hundreds. Furthermore, the V-bombers carried ECM jammers. However, as has been pointed out, by 1962 there were too many SAM sites for all of them to be avoided[63] and any V-bomber crew would have to use a good deal of initiative to avoid them all on the way into target and on the way out again.

What became of particular concern were the Soviet advances in SAM design especially the SA-2 (NATO codename GUIDELINE) and SA-3 (GOA). The SA-2 was rugged and easy to deploy in the field operating at medium and high altitudes. It achieved a good combat record against American aircraft in North Vietnam from 1965-68 and again in 1972. The more potent SA-2E could be fitted with a nuclear warhead of 15KT[64], a yield not much smaller than Britain's first nuclear bomb, 'Blue Danube'. However, with the switch from high level to low level attack, the V-bombers should only have been vulnerable to the SA-2 for a few minutes when climbing to release their nuclear weapon. This switch from high to low level did not make the V-bombers invulnerable to SAMs however. The SA-3 GOA was a short-to-medium range weapon. Deployed alongside other SAM batteries, the improved guidance system allowed it to be used against surface targets and naval vessels.[65] This ability for low-level interception would also have made it a useful weapon against low flying V-bombers. Soviet cities, the most numerous targets of the V-bombers, were well defended by SAMs.

With regard to AAA fire at low level, this was not considered such a threat as "Light AAA guns would have to rely on visual aiming or could set up a barrage in the predicted path of the bombers".[66]

Thus, we can see that from 1960 onwards, the V-bombers would face a gauntlet of fighters, surface-to-air missiles (SAMs) and AAA fire. If guided to their targets efficiently, this could represent a defence force that would inflict prohibitively high casualties and thereby undermine the credibility of the deterrent. It was with this in mind that Bomber Command looked into the possibility of using the V-bombers in a low-level role in order to overcome the increasingly formidable Soviet air defences. This was a bold proposal as the V-bombers had been designed for high level penetration and were not designed for low-level attack.

The problems of navigation at this altitude have already been discussed, but there were also other problems. Early low-level flight trials with a Valiant found that apart from the problems of navigation, other hazards included heavy flight controls, leading to premature fatigue on the part of the pilots, bird strikes and dead flies building up on the windscreen obstructing the view.[67] There were additional problems with turbulence that in turn affected the performance of all the crew as they were uncomfortably jolted around and of the temperature in the cabin as the emphasis had been on heating at high altitude, not air conditioning at low altitude.

Nevertheless, the problems of cabin temperature and heavy controls were solved and the V-bombers were configured to penetrate Soviet defences at low level to enable them to have a greater chance of getting through. On 23 January 1963, the Defence Committee approved measures necessary to give the V-bombers a low-level capability.[68] However, new problems arose apart from

In the high-low-high delivery configuration newly devised for the V-bombers, the Vulcan Mk2 would only be able to reach 16 of the 40 targets assigned to it and this did not include Moscow

the ones mentioned above. For one, low-level flying made for far higher fuel consumption which made air-to-air refueling a necessity if the V-bombers were to reach their targets.

This in itself wasn't that much of a problem, but the higher fuel consumption put many of the targets assigned to Bomber Command out of reach. In the high-low-high delivery configuration newly devised for the V-bombers, the Vulcan Mk2 would only be able to reach 16 of the 40 targets assigned to it and this did not include Moscow.[69] According to the same source, only the Victor would have been able to reach all 40 targets. Given the importance of the 'Moscow criterion' mentioned earlier, this could have represented a setback for British strategy. However, as Moscow was within range of the Victor, it must be assumed that a proportion of Victors would have been assigned Moscow as their target. Nevertheless, this limitation on the Vulcan Mk2 represented a reduction in the reach of Bomber Command and a downgrading in its capability.

There was also the additional factor of the other element that the V-bombers used to protect themselves apart from dispersion, surprise and the diminishing qualities of speed and altitude. This other factor was the V-bomber's only direct means of self-defence — electronic counter measures or ECM.

