



The Model Ballistics Firing Range ('Model Range') on Orford Ness

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January 2022

1. Background

The 'Model Ballistics Firing Range' was designed, built and operated by the **Royal Aircraft Establishment** (RAE) as part of a long-lasting programme to improve the aerodynamics of various projectiles (e.g. missiles, rockets and bullets) having different profiles. Design improvements were made after determining the best profile for each projectile. The 'Model Range' was built in 1955, although the use of spark photography on **Orford Ness** had evolved since 1946.

Reduced scale models of the various projectiles were propelled through the Model Range and their horizontal flight path recorded as they passed in front of a series of high-speed cameras and triggered an electrical discharge to illuminate the model as it did so. The shadows created by the model appeared on a 'shadow graph' mounted on the opposite wall. This is called 'Spark Photography*.

2. The structures in Model Ballistics Firing Range (Model Range)

This consisted of three separate structures. One was of a sheet-metal covered, semi-circular roofed structure ('**Nissen**' hut') 164ft (50m) long and 16ft (4.9m) wide. Contained within its totally darkened interior were a settling-chamber, a firing-chamber and a stop-butt.**



Fig 2. Internal view showing semi-circular profile was normally covered in steel sheeting. (as of 2021)
Entry port for sabot/scale-model combination is visible in wall.
External control room is just visible through doorway.

External to this were two other structures, (a) a 17-pounder smoothbore gun (the "17-pdr"), mounted on a concrete plinth 5m away, and (b) its Control Room, some 30m further away.

'Spark Photography' stations were located every 5ft (1.5m) along the length of the darkened firing-chamber and to ensure camera stability, were built on 40ft (12.2m) deep foundations.

The experiments (that were repeatable in such a controlled environment) were used to record the flight characteristics of rockets and bombs for AWRE Aldermaston's research. (AWRE was reorganised and renamed as **AWE** in 1987).

The information so obtained allowed scientists (called "boffins" many years before) to recommend the best profiles of full-sized weapons such as **Yellow Sun**.



Fig 2: View of 'Stop Butt' end of Model Range, 2021

* **Spark Photography**: photography in which an electric spark discharge provides the only illumination and which is used especially for catering the inflight profiles of high speed objects.

** **Stop-Butt**: an earth or concrete wall constructed to trap and collect projectiles at the end of its flight.

*** **Sabot**: a device attached either to the projectile or inside the barrel that falls away to ensure the correct positioning of a bullet or shell in the barrel of a gun.

3. History of Spark Photography on Orford Ness

RAE's initial Orford Ness-based research into the use of 'Spark Photography' to determine the most effective profile of various projectiles first took place in the 'Plate Store' in 1946.



Fig 3: View of the '17-pdr' plinth and gun port location

This building had previously had been used in the '**Lethality and Vulnerability Trials**' that took place on the Ness between 1938-1959. Modifications to the Plate Store included the construction of a stop-butt - a structure designed to stop and safely collect scale-models that were still travelling at high-speed).

During their use in wide ranging weapons trials many buildings on Orford Ness were 're-purposed'. This is illustrated by a change of purpose in 1959, for the Plate Store (later called Building 84).

This was used as an AWRE technical lab for testing of the theory of using 'Over The Horizon Radar' (OTHR) to detect atmospheric nuclear detonations.



Fig 4: 2021 View of camera supports from '17-pdr' end.

Following the earlier 'Plate Store' trials, where a single shotgun had been used to propel the model, further trials were held in Hut 9, that had previously been the WAAF's quarters when they arrived on the Ness in 1943.

Construction of the dedicated 'Model Range', located near the southern airfields, started in early 1955 and trials continued for about two years.

In 1959, the Ministry of Supply stopped bomb ballistics trials on the Ness and left. Later, after all the expensive and complex recording equipment in the Model range had been removed, it became an indoor shooting range for Orford Ness staff.

4. Operation of the Model Range

Spark Photography was used to record the horizontal flight of the scaled model after separating from its sabot.*** (see page 2). This involved using a series of camera stations, each comprising a high-speed camera and a linked optical sensor and electric spark generator. Each camera station was activated as the model flew past the front of it, when the sensor initiated a burst of light - created by a discharge of stored electrical energy - that was used when a photograph was taken.

Each scaled-down model was placed in a sabot and the temporary combination was fired from the 17-pdr gun. Soon after leaving the gun's barrel, the sabot itself dropped into a settling-chamber and the model, roughly 3.5 inches (9cm) in diameter and 7 inches (18cm) in length, continued its high-speed flight through the firing-chamber until it was safely collected by the stop-butt at the far end.

