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WE.177

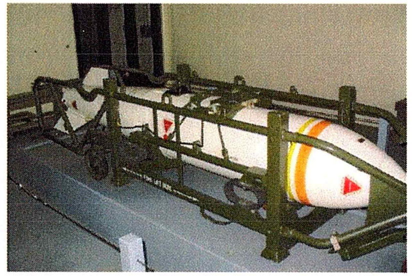
nuclear weapons

a guide to British nuclear weapon projects

Improved Kiloton Bomb
OR.1176 (fission warhead)
OR.1177 (casing)
OR.1178 (NDB)
OR.1195 (thermonuclear warhead for WE.177B)
Katie
Katie A
Simon
Cirene
Bomb, Aircraft, HE 600lb MC
Bomb, Aircraft, HE 950lb MC No1
Bomb, Aircraft, HE 950lb MC No2

WE.177 was the last air-launched nuclear bomb deployed by the UK. There were three versions, all free-fall and parachute-retarded. Two of these versions, WE.177B and WE.177C were thermonuclear weapons. The remaining version, WE.177A was a boosted fission weapon.

The first version to be deployed, the thermonuclear WE.177B, was delivered to the Royal Air Force in September 1966 followed by deliveries of WE.177A to the Royal Navy beginning in 1969,[1] and the RAF in 1971, after a delay caused by the need to produce the ET.317 warhead for the UK Polaris A3T first; and was followed by WE.177C deliveries to the RAF. The Navy weapons were retired by 1992 and all other weapons with the RAF were retired by 1998.[2]



WE.177A inert operational round at former AWRE test site, Orfordness. Photo: flicr

The WE.177A boosted fission weapon, deployed in 1971, was originally conceived as an Improved Kiloton Weapon to replace Red Beard, a tactical kiloton-range bomb. WE.177A was a dual-purpose weapon, being used by RAF and Royal Navy fixed-wing aircraft as a surface attack tactical bomb against land and sea surface targets. It could be delivered by several methods including low-level loft bombing. Forty-three were also deployed aboard Royal Navy surface vessels of frigate size and larger for use by embarked helicopters as an anti-submarine NDB (Nuclear Depth Bomb).[3]

Training rounds at IWM Duxford. Photo: Leitch

WE.177B was a stop-gap measure designed to fill a gap after the cancellation of another project, and was intended for a strategic role as described below.

WE.177C was added later to meet a Nato requirement for a high-yield tactical bomb not exceeding 200 kt yield, also described in more detail below.

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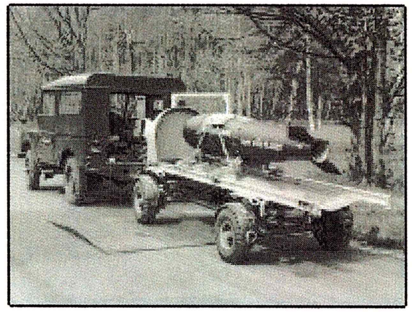


WE.177A training round aboard a Wessex naval helicopter. Photo: middlewatch

WE.177A training round aboard a Wasp naval helicopter. Photo: middlewatch

Road-durability testing on a Farnbrough test track. Photo: Mike Fazackerley

Genesis and development

WE.177 development began possibly as early as 1958 as an **Improved Kiloton Bomb** and Red Beard replacement. Red Beard was heavy, large for fighter-bomber tactical aircraft to carry underwing, and the storage and handling limitations were a hindrance. Also, there were highly radioactive components, comprising the primitive impact initiator (a neutron generator) that had a life measured in months rather than years, that had to be returned to AWRE for re-lifing every six months from locations in the UK, Cyprus, Singapore and with the Fleet. The logistical issues that arose were severe, and in the Improved Kiloton Bomb this arrangement was replaced with an Electronic Neutron Initiator (ENI). Red Beard was armed before take-off with no possibility to change selections in-flight, or to disarm the weapon for a return to base. A replacement was urgently sought, even before Red Beard entered service, and an Air Ministry Operational Requirement was issued as **OR.1176** for the warhead, and **OR.1177** for the complete weapon, in Aug 1959. The Royal Navy requirement **GD.10** was merged into OR.1176/OR.1177 as a joint requirement, and sometime later the RAF Coastal Command requirement **OR.1156**, for an anti-submarine nuclear depth bomb (NDB) was added, although WE.177A was subsequently never issued to RAF maritime anti-submarine patrol aircraft. They were issued with an American B-57 NDB from US Navy stocks held in Europe.

