



IRGON - International Research Group Orford Ness

Bomb Ballistics Trials on Orford Ness

Cold War bomb ballistics

Version 1.1

Steve Clifton 20th April 2026

The increasing sophistication of air dropped weapons in the atomic age meant that purely ballistic testing overlapped considerably with other test regimes.

Besides visual observation of a weapon via cameras and kine-theodolites, essential internal systems often had to be monitored, and other physical and aerodynamic data (e.g. vibration levels) would have to be transmitted via telemetry. The necessity for airborne systems testing arose partly because the techniques for ground testing were not yet mature. Refer to the separate articles on telemetry and vibration testing (in preparation).

There was a second important factor which distinguished the science of bomb ballistics in the cold war era. This was the fact that a quantum leap had occurred with the introduction of the jet bomber, meaning that heights and speeds at which bombs could be released had effectively doubled. Early ballistic tests with dummy casings representing the first generation weapon Blue Danube were compromised as suitable aircraft were not at first available. The limits and workarounds are explained below.

Not everything is known about every aspect of the ballistic testing of UK nuclear weapons on Orford Ness. This chapter represents a work in progress.

For references, please click [here](#)

Description of the Orford Ness range

A 1957 document⁴⁰ describes the various bombing ranges available for the British armed forces, including the Australian establishment at Woomera. In this appendix, Orford Ness is described as follows:

“Orfordness Range. Primarily a sea D.A.* situated off the Suffolk coast just south of Aldeburgh. Bombing is possible only on Clear Range Procedure, a surveillance radar is installed. Live bombing is prohibited. Limited recovery is possible when stores are dropped on the shore. Orfordness is the only range in U.K. which is fully instrumented for ballistic measurements and in addition there is a permanent A.W.R.E. telemetry installation. An adjacent area has been approved for low altitude flying and instrumentation for loft bombing trials is available.”

* D.A. = Danger Area

For references, please click [here](#)

Blue Danube

As Britain's first generation nuclear weapon, *Blue Danube* was a sizeable device. A.W.R.E. in conjunction with the Armament and Instrument Experimental Unit at Martlesham Heath carried out trials in connection with *Blue Danube* from 1951 onwards⁴¹. Converted Lincoln aircraft were initially used, as the availability of V-bombers was some years away (the first of the V-bombers, the Vickers Valiant, did not enter service until February 1955)⁴².



*Replica casing of a Blue Danube bomb at the former storage facility at RAF Barnham.
A large weapon, which determined the design of the V-bombers.*

Initially, by September 1950, eleven ballistic models had been dropped from altitudes between 28,000 and 35,000 feet.⁴³ Two types of fin configuration were tested. Drops 2 to 7 were made with 1.65D (= 1.65 bomb diameters, 102", 259cm) and drops 8 to 11 with a smaller 1.4D (87", 221cm) set of flip-out fins.

For references, please click [here](#)

Drop No.	Height (ft.)	Airspeed (m.p.h.)	Terminal Velocities		Striking Velocity ft./sec.	Line error ft.	Notes
1	Purely functional drop, no measurements taken						
2	31022	257.3	2088	1610	1060	64 L	
3	28360	275.4	1937	1521	1052	146 L	
4	31504	254.8	1971	1632	1056	101 L	
5	33368	245.6	-	-	1076	132 L	Assumed time of impact
6	32909	213	2239	-	***	162 R	Late release
7	34588	223.1	1624	1434	***	148 R	
8	33400*	220**	-	-	1070	-	Striking velocities are vertical components only. No impact time.
9	33977	214.7	-	-	-	-	
10	33594	215**	-	1399	-	-	
11	34783	234.4	1718	1430	1110	1110	

* altimeter reading ** A.S.I. reading *** Bomb not seen in air on Vinten

In the table above, most of the heights plotted by radar in column 2 are above the service ceiling of the Lincoln (officially 30,500 ft). One can imagine the four Merlin 66 engines straining to lift the full size casing with its ballast to this altitude. One measure taken to get closer to matching the higher speeds and altitude capability of the V-bombers was the use of the Python-Lincoln. This was an experimental engine test-bed, with the outboard pair of Merlins replaced with Armstrong Siddeley Python turboprops. Two Lincolns appear to have been modified in this way, one was sent to carry out similar trials in Australia at the Woomera range. The second aircraft, RE339, was probably used for drop trials at Orford Ness: at the time of writing this has not been confirmed.