The high-speed cameras - built on 40ft (12.2m) piles to provide optical stability - photographed the 'yaw' and 'pitch' of the model along its path, with its shadow effectively 'projected' onto a backdrop of graph paper to give an accurate record of its vertical positioning. The speed at which the model travelled through passed across the cameras was determined by the amount of explosive used in the 17-pdr.

(An Orford Ness veteran is quoted as saying that in an attempt to obtain a higher speed, too much explosive was used and damaged the gun's breech: however no written evidence has yet been found).

Tests with a variety of bombs and missiles took place over a period of two years involving AWRE's current nuclear weapons that included the Royal Navy's **Sea Slug**, and its air-dropped **Yellow Sun** (which, to reduce its forward speed, was designed with a blunt nose!). Also included was **Blue Streak** the UK's proposed ballistic missile.

The nose cone of Blue Streak (the UK's only Intermediate-Range Ballistic Missile) was also tested on the Ness in the early 1960s using a purpose-built, totally wooden, gantry to determine the best locations for telemetry aerials within its nose cone. See **Blue Streak on Orford Ness** for more detail.

More information about some of the wide ranging series of military test projects that occurred on Orford Ness, and currently being researched by IRGON, can be found in the project list under **IRGON Research**.

5. Additional Information

5.1 The Model Range's remains can be found at:

- Long/Lat: 52.083742 N, 1.550964 E
- What3Words: <https://w3w.co/research.fear.dusters>

5.2 English Heritage Report

Information about the 'Model Range' and many other Orford Ness military structures - and their purposes - can be found in a comprehensive 2009 English Heritage report:

5.3 Floor Plan of the Plate Store (B84) - with likely stop-butt

During an IRGON survey of the Plate Store (B84) in 2019 unusually shaped brick walls - and a void behind them - were found. The reasons for this were initially a mystery.

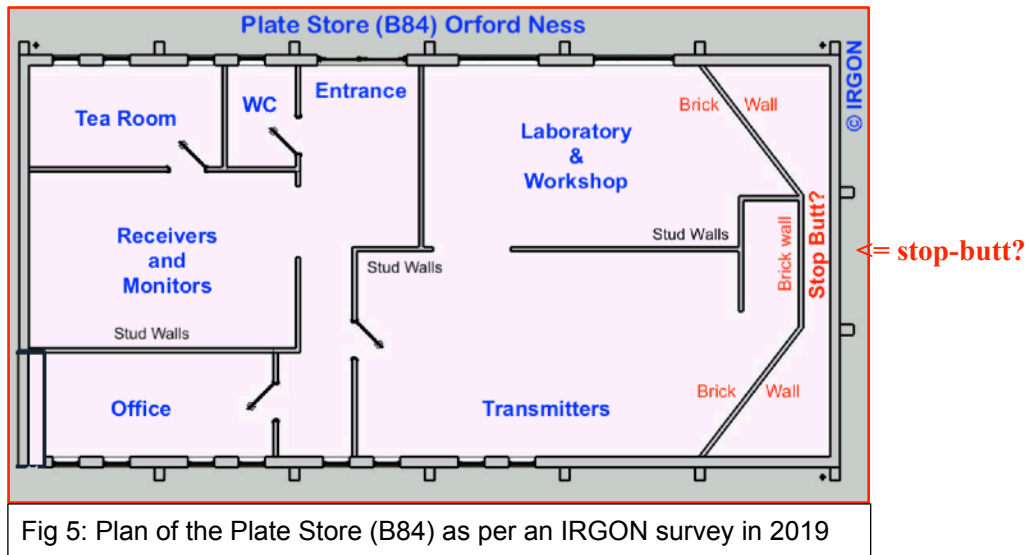


Fig 5: Plan of the Plate Store (B84) as per an IRGON survey in 2019

The brick wall and the other walls (of plasterboard and stud construction) recorded in the IRGON survey, shown in the graphic above, were known to have been present from 1959 when an AWRE team working on the possible use of Over The Horizon Radar (OTHR) to detect atmospheric nuclear tests, operated from the Plate store.

(On 13th February 1960, the team succeeded in detecting the first, and maybe the second (of a series of four) French atmospheric A-bomb tests carried out in Reggane, French Algeria, more than 2800km away. See [French Nuclear Tests - Sahara](#).

This Model Range research appears to confirm that this brick wall was in fact a 'stop-butt', built for the Spark Photography testing located in the Plate Store (but this is yet to be confirmed).

5.4 The Plate Store (B84) is located at:

- Long/Lat: 52.083742 N, 1.550964 E
- What3Words: <https://w3w.co/shine.plenty.sprinter>

5.5 Most Secret - The Hidden History of Orford Ness, Paddy Heazell, Page 156

An extremely detailed record of the many Orford Ness trials, spanning nearly 60 years by a sadly deceased Orford Ness Volunteer.

For more information about IRGON and its research plans please visit:

www.irgon.org.uk