An RAF report of 1955 came to the conclusion that day operations of Victors and Vulcans in the 1958/59 period would be costly but that ". . . such losses might be relieved by the introduction of ECM. It was agreed, however, that the Valiant would suffer heavy losses if operated against long range targets by day in this period . . . The meeting further agreed that the Victor and Vulcan would be able to operate satisfactorily by night, with ECM, even against surface to air guided weapons (S.A.G.W.)".[70]

Thus it can be seen that even in the early years of the life of the V-bombers, there was already concern with regard to the vulnerability of them and that Air Staff planners were engaged in a constant struggle to keep the V-bombers one step ahead of the Soviet air defences and ECM capability would be a major counter-measure for the V-bombers against Soviet air defences. Therefore, the question needs to be asked, how effective were the ECM countermeasures?

The first problem with ECM countermeasures for the V-bombers was where to fit them. With this problem solved, it only remains to consider how effective the ECM countermeasures would have been in a combat situation. It will not be necessary here to look at the technical aspects of the ECM of the V-bombers. Rather it is important to try and understand how effective the ECM measures would have been in increasing the chances of survival of the V-bombers in hostile airspace.

Electronic countermeasures in the V-bombers fell into two categories — defensive and offensive. The defensive component consisted of warning equipment to detect when the bomber had been 'spotted' by Soviet ground radar and also a tail warning radar to observe enemy fighters attempting to move into firing position.[71] The offensive part of the V-bomber's ECM was a jamming device that used the same technique that Bomber Command had used with its heavy bombers during the Second World War, that of jamming the enemy early warning and fighter control radars with noise.

The system, known as 'Green Palm' emitted a noise that was likened to ". . . a cross between a continental police siren and the bagpipes".[72] Nevertheless, this still leaves the question of how effective would it have been in protecting the V-bombers from air defences? According to Brookes, "Fortunately for Bomber Command, Soviet fighters of the time used only four VHF channels for their radio communications, and the V-bombers carried Green Palm, which was a VHF jammer tuned in to those four frequencies".[73]

Assuming that the fighter radio frequencies set on the V-bombers were correct, this would be a very effective deterrent against interception by fighters because Soviet air doctrine favoured fighters having instructions issued and being guided from the ground.[74] If Soviet pilots were unable to receive orders from the ground, they would be in a weak position to find the attacking V-bombers for a

The last Valiant training sorties were flown in December 1964 and by January 1965 they had all been prematurely withdrawn from service

number of reasons. For one Soviet pilots were discouraged in their training from showing initiative, the vast expanse of the USSR would make them difficult to find without radar guidance from the ground and the defensive measures fitted to the V-bombers meant that the pilots would do all that they could to avoid an interceptor once it was detected. As a last resort, the V-bomber pilot could also try to out-manoeuvre the intercepting fighter.

Another problem arose in the stresses and strains that long duration low level flight placed on the airframes of the V-bombers. Most worryingly, in 1964, a fracture occurred in the rear spar of a Valiant and when other Valiants were inspected, signs of metal fatigue were found on the wing spars.[75] The last Valiant training sorties were flown in December 1964 and by January 1965 they had all been prematurely withdrawn from service. This meant a reduction of the V-force by six squadrons, a sizeable proportion of the force. This in turn meant that greater numbers of Vulcans and Victors would have to get airborne and reach their targets (with the Vulcans already being limited due to its reduced range at low level) for the force to still be a credible deterrent.

A further problem with low level flying was related to the type of nuclear weapons used. Whereas at high altitude, the V-bombers would have been high above the detonation and therefore relatively safe, it would have been impossible for the V-bombers to release their nuclear weapons at the altitude of 300 ft and survive due to the required minimum safe distance from the explosion. With regard to accurate delivery of their weapons, Bomber Command had a good record of accuracy in training exercises and bombing competitions held with the USAF.

In 'Operation Skyshield' in October 1961, eight Vulcans were dispatched from RAF Scampton to test their ability to penetrate the North American Air Defense Command (NAADC), alongside USAF aircraft.[76] The result was that five of the eight Vulcans penetrated the defences to reach their targets using their ECM to good effect. Those

It would have been impossible for the V-bombers to release their nuclear weapons at the altitude of 300 ft and survive due to the required minimum safe distance from the explosion

interceptors that tried to intercept the V-bombers at high altitude found they were too low on fuel having had to intercept lower-flying intruders earlier.[77] This experience could have been a pointer to how the V-bombers would have faired in a real high-altitude attack during the early 1960s.

