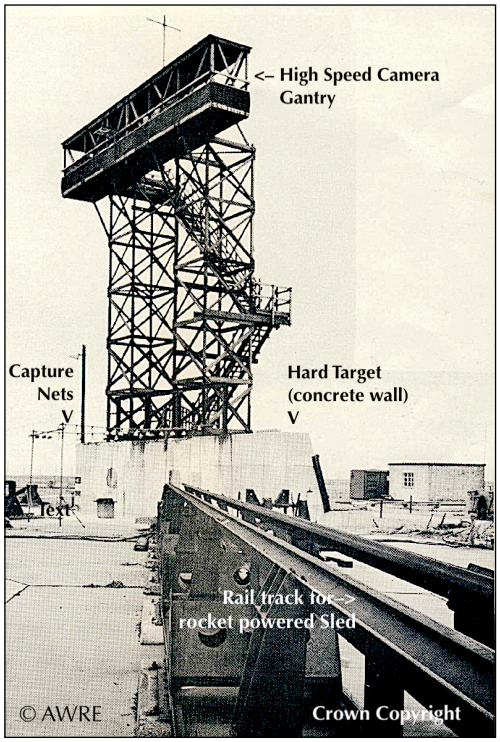
# The Impact Facility on Orford Ness

(David Warren, September 2021)

## Background

The Impact Facility, or the 'Hard Target', was a test structure built by AWRE Aldermaston on Orford Ness that became operational in 1964. It destructively tested the ability of the WE177 bomb - a series of low-level-release, free-fall, nuclear weapons - to achieve the planned delayed detonation subsequent to significant mechanical shocks that may have occurred during a 'Laydown' delivery.




The UK's early atomic bombs, Blue Danube (24ft long and weighing 10,000lb) and Red Beard (12ft long and 2,000lb), were large and cumbersome and required delivery by strategic bombers. They also had operational shortcomings. The shooting down of a high-altitude Lockheed U-2 spy-plane over the USSR in 1960 showed that altitude itself no longer provided adequate protection against improving defence missiles.

Military planners needed to design relevant replacements. With increased nuclear yields it became possible to produce smaller weapons that could be delivered from low-flying 'tactical' aircraft.

This strategy was achieved via 'laydown bombing'. This covered several variations, including what was essentially a free-fall, parachute-retarded landing followed by a pre-set time-delayed ground detonation. Several variations of this strategy are described more fully later in this full report.

## Laydown Bombing

This has been described as a "controlled crash landing" with a reduced impact due to a parachute-retarded landing, followed by a pre-set "ground-burst delayed detonation". This allowed the pilot and his aircraft to escape from the consequent nuclear radiation and shock waves.

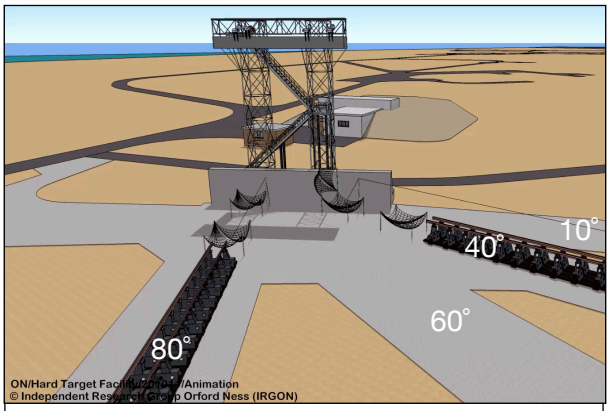
## **The Impact Facility** (or Hard Target)

The Impact Facility was built on Orford Ness in 1963, it operated between early 1964 and 1968, and consisted of three distinct structures. These were:

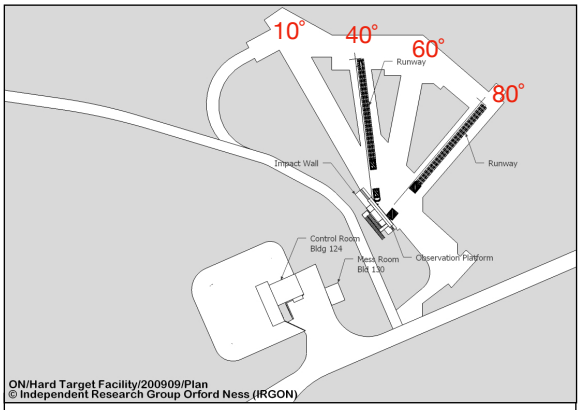
(a) the 'Hard Target' - a large concrete wall (50ft wide, 12ft thick and 10ft high), a concrete apron and four raised rocket sled tracks
(b) a wooden camera gantry located on top of the Hard Target
(c) a control room (shared with Lab 1).