Column 6 in the above table shows striking velocity in feet per second. These values are approaching Mach 1, and R.A.E. were worried about transonic effects (see also the following graph). Two areas of concern were the transonic drag effect having an influence on accuracy, and also pressure artefacts impacting the barometric fuse. Tests were conducted at the Larkhill artillery range using models, and the results were available by the end of 1950.

For references, please click [here](#)

NR ORS. 748

DR
TR L.K.R.
CH
APP.

RUN NO 2377
10,000 LB. L.C.

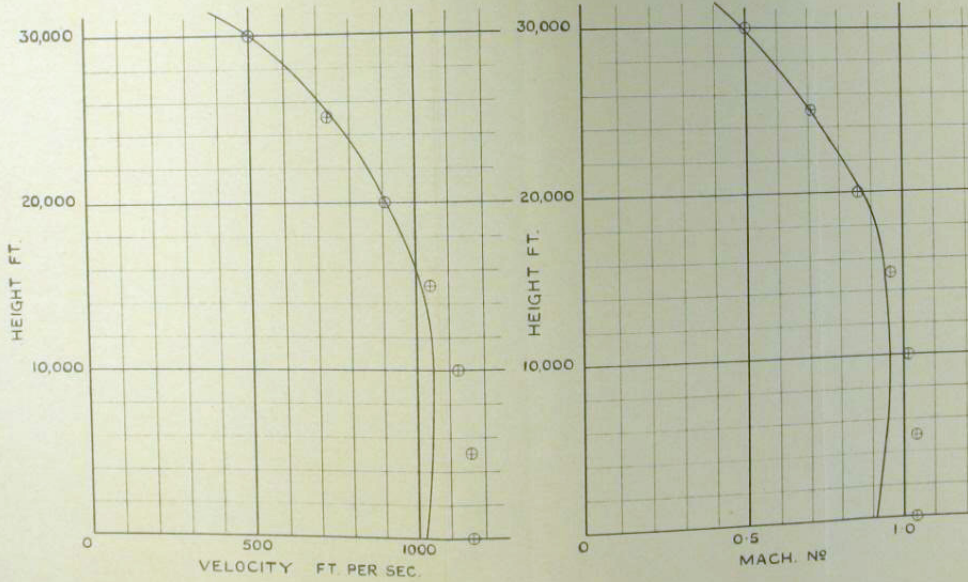
SECRET.

TOP SECRET

RELEASE HEIGHT_ 31624 FT.
AIRSPEED_ 255.7 MPH.
Z λ 1926 FPS.
Z T 1720 FPS.
Z x 2267 FPS.
STRIKING VELOCITY_ 1056 FPS.

POINTS THUS:- ⊕ VELOCITY &
MACH NUMBERS FROM BALLISTIC
TABLES USING Z = 1720 FPS.

IMPACT POSITION { X Y	RADAR	BALLISTIC EQUIPT.
	+ 17375 FT. + 93 FT.	+ 17284 FT. + 114 FT.
HEIGHT	31639 FT.	31624 FT.
GROUND SPEED AT RELEASE	376 FPS.	383 FPS.