As originally envisaged WE.177A was to be merely an **Improved Kiloton Bomb** to the twin specifications of **OR.1176** for the boosted fission warhead, known by the designator **PT.176**, and OR.1177 for the complete weapon. But the early 1960's was a period of rapid change in both warhead design and delivery systems. The era of the manned high-speed, high-altitude bomber was ending with the arrival of guided missile defences and the ballistic missile, and several false starts were made in weapon choices. Efforts to extend the life of the RAF strategic bomber force resulted in the Blue Steel short-range stand-off bomb and the Skybolt programme. Skybolt was to extend the bomber's strategic role beyond the 1970's, and when cancellation came, followed by a decision to acquire Polaris, a gap appeared between 1965 and the arrival of Polaris in service at the end of the decade, when the RAF strategic bomber force was unlikely to be able to penetrate Soviet defences at high-level. A stop-gap weapon was needed that would permit the bombers to penetrate at low-level, beneath the radar, and SAM defences. That stop-gap weapon, referred to at the time occasionally as **Weapon X**[4] was the genesis of **WE.177B** to the specification **OR.1195** for the complete weapon. It is not known if there was an Operational Requirement specification written for the warhead only, as had been the case with WE.177A.

In this emergency, the Improved Kiloton Bomb, WE.177A, was put onto the back-burner, with efforts concentrated on the stop-gap WE.177B, followed by the Polaris warhead, followed by WE.177A. Deployment of WE.177B began in 1966, with WE.177A service entry delayed until 1971.

The original warhead choice for WE.177A was an all-UK boosted fission design codenamed **Una**. Simultaneously, a thermonuclear warhead codenamed **RE.179** was being developed for Skybolt, and this was an anglicised copy of the US W-59 warhead. The fusion secondary of the anglicised W-59 was known in the UK as **Simon**, and the fission primary was an anglicised US **W-44 Tsetse** warhead, known in the UK as **Tony**. There were also other delivery systems that these RE.179 components were intended for, so Una was abandoned and the RE.179 warhead components were chosen as common components for a 'family' of similar warheads. It seemed sound economics. Scientific manpower and other resources were scarce, and it made sense to standardise and reduce spares stockholdings. After Skybolt cancellation and cancellation of the Army's tactical battlefield missile Blue Water, the only remaining prospective users of RE.179 components was to be the 'stop-gap' weapon WE.177B, and the Polaris warheads, although another US design, the W-58 thermonuclear warhead was also considered and rejected for Polaris. And then another issue arose.