Another exercise although held in 1974 is a good indicator of bombing accuracy in the V-force. Held in the USA, the competition resulted in one of the Vulcan crews taking part being awarded the Mathis Trophy for bombing accuracy, ahead of their American rivals and on American soil.[78] This seems a good testament to the ability of the V-bomber crews.

Nevertheless, there were still delivery complications in environments outside of bombing competitions. Complications with Blue Steel were further compounded by the way the stand-off missile, which entered service in 1963, operated. Blue Steel allowed the V-bombers to have to get no nearer than 100 miles of the target as once released, it would then guide itself the rest of the way to the target from information fed to it by the parent V-bomber prior to release and at supersonic speed.[79]

Blue Steel also required that it be released at a minimum altitude of 26,000 ft[80] which meant that a low flying V-bomber would have to pull up to a minimum of 26,000 ft between 100-200 miles from the target in order to release the weapon, thus revealing its position to Soviet radar before 'going to ground' again for the return journey home. This climb would take a minimum of four minutes during which time, the V-bombers would be vulnerable to defences such as SAMs.[81]

Nevertheless, Blue Steel made up for this in other ways. It had the advantage of being 'self-sufficient' once launched and needed no outside guidance to the target. This in turn meant it couldn't be jammed and so enhanced the credibility of Britain's nuclear deterrent.[82] As Jackson has pointed out, "Its importance lay in the fact that it gave the V-force a continued operational viability into the mid-1960s in the face of increasingly sophisticated enemy fighter and SAM missile defences".[83]

Further pressure was placed upon the role of Blue Steel by the cancellation of two major nuclear delivery systems — Blue Streak and Skybolt. Blue Steel's intended replacement 'Skybolt' which would have had vastly increased range and enabled the launch aircraft to be as far away as 1,000 miles from the target,[84] was cancelled by the Americans in December 1962. This made the role of Blue Steel even more important.

From 1964 until the RAF passed on the carrying of the nuclear deterrent to the Royal Navy, the V-force and the British deterrent relied upon a combination of Vulcan, Victor and Blue Steel. By the mid-1960s, 100 miles from the target would have been uncomfortably close given the sophistication of Soviet air defences by that time. The cancellation of another major RAF programme, the TSR-2 in 1965, was another blow. Although designed as a tactical strike aircraft, it had been proposed to use the TSR-2 in a minor strategic role to supplement the V-bombers. Capable of much higher speeds than the V-bombers and with a sophisticated delivery system, it was proposed that TSR-2s could be armed with tactical nuclear weapons and strike at the Soviet Union[85] in a similar way that the Panavia Tornado was designed to do during the 1980s.

Certainly this would have enhanced the RAF's deep strike capability. Sadly, this possibility was to end with the cancellation of the TSR-2 programme. It was also proposed to use the Royal Navy Blackburn Buccaneer in a nuclear role to penetrate enemy defences at low level. Flying from Lossiemouth, potential targets included Leningrad, Riga, Kaumas, Kalingrad, Talinn and Gdansk.[86] However, this was not carried through, leaving the remaining two types of V-bomber and Blue Steel to carry on. The fact that other types of aircraft were considered in a minor strategic nuclear role gives an indication of the concern over the vulnerability of the V-bombers by this time.

What then of the V-bomber force from 1964 until its retirement in the nuclear role in 1969? There were significant developments in Soviet air

The Galosh had a nuclear warhead of several megatons that would saturate an area where approaching enemy aircraft were believed to be

defences in this period that would have made any attack on the USSR more hazardous. One of these was the 'Galosh' air defence system, that deployed the A-35 Anti-Ballistic Missile (ABM). First seen in 1964 and deployed around Moscow in 1966[87], the Galosh had a nuclear warhead of several megatons that would saturate an area where approaching enemy aircraft were believed to be. Although indiscriminate, it would be a major obstacle to any attacking aircraft or stand-off missile or even a Polaris ICBM.[88] It also carried its own guidance system in the form of the 'Try Add' radar stations based just outside of Moscow.[89]

As discussed earlier, Moscow was an important target in British strategic thinking and for the V-bomber force. The deployment of the Galosh system could have been a serious setback to the chances of the Victors or Blue Steel actually striking at Moscow. As it was only deployed around Moscow in this period however, other targets would not have had such a formidable defence. Nevertheless, the Galosh system, coupled with the reduced number of V-bombers that had the range to reach Moscow at low level would have made Moscow an increasingly difficult target from 1966 onwards.