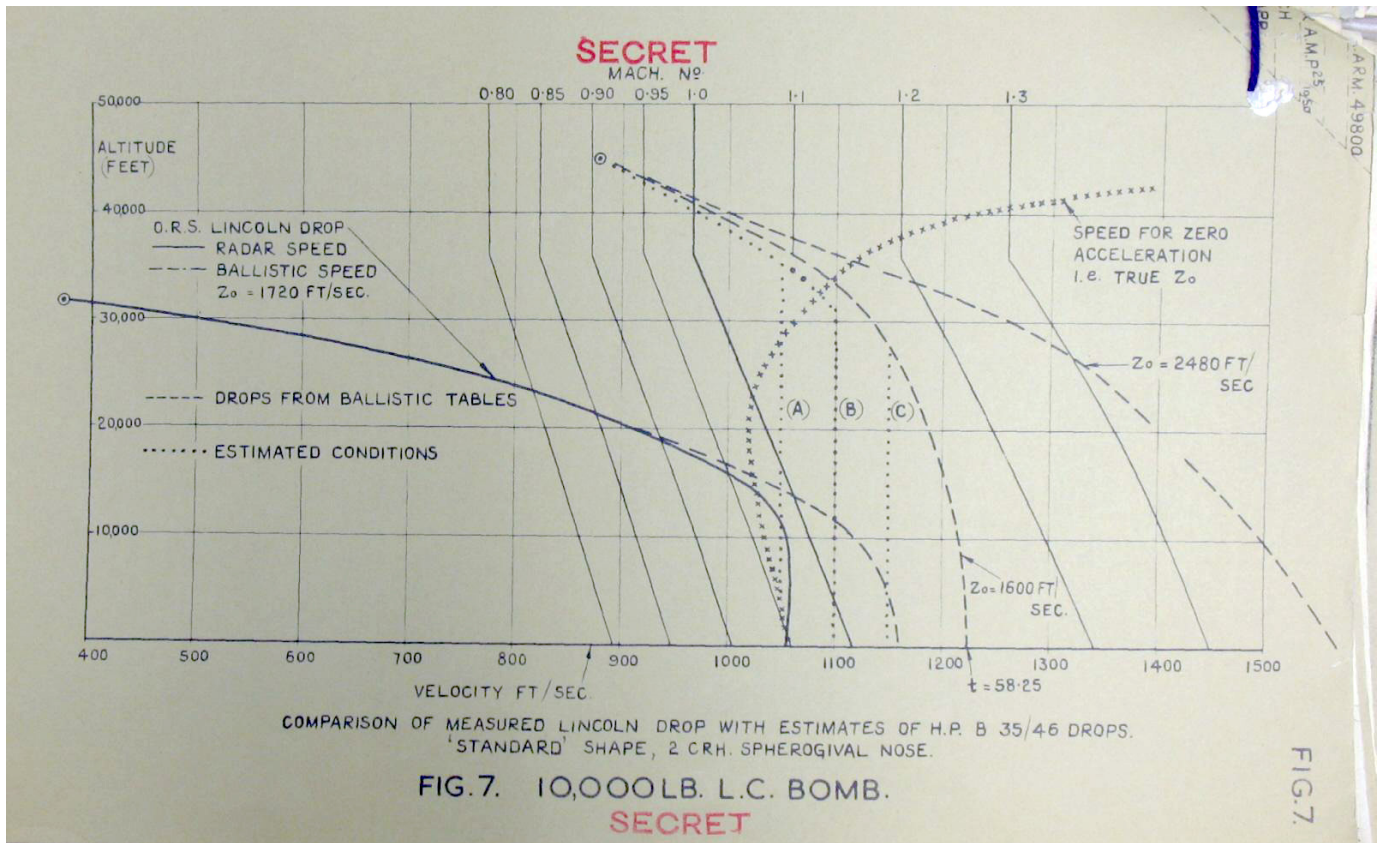


VARIATION OF VELOCITY AND MACH. NUMBERS OF STORE WITH HEIGHT USING RADAR TRAJECTORY.

Plot of a Blue Danube ballistic casing drop on Orford Ness. Note the close approach to the sound barrier as evidenced by the right hand plot.

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Graph showing mixture of Orford Ness drop data (solid line) and wind tunnel data from R.A.E. as part of the Blue Danube ballistics development programme. Note that at this early date (1950) R.A.E were using wind tunnel models of the H.P. B. 35/46, later to become the Victor.