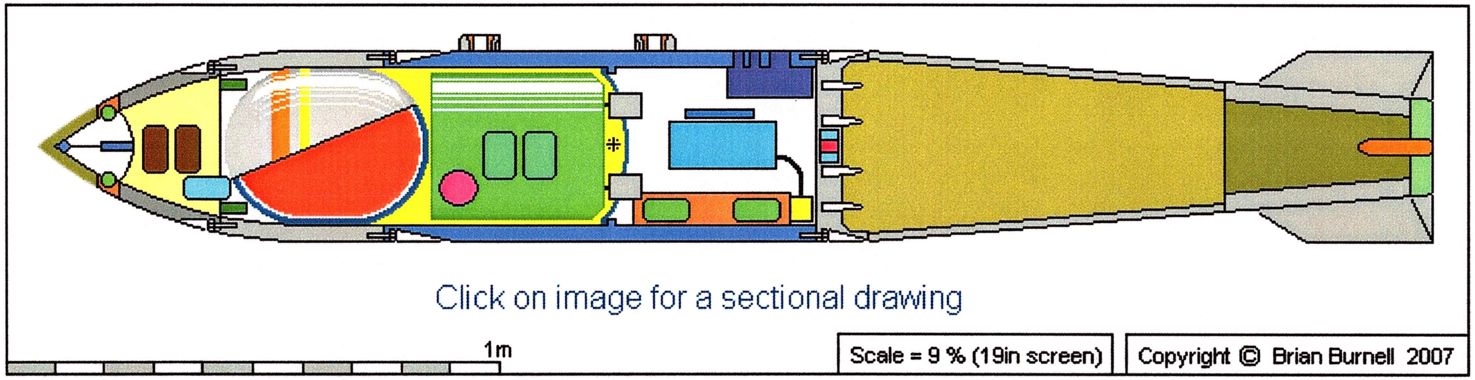
The US W-44 Tsetse primary used in the US W-59 used a plastic-bonded explosive (PBX-9404) that was too shock-sensitive to comply with stringent British explosives requirements. If replaced in an anglicized version of the W-44 with a less shock-sensitive British HE, the implosion device would generate less compression at the core, and a lower yield insufficient to guarantee ignition of the fusion secondary. The British solution was to substitute a different primary based on a wholly UK design that began as **Octopus**, then **Super Octopus** and then evolving into **Cleo**. Declassified files[5] describe it as "a novel form of implosion", and it was tested (originally for the Skybolt warhead) underground at the Nevada Test Site as test **Pampas** on 01 March 1962.[6] It was the first British underground test, and it's yield was 9.5kT. The design incorporated gas-boosting, a composite-core and a mechanical safing device, for the design was not inherently one-point-safe. Following Skybolt cancellation and the start of the WE.177B project there were concerns that the mechanical safety device would not be reliable, and a modified design that had a larger HE supercharge producing more compression at the core, a smaller core that was inherently one-point-safe, and dispensing with mechanical safing, was re-tested as **Tendrac** on 07 Dec 1962.[7] This device became the WE.177B primary known as **Katie**. The secondary, derived from RE.179 (itself an anglicised copy of the US W-59) was codenamed **Simon**, and the complete WE.177B warhead was codenamed **ZA297**. A similar primary was adopted for the Polaris warheads then being designed, using scaled-down components derived from the RE.179 and WE.177B warheads. The tests that followed Tendrac were concerned only with the Polaris variant, and were also known as the **Polaris Economy Tests**, because their objective was to economise on the scarce and expensive plutonium used in both their fissile cores and as a thermonuclear 'spark-plug'. Though it is reasonable to conclude that there were spin-offs and beneficial effects for the same basic design used in all versions of WE.177.

Other versions of Katie emerged later. **Katie A** also known as **PT.176**, is identified in declassified files with WE.177A. **Scenic**[8] is decribed as an all-oralloy Katie. Oralloy being a term used to describe weapons-grade U-235. So there was a version of Katie that used no plutonium, although nothing is known of this version's purpose.

In the early 1990's some writers asserted that the WE.177A design was based on the US B57 bomb,[9] which was of a similar size, weight, yield and purpose, and that speculation has been widely repeated elsewhere. The B57 also functioned as a NDB, and it used the W-44 Tsetse/Tony boosted fission warhead rejected by the British for their RE.179 primary. It is also true that the British had access to its design and planned to manufacture it in the UK for various purposes. However, since the early 1990's, many secret files have been declassified, and these make it clear that the claims about a common design were merely speculation and wrong.

Some writers made the assertion[9] that because the British conducted so few full-scale nuclear tests, WE.177 was unlikely to be an indigenous design. That it must, by a curious extension of that logic, be an American design, the closest being the B57, while failing to understand that the WE.177 fission element was one of a 'family' of designs, deliberately similar, intended to produce a 'common design', usable with only minor changes, in a variety of applications from Skybolt, Polaris, Blue Water and WE.177. As it indeed was, and so a single series of only four full-scale underground nuclear tests were necessary, plus one failed test.[10,11] There were four other [nuclear] 'effects' tests conducted in the US, and numerous non-nuclear 'scaled' tests in the UK. Hardly a small testing programme for a single fission device. In fairness to those writers, it may not have been so apparent then as now, after numerous declassifications of archived documents.

Such speculation also fails to take into account the cultural and financial differences between the US and British nuclear programmes. The early US programme was over-reliant on full-scale testing because of the extreme urgency attached to its very large programme. There are instances of poor design directly attributable to a poorer theoretical understanding of the physics, and an empirical design approach.[12] The fission primary of the W-28 being one example of design flaws attributable to an imperfect theoretical understanding.[13] On the other hand, the British, with fewer resources, and always short of cash, employed their meagre resources to better effect, with a better understanding of the theory that underpinned their efforts. They also benefitted from the shared US test data, as the US benefitted from equally valuable British know-how. That shared know-how, coupled with British experience and greater theoretical understanding was one factor that contributed to an American desire to complete the 1958 Bilateral, or Mutual Defence Agreement. The US understood that they had much to gain from the British, as the British also gained. It was a shared experience, not a one-way street.