**Link to the Impact Facility 'FlyBy' video**

To simulate the impact forces that a WE177 might experience during a 'laydown' delivery, when the weapon would strike the target with a low angle of attack, the weapon was fired into the Hard Target (the wall). This was to assess the adequacy of its structural strength and its ability of the inbuilt timers (fuses) to reliably detonate after a pre- determined




**CGI Illustration from View of Impact Facility**
Camera Gantry, Control Room & two of four tracks visible

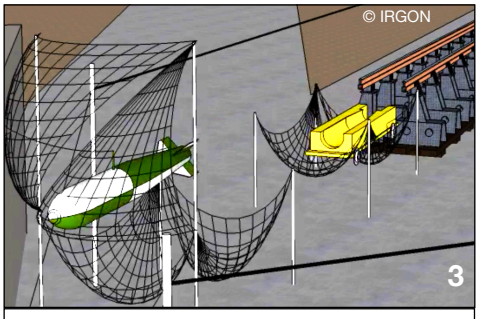



**Plan view of Impact Facility**
Showing four tracks at angles to Hard Target

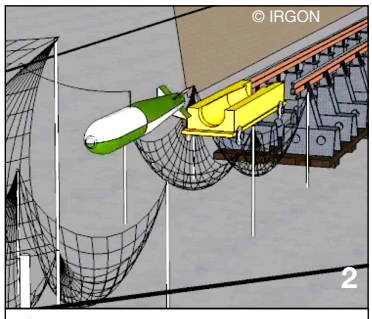
delay, following impact with the concrete wall. The fissile component (the 'physics package') was not present, but often the high-explosive components frequently were

The WE177 was mounted on a rocket-propelled wooden sled that accelerated along an elevated metal track and hit the wall at 150mph. Mechanical and fusing data from the impact - from sensors within the weapon - were transferred to external 50-channel digital recorders via a trailing umbilical cable.

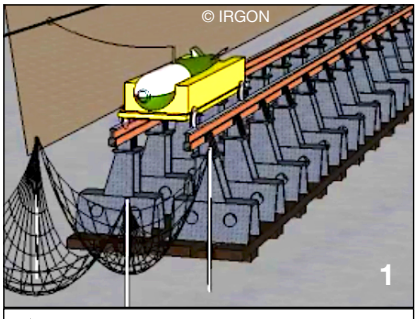
Before the end of the track the sled was slowed by an onboard retro-rocket but the WE177 continued into the wall, where it was captured by netting after the impact. The moments




WE177 impacts Wall. Sled in Net




WE177 & Sled Separate




WE177 & sled at track end

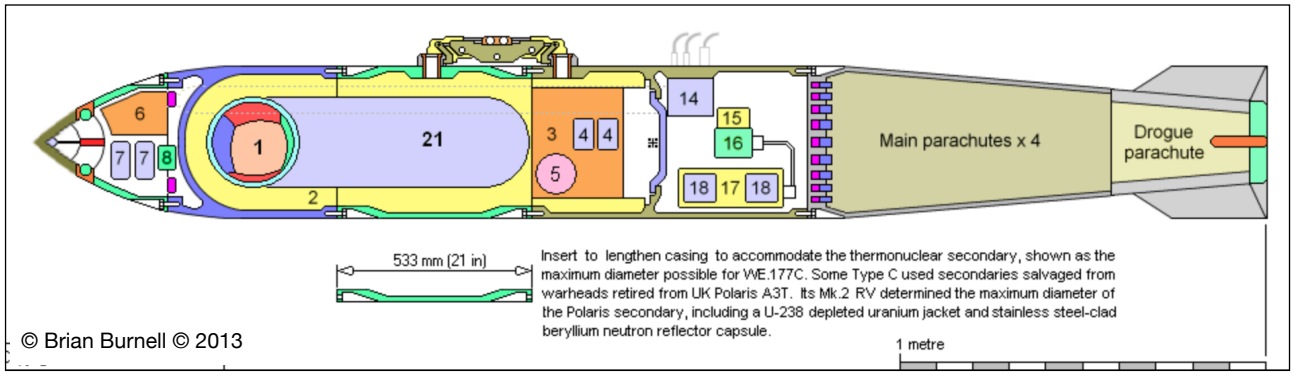
before impact of the weapon are summarised below, using 'stills' taken from an IRGON-created video.