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Further drops of a full size casing were made when the Short Sperrin became available. 30 drops were made using the Sperrin⁴⁴, but it is not clear at the time of writing which range was used, although as Sperrin VX 161 was stationed at Woodbridge, it is highly likely that the drops were made at Orford Ness.

Britain's first jet bomber, the English Electric Canberra, had a performance much closer to the V-Bombers, but was too small to carry a full-size *Blue Danube*. However, a full-size ballistic casing was not always essential, and tests using full size casings had a cost impact too. For subsystem tests, a number of flying trials were devised (A.W.R.E. series F1, F2 and F3) which were scaled down test vehicles for testing specific subsystems. The Canberra could accommodate the F1 to F3 vehicles with minimal modifications.

As mentioned in the opening paragraphs, here there was some deviation from pure ballistics testing. In the AWRE Progress Report covering the period 1st June - 1st September 1957⁴⁵, a trials series under the designation "F2" is listed (see below). The report indicates that some trials of this vehicle took place over Orford Ness up till 19th February 1957, and it was planned to recommence these tests some time later.

For references, please click [here](#)

F1 and F3 were concerned with the early development of firing components and their associated circuitry.

F2 was a test vehicle some 1000lb (453kg) in weight and designed to check the operation of *Blue Danube's* ground proximity radar fusing mechanism⁴⁰. There are some more details of these non-ballistic tests in the chapter on Orford Ness Telemetry, in preparation.

By 1955, the Valiant was available and trials with *Blue Danube* (or the 10,000 lb. M.C. Bomb, as it was referred to in many A. & A.E.E. documents) commenced at Orford Ness in June of that year⁴. The clearance trials consisted of a series of carriage trials, with the bomb doors both closed and open, to ensure the weapon remained firmly attached during manoeuvring and normal flight regimes. Two series of release flights to observe the behaviour of the weapon once dropped (to ensure it left the aircraft cleanly, that the tail fins extended correctly, etc.) were carried out. Wind tunnel tests had suggested that air spoilers might be needed to assist the bomb release⁴⁶, so to confirm this a series was carried out with the spoilers deployed, another with a clean configuration.

Observation of the trials was both airborne (using cameras mounted on the wing-tips and in the bomb bay) and ground based kine-theodolites.

SECRET GUARD

Appendix D

Ballistic Data provided by O.R.S. Orfordness

Flight No.	Height (feet)	Airspeed (m.p.h.)	Trail (ft.)	Time (secs)	Air Range (feet)	Striking Velocity (f.p.s.)	I. trail	I. time	I.'s velocity
17	39,041	512.9	8471	55.84	33,534	1060	98	91	140
18	13,561	437.9	1562	-	-	1020	149	128	100
19	14,217	368.1	792	30.5	15,674	1010	96	-	95
20	14,425	424.0	-	30.59	-	-	-	91	-

NOTES: (1) Flights Nos. 17 and 18 were with airspoilers out and flights 19 and 20 without airspoilers.
 (2) There was no radio release signal for flight No. 18 therefore trail only was determined.
 (3) On Flight No. 19 the aircraft was above cloud therefore the height was obtained from the height meter and the airspeed by radar. There were no records of the impact positions.

Table showing Blue Danube release trials 17 to 20 over Orford Ness, summer 1955. The aircraft was a Vickers Valiant B. Mk.1 WP199.

Some later V-bomber tests with *Blue Danube* at Orford Ness are tabulated below. These tests were aimed at ensuring the release mechanisms and fuses were working properly.

Blue Danube Trials at Orford Ness

Serial	Originating Establishment	Aircraft	Task	Period	Total Flights	Facilities required	Operating altitudes
3	R.A.E.	Victor	Development: <i>Blue Danube</i> Release disturbance	Feb -March 1957	5	Kine-theodolites, ground cameras	1,000ft
4	R.A.E.	Vulcan	Development: <i>Blue Danube</i> - Fuse F4	Jun - Oct 1957	5	Radar control, A.W.R.E. telemetry, Kine-theodolites	45,000ft
5	R.A.E.	Victor	Development: <i>Blue Danube</i> - Fuse F4	Feb - Jun 1958	5	Radar control, A.W.R.E. telemetry, Kine-theodolites	45,000ft



Estimated typical bomb run by a Valiant releasing a full size weapon casing over the Orford Ness range

For references, please click [here](#)

Red Beard

Red Beard was a tactical nuclear weapon small enough to be carried by aircraft such as the Canberra (refer to the article on nomenclature).