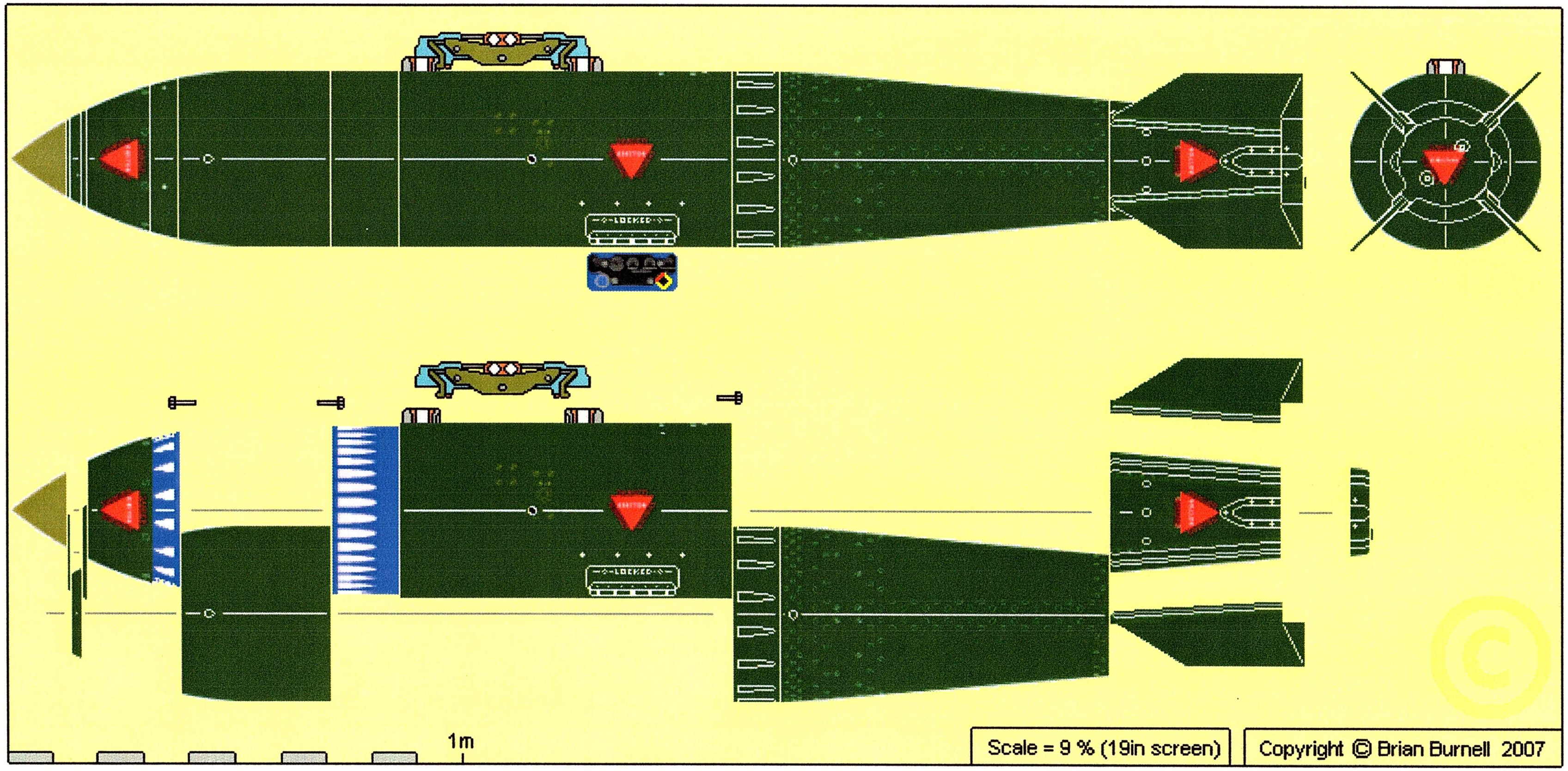
WE.177A

WE.177A weighed 272 kg (600 lb), with a selectable yield of 10 kT and 0.5 kT. This was a boosted fission weapon. The 0.5 kT yield was used only in the NDB role for detonation below 140 ft (43 m) in shallow coastal waters or in oceanic deep waters below 350 ft (107 m) to limit damage to nearby shipping. The full 10 kT yield was used only below 350 ft (107 m) in deep oceanic waters where no shipping was at risk.[14]