For those V-bombers that did manage to overcome all of the obstacles and deliver their weapon, all that would remain would be to find a way to return home, not an easy task considering they would have to face all of the obstacles they faced on the way to the target and there would probably have been little to return to.

Conclusion

It has already been established that a significant number of V-bombers would more than likely get airborne in the event of a nuclear attack and that their dispersal, both around the British Isles and in Cyprus would scatter the attackers leaving the Soviet defenders with a wide area to defend. Air-to-air refueling outbound to the target would increase their endurance and enable tactical re-routing inbound to the target. There was the navigational

expertise and equipment onboard the aircraft to navigate into Soviet airspace accurately at both high and low levels.

The picture that emerges with regard to the ability of the V-bombers to penetrate Soviet defences is a mixed one. When the V-force came into service, the performance of the respective types of V-bomber was sufficient to overcome the Soviet defences. However, by 1960, this was beginning to be called into question. Soviet advances in co-ordinated air defence, high performance fighter interceptors and SAMs would have made the V-bombers' task increasingly difficult.

By 1960 the Valiant was rapidly becoming obsolescent in the high level role and by 1963, all the V-bombers would be forced to fly at low level. This in turn brought problems in that the Valiants had to be retired early due to metal fatigue and the Vulcan would not have been able to reach certain targets such as Moscow. In addition, problems occurred with the delivery of nuclear weapons at such an altitude and the V-bombers would have to have made themselves vulnerable by climbing on the approach to target. Deployment of the Galosh ABM system around Moscow would have made attacking the city, an important British target, a very difficult proposition from 1966 onwards.

The task of the V-bombers was not helped by the cancellation of Blue Streak and the TSR-2, both of which would have given the RAF a more flexible strategic capability.

For all these arguments though, there are also convincing arguments that the V-bombers could have succeeded in the sense that enough bombers would have got through to make the V-force a credible deterrent. Combat exercises such as 'Skyshield' showed that high altitude bombers were difficult to intercept if the interceptor fighters had been engaged previously due to the amount of fuel required to reach 60,000 ft. The problems the Soviets had with the lack of range of their jet fighters at this time could have made this a real problem.

ECM jammers carried by the V-bombers were proven to be effective in such exercises and the navigational capabilities and bombing accuracy of the aircrews were among the best in the world. Once the problems of low level flying were solved, the V-bombers would have been difficult to intercept except during their approach to target but even then, they were exposed for only a short while.

Although the Blue Steel only afforded the V-bomber 100 miles of distance between itself and the target, this would have allowed tactical re-routing to try and avoid the worst of the Soviet defences. The use of the 'Yellow Sun' free-fall bomb up until 1966-67 would have made the task for an attacking V-bomber more difficult.

Above all, it has been argued that the best chance the V-bombers had of carrying out their mission was as acting as part of a wider NATO force. The V-bomber force acting alone against the USSR would have had little chance of success. As part of a wider NATO force however, the V-force would have had the advantages of prior strikes on Soviet targets by ICBMs, numerical strength with a large contingent of American bombers and combined ECM capability. This 'saturation' of the Soviet air defences coupled with the devastation and confusion that prior strikes by ICBMs would have caused was the V-bombers best chance of success.

The fact that peace was kept between East and West during the Cold War period can be attributed to many different factors. One of these was the deterrent threat and the capability of Britain's V-bombers.