The main vehicles used in trials were the TMB* for general trials of the ballistic weapon (there was also a version optimised for loft delivery) and TMS for fusing trials⁴¹.

Beginning in March 1957, drop trials of the TMS stores began, and TMB trials later that same year. Most releases took place over the Orford Ness range. Impact trials were conducted elsewhere, at the Imber range (Salisbury Plain).

TMS trials took various forms. Type A tests would be made by overflying the range at various speeds and altitudes but without releasing the store. The bomb doors would be opened and the radar fuse switched on. Type C tests would be similar, but would also check the radar release signal. Type B overflights would follow a lower altitude regime (3000 ft, descending to 1000 ft then slowing down to 175 knots), whereas Type D would actually be a release test. Radar reflectors were fitted in the Canberra bomb bay to simplify tracking, and a visible smoke puff would allow ground observers to verify the fuse operation. As the TMS trials were more electronic than ballistic in nature, they are covered in more detail in the article on telemetry (in preparation).

TMB trials for the ballistic version of *Red Beard* would be designed to prove the barometric fuse and its combination with the radar fuse.

LABS

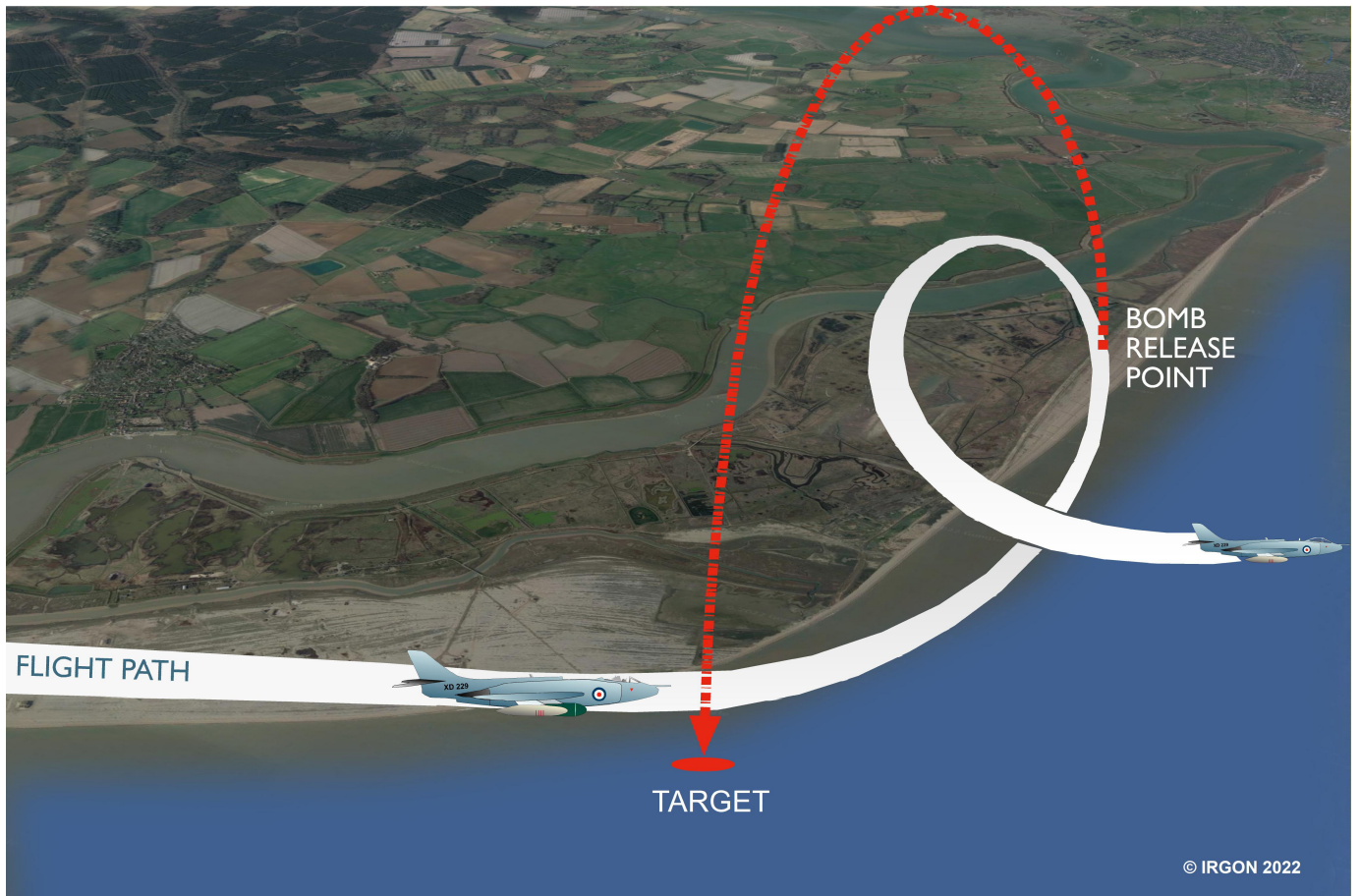
LABS or Low Altitude Bombing System was a bombing tactic pioneered by the US Navy in the post war period. This manoeuvre has the advantage of rapidly distancing the delivery aircraft from the bomb impact point, which is helpful over heavily defended targets or when blast effects are to be avoided.