The full 10 kT yield was used by fixed wing aircraft for surface attack. It had airburst, ground burst or laydown options. Although this variant matched the original concept with an added NDB function, and was identified as the 'A' model, it was not the first to be deployed. Development was purposely delayed when the Skybolt ALBM was cancelled. Revised priority was then given to a bomb intended to extend the life (in a strategic role) of the Vulcan force. This stopgap weapon was WE.177B, a thermonuclear parachute-retarded free-fall bomb based on a lengthened WE.177A casing, using as a thermonuclear primary the intended warhead for WE.177A. This was known as KATIE in WE.177B. and as KATIE A in WE.177A.

Twenty WE.177A bombs were transferred to the RAF from the Royal Navy when the large carriers were decommissioned, and the remaining 43 that were assigned to the Navy's helicopters were retired in 1992. These were also capable of use by Sea Harriers. It was known to the Armed Services as 'Bomb, Aircraft, HE 600 lb MC'. In this service jargon MC (Medium Capacity) referred to a nuclear weapon in the kiloton range. The suffix HC (High Capacity) referred to a weapon in the megaton range, although there were some anomalies.

WE.177A anti-submarine weapons were deployed afloat by the Royal Navy for use by embarked helicopters. They were never deployed by the RAF aboard their maritime anti-submarine aircraft. RAF Nimrods based in the UK were equipped with US B-57 weapons drawn from NATO stocks maintained in the UK at RAF St Mawgan for RAF and Dutch Navy maritime aircraft.[15] Nimrod aircraft based in the Mediterranean and assigned to SACEUR were also equipped with US B-57 weapons maintained in a US Navy stockpile at Signorella in Sicily. Although it was intended to issue WE.177A to all Nimrod squadrons and the 'shadow squadron' made up of operational training units, there were never enough WE.177A weapons in British stockpiles to permit implementation of those plans.