**Link to a 'three camera views' video of the WE177 transit**

The impact was also recorded on **Vinten** high speed (300 or 3000 frames per second) film cameras mounted on a wooden gantry some 50ft above the impact point.

Impact trials took place at about one per week between 1964 and 1968. Five days were needed to prepare the weapon, the Impact Facility and instrumentation, recording equipment and the control room. Simultaneously the wall's concrete surface damaged by a previous impact had to be repaired back to a 'standardised' hardness before the next trial.

The nose, tail and rear-centre sections were designed to absorb much of the impact energy, with the equipment becoming redundant after touchdown. A 'warhead capsule' - protected by its shock-absorbing qualities - contained its own power supply and all equipment needed for it to achieve the delayed detonation. After the impact tests the damaged weapon and its recorded data, were sent elsewhere for analysis and to address any design issues.




***Cross Section of WE177 Variant B/C*** *(Key to components: item 7,Page 6)*

Some WE177 impact trials involved changing the temperature of the warhead's high explosive charge between +100˚C and -40˚C. In other trials these weapons were subjected to combined vibration and temperature stress testing, and these were carried out in one of two the two 'Pagoda' test labs located on the Ness.


**WE177 following Impact Test**
Two of four elevated tracks visible in background


**WE177 mounted on electro/mechanical vibrator**
within local thermal chamber

## Two people involved in WE177 trials on Orford

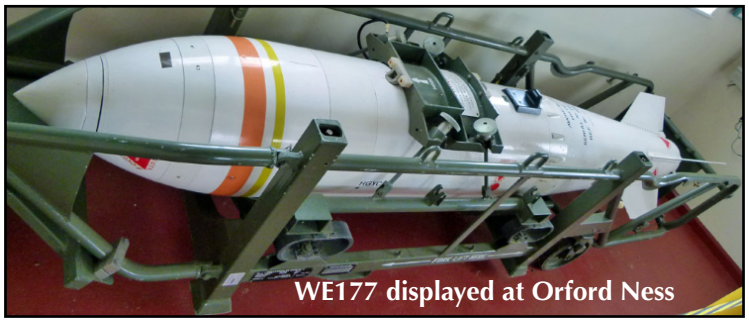
### *1. Frank Tanner*

One of those directly involved in these impact facility trials was Frank Tanner an RAE Scientific Officer and highly respected expert on bomb ballistics (the science of unguided weapons). Between 1948 and 1955 Frank worked on Orford Ness for RAE Farnborough, and had participated in many of the bomb ballistics flying trials that took place there.

But later (1966-68) he became involved in the many flight trials of the US-developed **'LABS'** (Low Altitude Bombing System) concept and observed many different aircraft types and designs during these 'laydown' trials on the Ness.

**2. Les Armer**

Another expert involved in the WE177 development and testing programme on the Ness was Les Armer. He was an AWRE technician employed to manage the impact trials to determine the ability of the weapon to continue to function after experiencing impacts during simulated 'laydown bombing' with a Hard Target.



WE177 displayed at Orford Ness

| Version A | Versions B & C |
|---|---|
| **Length:** 112in (2.84m) | **Length:** 133in (3.35m) |
| **Diameter:** 16in (0.41m) | **Diameter:** 16in (0.41m). |
| **Weight:** 600lb. (272kg) | **Weight:** 1010lb. (457kg) |
| **Yield:** 0.5kt or 10kt. | **Yield:** 200kt/450kt. |

**The WE177 series - a summary**

The WE177 was a family of UK parachute-retarded free-fall nuclear weapons that was developed to provide tactical low-level delivery capability - using UK strike aircraft. It was in use between 1966 and 1998, and was produced with three different variants for different targets and had a wide range of selectable nuclear yields.

Variants A and B were both high-yield 'strategic' weapons, but variant C was a low-yield 'tactical' weapon. A and B were in service with the RAF from 1966 and C, used as 'depth bombs' by the Royal Navy, was in service from 1971.

One mode of attack using a free-fall nuclear weapon, is to slow the weapon's speed of descent to the ground or sea target area, by using a ribbon parachute during the "laydown' bombing' delivery. Another is the 'ground-burst' option that involved a time-delay fuse that triggered the detonation some time after the weapon had landed.

Weapon delivery could be from a wide variety of aircraft including Britain's V-bombers (Valiant, Victor and Vulcan), tactical aircraft (such as the Canberra and Buccaneer) and helicopters (such as the Wessex and Lynx).