Bibliography

Brookes, Andrew (1982), *V-Force: The History of Britain's Airborne Deterrent* (Coulsdon: Jane's Information Group)
Brown, Neville (1964), *Britain in NATO* (London: Fabian Society/Devonport Press)
'Careful with that Nuke', *New Scientist*, 23rd June 2001
Freedman, Lawrence (1989), *The Evolution of Nuclear Strategy* (London: Macmillan)
Heuser, Beatrice (2000), *The Bomb: Nuclear Weapons in their Historical, Strategic and Ethical Context* (London: Longman)
Isaacs, Jeremy & Downing, Taylor (1998), *Cold War* (London: Bantam Press)
Jackson, Robert (1981), *V-Bombers* (London: Ian Allan Ltd.)
Jones, Barry (2000), *V-Bombers: Valiant, Vulcan and Victor*

(Marlborough: The Crowood Press)
Menaul, S.W.B. and Gunston, Bill (1976), *Soviet War Planes* (London: Phoebus Publishing)
Miller, David (2001), *The Cold War: A Military History* (London: Pimlico)
Pierre, Andrew J. (1972), *Nuclear Politics: The British Experience with an Independent Strategic Force: 1939-1970* (London: Oxford University Press)
The NATO Handbook: 50th Anniversary Edition (1999: Brussels: Office of Information and Press)
Sgarlato, Nico (1979), *Soviet Aircraft of Today* (Carrollton, Texas: Squadron Signal Publications)

Public Records Office Documents
Operation of V Bomber at Low Level (1955-61), AIR 2/14578
Operation of V Bomber at Low Level (1961), AIR 2/14700
State of Readiness of V Bomber Force (1960), DEFE 13/306
State of Readiness of V Bomber Force (1960), DFB (60)4
State of Readiness of V Bomber Force (1960), DFB (60)5
Nuclear Weapons: Lay Down Nuclear Weapons for V-bombers (1963), DEFE 25/23
V-Bomber Force Future Policy (1961), AIR 2/14700 CMS 2948/III
V-Bomber Force Future Policy (1961), AIR 2/14699
V-Bombers in Low Level Role (1956), AIR 2/13415

Internet Sources
http://fas.org/nuke/guide/russia/airdef/v-75.htm
http://fas.org/nuke/guide/russia/airdef/v-125.htm
http://www.fas.org/spp/starwars/program/soviet/galosh.htm
http://www.wonderland.org.nz/a-35.htm

Notes
1 Pierre (1972) p94
2 Pierre (1972) p87
3 Heuser (2000) p94
4 Pierre (1972) p94
5 Brookes (1982) p75
6 Pierre (1972) p94
7 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 4 (1960)
8 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 4 (1960)
9 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 4 (1960)
10 Brookes (1972) p102
11 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 5(1960)
12 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 5(1960)
13 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 5(1960)
14 Miller (2001) p.142-144
15 *State of Readiness of V-bomber Force* Public Records Office DEFE13/306 SZ/702/61 (1961)
16 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60)5 (1960)
17 Brookes (1982) p83
18 Brookes (1982)p84
19 Jackson (1981) p22
20 Brookes (1982) p84
21 *V-bomber Force Future Policy* Public Record Office AIR 2/14700 CMS. 2948/III paragraph 4 (1961)
22 Jackson (1981) p100
23 Jackson (1981) p101
24 NATO Handbook 50th Anniversary Edition (1999) p26
25 Brookes (1982) p 83
26 RAF Museum, Hendon information plaque
27 Miller (2001) p.236-237
28 Miller (2001) p 137
29 'Careful with that Nuke' (June 2001) New Scientist
30 'Careful with that Nuke' (June 2001) New Scientist
31 Jackson (1981) p93
32 Jackson (1981) p94
33 Isaacs & Downing (1998) p151
34 'Valiant & Victor- United Kingdom Nuclear Forces' http://www.fas.org/nuke/guide/uk/bomber/valiant/victor.htm Accessed 14 August 2001
35 *Operation of V-bomber at Low Level* Public Record Office AIR2/14578 CMS.2733/55 page 7 (1955)
36 *V-bomber Force Future Policy* Public Record Office AIR 2/14700 CMS. 2228/53 Paper No. A.C. (57) 92 (1961)
37 *V-bomber Force Future Policy* Public Record Office AIR 2/14699 AF/CMS 572/64 75.B 3. (1961)
38 *V-bomber Force Future Policy* Public Record Office AIR 2/14699 AF/CMS 572/64 75.B 4. (1961)
39 Miller (2001) p139
40 Miller (2001) p139
41 Pierre (1972) p86
42 Miller p139 (2001) – H. Wynn, the RAF Strategic Deterrent Forces 1946-69 p276
43 Heuser (2001) p87
44 Heuser (2001)p87
45 Brown (1964)p10
46 *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 CMS. 2733/55 page 5 (1955)
47 Brookes (1982) p78
48 *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 CMS. 2733/55 page 5 (1955)