LABS techniques were tested at Orford Ness and West Freugh with *Red Beard*. The Canberra was cleared for LABS type delivery and the first release of the loft variant was made July 1958, at the time of writing it is not clear if this took place at Orford Ness.

Orford Ness however was definitely involved in the LABS testing programme. Improvements in accuracy were sought for the LABS technique, and Supermarine Scimitar XD229 took part in several Orford Ness trials. This aircraft was operated by the R.A.E. Weapons Flight. It was written off in a ground hydraulics accident at West Freugh in 1965.

* These weapons were code named "Target Marker", a Pathfinder-era name for an illuminating bomb. TMB was Target Marker, Ballistic, and TMS was Target Marker, Switch.

For references, please click [here](#)



Artist's impression of Scimitar aircraft carrying out a LABS manoeuvre with Red Beard

Click on the image below to see a photo of XD229 taken at Biggin Hill in 1963 (external link).



For references, please click [here](#)

Yellow Sun

Yellow Sun was the megaton-range weapon designed to replace the stop-gap *Violet Club*. Like *Blue Danube*, the large dimensions of the bomb meant that a V-bomber was needed to carry the full size casing.

Although V-bombers were available as carrier aircraft from 1955 onwards, economy dictated that not all testing needed the full-size weapon. As in the case of *Blue Danube*, a set of scaled-down test vehicles were produced. These could be carried by smaller aircraft like the Canberra.

One of these stores was the NTV, which was an approximately one-fifth scale model of *Yellow Sun*, constructed by Hunting Engineering. These NTV drop trials began in 1957 using two Canberras, WH661 and WD94741. Initially, ballistic drops were made to compare the scaled down NTV to the full size store. Drops were carried out over Imber, Orford Ness and West Freugh, with telemetered data being transmitted, the trajectories for some trials confirmed by kine-theodolite.

There is evidence that some high speed tests were done on models of *Yellow Sun* in the model range (also referred to as the “indoor spark range”).

Research continues on *Yellow Sun* trials at Orford Ness.