More Impact Facility and WE177 images and videos are available on this website via:

**https://www.irgon.org.uk/impact-facility-and-we177-weapon**

**Impact Facility**
The photograph below shows the condition of the Impact Facility in 2018: this is typical of the condition of most of the other Cold War structures on Orford Ness.


Other photographs are available via the '**Photographs**' button.
CGI images and videos are available via the '**Graphics'** button.

David Warren
September 2021

***Independent Research Group Orford Ness (IRGON) - an overview***
*Our primary objective is to raise the public's awareness of the significant contribution to the UK's defence of the weapons testing and trials that took place on Orford Ness.*

*We are a small team of independent and hobbyist researchers that share a common interest of gathering and promoting that military history of Orford Ness.*

*We plan to achieve this by:*
- *Researching the less well-known weapons trials that took place on the 'Ness'.*
- *Gathering information and real-life experiences from Orford Ness Veterans (those who worked on the Ness)*
- *Cooperating with those already aware of the UK's nuclear weapons' history*
- *Using CGI to create 'FlyBy' and 'Walkthrough' videos for those buildings and parts of the site that are not permitted to them so that they may experience a 'virtual' tour of Orford Ness.*
- *Use our website to present that information and to try to become a digital 'one-stop shop' for Orford Ness military information.*
- *Seeking to recruit more IRGON researchers, in both front-line research and support roles.*

**1a. Link to 'FlyBy' of the Impact Facility showing a 360˚ view.**
**1b. Link to three camera views of a WE177 in transit on rocket powered sled**

**2. Abbreviations**
**AWRE/AWE**: see below
**MOD:** Ministry of Defence
**RAE:** Royal Aircraft Establishment

**3. AWRE Aldermaston (Atomic Weapons Research Establishment)**
AWRE/AWE is the UK's Ministry of Defence research facility responsible for the design, manufacture and support of warheads for the UK's nuclear weapons.

AWE plc, assumed responsibility for the operation of all AWE sites on 1 April 2000. This was not full privatisation as the Ministry of Defence continued to own all the AWE sites as well as a golden share in AWE plc. In July 2021 AWE returned to full UK Government. ownership, operating under the Ministry of Defence.

**4. Bomb Ballistics**
Ballistics is the field of mechanics concerned with the launching, flight behaviour and impact effects of projectiles such as bullets, bombs, rockets or the like, so as to achieve a desired result.

**5. UK's Nuclear Weapon names**
Richard Moore has written an excellent paper listing and explaining the names applied to each of the UK's different nuclear weapons systems:
**"The Real Meaning of the Words: a Pedantic Glossary of British Nuclear Weapons"**

**http://nuclear-weapons.info/Working_Paper_No_1.pdf**

**6. WE177 History and explanation**
6.1 A 2019 paper written by Dr John Walker gives a very complete description of the WE177's evolution and use.
**"A History of the United Kingdom's WE177 Nuclear Weapons Programme"**

**https://basicint.org/wp-content/uploads/2019/08/A-History-of-the-UK-WE-177.pdf**

6.2 Brian Burnell is another expert who provides detailed WE177 information. This is included in Brian Burnell's "nuclear weapons" web site:

**http://www.nuclear-weapons.info/vw.htm#WE.177**

**7. The Key to Brian Burnell's illustration of the WE177 on page 3 is shown here.**

| | | |
|---|---|---|
| 1 Boosted fission warhead and thermonuclear primary | 8 Radar triggered airburst fuzes x 2 | 15 Gas-operated motor triggered velocity sensor extension x 2 |
| 2 Thermal insulation | 9 Jettisonable ceramic nose cone | 16 Velocity sensor unit x 2 |
| 3 Arming unit | 10 Nose cone ejector explosive charge | 17 Ground Control Unit (GCU) |
| 4 Arming unit thermal batteries x 2 | 11 Saltwater sensors x 4 | 18 Ground Control Unit thermal batteries x 2 |
| 5 Gas motor triggered clockwork timer | 12 Ground impact sensors x 4 | 19 Main parachute attachments and explosive cutter charges |
| 6 Radar aerials (altitude sensors) x 2 | 13 Hydrostatic fuzes for use in depth bomb mode x 4 | 20 Drogue parachute ejection gun and explosive charges x 2 |
| 7 Radar thermal batteries x 2 | 14 Snatch plugs terminal box | 21 Fusion fuel compartment for thermonuclear secondary device |