[49] *V-bombers in Low Level Role* Public Record Office AIR 2/13415 acas (ops) 8232 page 4 paragraph 3.8 (1956)
[50] *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 BC/S. 96737 (1961)
[51] *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 BC/S. 96737 (1961)
[52] *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 BC/S. 96737 paragraph 39. (1961)
[53] Menaul & Gunston (1976) p 54
[54] Menaul & Gunston (1976) p 55
[55] Menaul & Gunston (1976) p 52
[56] Sgarlto (1979) p13
[57] Brookes (1982) p85
[58] *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 1271/s.6 page 1 (1955)
[59] *Operation of V-bomber at Low Level* Public Record Office AIR2/14578 CMS. 2733/55 page 1 (1955)
[60] *Operation of V-bomber at Low Level* Public Record Office AIR2/14578 CMS. 2733/55 page 1 (1955)
[61] *Operation of V-bomber at Low Level* Public Record Office AIR2/14578 CMS. 2733/55 page 8 (1955)
[62] Brookes (1982) p107
[63] Brookes (1982) p107
[64] 'Soviet Nuclear Forces' http://www.fas.org/nuke/guide/russia/airdef/v-75.htm Accessed 20 August 2001
[65] 'Soviet Nuclear Forces' http://www.fas.org/nuke/guide/russia/airdef/v-125.htm Accessed 20 August 2001
[66] *Operation of V-bombers at Low Level* Public Record Office AIR2/14578 CMS. 2733/55 page 3
[67] *V-bombers in Low Level Role* Public Record Office AIR 2/13415 acas (ops) 8232 paragraph 4.1 (1956)
[68] *Nuclear Weapons: Lay Down Nuclear Weapons for V-bombers* Public Record Office DEFE 25/23 SZ/54/64 (1960)
[69] *Nuclear Weapons: Lay Down Nuclear Weapons for V-bombers* Public Record Office DEFE 25/23 RHS/26/63 (1963)
[70] *Operation of V-bombers at Low Level* Public Record Office AIR2/14578 CMS. 2733/55 page 4-5 (1955)
[71] Brookes (1982) p105
[72] Brookes (1982) p106
[73] Brookes (1982) p106
[74] Menaul & Gunston (1976) p. 55
[75] Jackson (1981) p35
[76] Jones (2000) p161
[77] Jones (2000) p162
[78] Jones (2000) p165
[79] Jackson (1981) p94
[80] *Nuclear Weapons: Lay Down Nuclear Weapons for V-bombers* Public Record Office DEFE 25/23 RHS/26/63 (1963)
[81] *Nuclear Weapons: Lay Down Nuclear Weapons for V-bombers* Public Record Office DEFE 25/23 RHS/26/63 (1963)
[82] Brookes (1982) p126
[83] Jackson (1981)p95
[84] Jackson (1981)p95
[85] *Nuclear Weapons: Lay Down Nuclear Weapons* Public Record Office DEFE25/23 RHS/23/63 (1963)
[86] *Nuclear Weapons: Lay Down Nuclear Weapons* Public Record Office DEFE25/23 RHS/23/63 (1963)
[87] Menaul & Gunston (1976) p52
[88] 'The A-35 Ballistic Missile System' http://www.wonderland.org.nz/a-35.htm Accessed 21 August 2001
[89] 'Galosh-Moscow System' http://www.fas.org/spp/starwars/program/soviet/galosh.htm Accessed 21 August 2001

This article has been republished online with Open Access.

Ministry of Defence © Crown Copyright 2023. The full printed text of this article is licensed under the Open Government Licence v3.0. To view this licence, visit https://www.nationalarchives.gov.uk/doc/open-government-licence/. Where we have identified any third-party copyright information or otherwise reserved rights, you will need to obtain permission from the copyright holders concerned. For all other imagery and graphics in this article, or for any other enquires regarding this publication, please contact: Director of Defence Studies (RAF), Cormorant Building (Room 119), Shrivenham, Swindon, Wiltshire SN6 8LA.

ROYAL AIR FORCE
Centre for Air and Space Power Studies

OGL