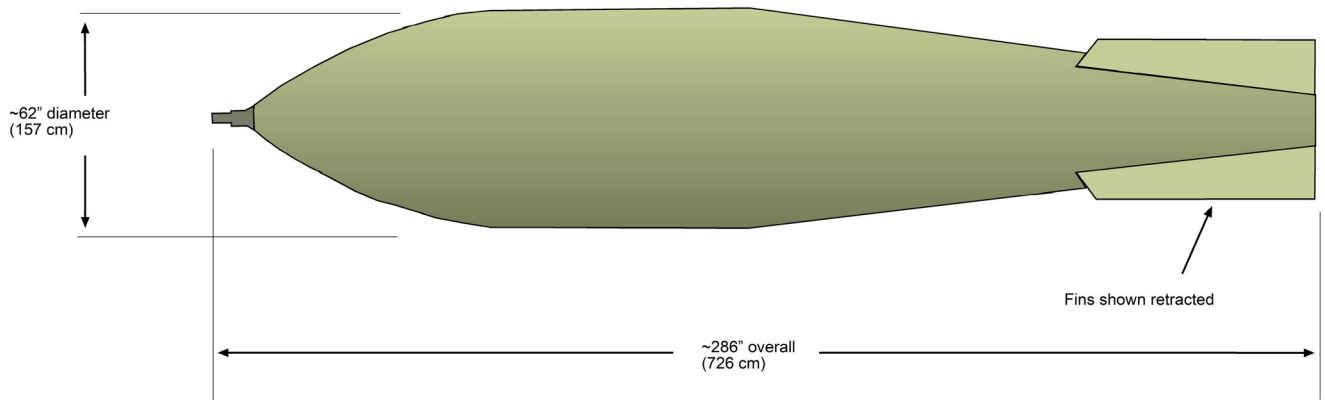
WE177

So far we have gathered some information regarding impact testing (see [Impact Facility and the WE177 Weapon](#)). Work continues on ballistics trials for WE177.

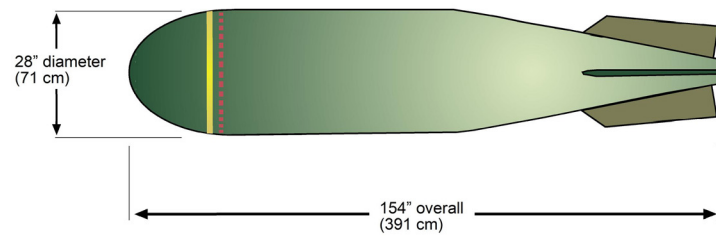
For references, please click [here](#)

A size comparison of the British nuclear weapons tested at Orford Ness

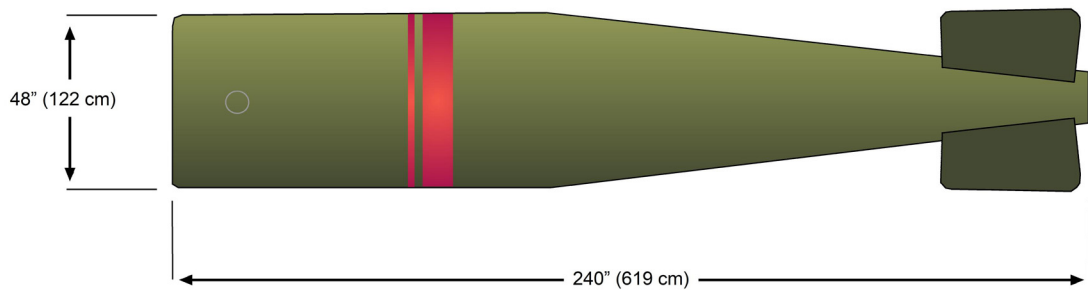
BLUE DANUBE



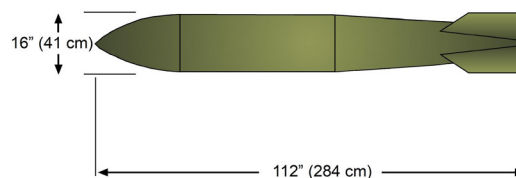
RED BEARD



YELLOW SUN



WE 177A



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For references, please click [here](#)

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