WE.177B

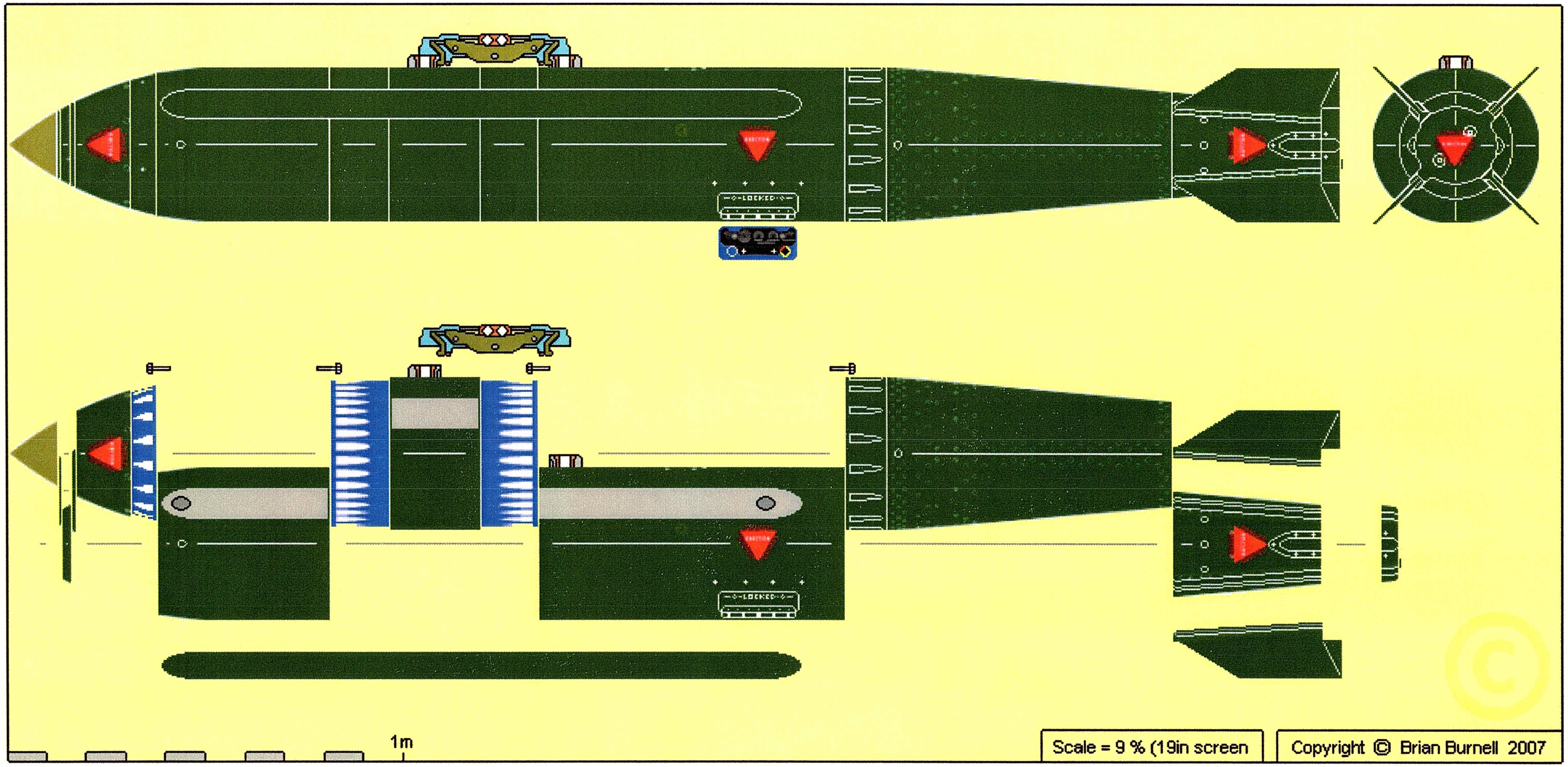
WE.177B weighed 457 kg (1'007.5 lb), with a single yield of 450 kT. Although it weighed in excess of 1'000 lb it was known to the Armed Services as Bomb, Aircraft, HE 950 lb MC No.1.

WE.177B and carrier, awaiting aircraft loading at RAF Marham. Photo: Leitch.

WE.177B had a thermonuclear warhead, comprising two parts. The primary was KATIE referred to above, but without the variable yield facility or the NDB's hydrostatic fuse. KATIE was based on a British design known as CLEO, earlier known as Super Octopus, intended as the thermonuclear primary for RE.179, a British warhead for the RAF version of the cancelled Skybolt air-launched ballistic missile. The secondary (or fusion element) of RE.179 was based on the US W-59 warhead and was known by the British codename of SIMON. However, the W-59 primary used PBX-9404, a plastic-bonded-explosive, considered by the British to be unsafe. The US W-44 primary was replaced with a British primary developed from CLEO, that evolved into KATIE, that did not use the shock-sensitive PBX-9404. When Skybolt was cancelled RE.179 was adapted to become WE.177B (also referred to as Weapon X) and in a smaller version, the British warhead for the Royal Navy's Polaris A3T.

WE.177B had airburst, impact, ground laydown and water laydown options. Roughly, 'laydown' can be taken to mean a ground burst or a sea surface burst with a time delay, enabling the bomber to escape the detonation.

Skybolt warheads ordered numbered 90,[16] and at cancellation this was the RAF requirement for WE.177B, although this quantity was reduced later. Numbers built are still uncertain but reliable sources put the figure at 53,[17] and all were retired by August 1998. When Polaris became operational with the Royal Navy, the RAF bomber force continued in a tactical role with these and other bombs. With the conversion of the Victor bombers to fuel-tankers and retirement of the Vulcan bombers WE.177B was carried by successor aircraft, including RAF Tornados.



WE.177C

WE.177C weighed 457 kg (1'007.5 lb), with a single yield of 200 kT. It was deployed only by RAF Germany in the tactical strike role, and used by Tornado and other strike aircraft. It was developed to meet a NATO committment to arm RAF Germany strike aircraft with weapons of a maximum 200kt yield for use at the forward-edge-of-the-battlefield. An agreed NATO policy was to limit such weapons to 200kt, and WE.177B