Extracts from....
THE VMARS NEWS SHEET
A publication of the Vintage and Military Amateur Radio Society
The VMARS News Sheet Issue 146 May 2015

***"The Bomber will always get through"* –** Stanley Baldwin in his 1932 Parliamentary speech *"A fear for the future"*

2015 marks the 80th anniversary of Robert Watson-Watt's now famous "Daventry Experiment" which took place in a muddy field on a cold February day in 1935.

Baldwin's 1932 speech containing the words *"The Bomber will always get through"* caused grave disquiet in Parliament and created a stir with the public. The view that the bomber will always get through had been largely propagated in Britain by the science fiction novelist HG Wells, whose doom laden books and films predicted the subjugation of entire populations by men in aeroplanes. The military view was mixed, but Air Vice Marshall Hugh Dowding, who was the Air Officer Commanding *Air Defence of Great Britain* – which in 1936 became *RAF Fighter Command*– was a firm advocate of the theory that with appropriate defensive preparations and equipment, bombers could be stopped in sufficient numbers to minimise their effectiveness.

In 1934 the Royal Air Force undertook a major air defence exercise which simulated a full scale bomber attack on London utilising all the air defences and countermeasures available at that time. At the conclusion of the exercise it was found that half of all attacking aircraft had got through to their targets unopposed and that all targets had been destroyed. The results of the air exercise were kept secret but, shocked by the apparent lack of defence against air attack, the governing body of the Air Ministry, the Air Council, formed the Committee for the Scientific Survey of Air Defence (CSSAD) under the chairmanship of Imperial College Rector Sir Henry Tizard, with the purpose of seeking new technologies to assist in countering the bomber threat. Extraordinary though it may appear today, the CSSAD gave credibility to intelligence reports that German scientists were developing a "death ray". During the 1920's and 1930's the "death ray" had become a weapon of choice for writers of popular science fiction and in the minds of many people such a weapon had assumed a very real possibility, creating opportunities for mischief making by the German Reich's newly formed Ministry of Propaganda led by Joseph Goebbels. Not wishing to take any chances, the CSSAD offered a prize of £1,000 to anyone who could make a practical demonstration of killing a sheep with a "death ray" at 100 yards, while at the same time they commissioned Scotsman Robert Watson-Watt, a leading scientific expert in radio direction finding, to undertake a hasty feasibility study.

Sir Robert Alexander Watson-Watt, KCB, FRS, FRAeS – National Library of Scotland
Photograph reproduced under the NLS Creative Commons licence

At the time, Watson-Watt had been head of the Radio Research Station in Slough, and was undertaking research for the Meterological Office on the detection of clouds and weather systems using wireless waves. He asked a colleague, Arnold Wilkins, to *"calculate the amount of RF power which should be radiated to raise the temperature of eight pints of water from 98°F to 105°F at a distance of 3 miles and a height of 3,000ft"* The actual figures that Wilkins calculated were in the region of multiples of Gigawatts and he quickly established that the whole idea of creating a "death ray" using wireless waves was completely impractical with the available technology. Even if it had been possible on a small scale, it would have created more risks to any

unfortunate operators of the equipment than it would to the enemy. In his report to Watson-Watt, Wilkins added that using the "rays" for the detection of aircraft might be a more productive avenue of research.

Arnold Frederick Wilkins - 1941 National Portrait Gallery
Photograph reproduced under the NPG Creative Commons licence

Watson-Watt agreed with the results of Wilkins calculations and delivered two Response Memoranda to the CSSAD, one stating that the power levels required to meet their requirements were beyond the capabilities of current technology and the other suggesting that research for using wireless waves for the detection of aircraft should be undertaken with a grant under the cover of research into the ionosphere using ionosondes, which would lead casual observers to assume that Watson-Watt was continuing his earlier work at the Radio Research Station.

An initial grant of £2,000 was made, enabling Watson-Watt to assemble a small team, which included Arnold Wilkins, to undertake experiments and trials in order to prove the aircraft detection concept. Air Marshal Sir Hugh Dowding, now a member of the Air Council, had sufficient faith in Watson-Watt's project to lend his support to grant a further £10,000 which accelerated research and brought the team to the muddy field near the Northamptonshire hamlet of Litchborough, about 1 mile south of the village of Weedon, to undertake the "Daventry Experiment" on Tuesday 26th February 1935.

The BBC 1930's Daventry Empire Short Wave Station control room - *Photograph BBC Library*

The object of the experiment was to demonstrate the practicality of aircraft detection using wireless waves and this was to be achieved by utilising scheduled transmissions made on 49.8m from the BBC Empire short wave broadcast station at Daventry. A large aircraft was desirable for the experiment and Dowding arranged for a Heyford heavy bomber to be made available to fly at pre-determined altitudes through the 5 mile (8Km) gap between the BBC transmitter at Borough Hill and the Litchborough field. The choice of the Handley Page Heyford aircraft was no accident. It was a large metal biplane with a wingspan that corresponded roughly to half wave of the Daventry signal and would make a very large reflective target for Watson-Watt's experiment. In the field, Wilkins's team had erected two horizontal half wave aerials positioned 100 feet apart and connected to two receivers which were fed into a cathode ray oscillograph (oscilloscope). To cancel the ground wave signal a phase shifter was used in one of the receive channels so that only the sky wave component reflected from the aircraft would deflect the oscillograph trace. The ground equipment was installed into an ambulance acquired cheaply by the team and driven to the site. Present at the "Daventry Experiment" were Watson-Watt and Wilkins who were joined by AP Rowe from the CSSAD, who eventually became the head of radar research at Malvern. As RAF Flight Lieutenant R. S. Blucke navigated his Heyford aircraft along the pre-determined flight path, the watching scientists crammed into the converted ambulance observed a large blip as it appeared on the screen of the oscillograph at a range of 5 miles and moved along the trace as the aircraft passed through the test area. Further observations were made as the Heyford was flown backwards and forwards through the test area. The "Daventry Experiment" had been a complete success and proved that using wireless waves to

detect aircraft was a reality. Watson-Watt's Memorandum *'Detection and Location of Aircraft by Radio Methods'* which he must have surely written in anticipation of the success of the experiment before it took place, but to which he was now able to add the detailed consolidated data from the practical trials, was presented to the CSSAD at the Air Ministry the following day, 27th February 1935, and created the foundation stone of British Radar development

Following the "Daventry Experiment", further advanced research and development was quickly established on a dilapidated site at Orford Ness, an inaccessible, inhospitable and isolated Suffolk peninsula that had long been used for conducting secretive military equipment and ordnance trials. Another scientist who was later to become a major force in airborne radar development was Edward "Taffy" Bowen, then a Scientific Officer working under Watson-Watt at the Radio Research Station in Slough, and he was recruited to the development team at Orford Ness. Two 80ft (25m) high half wave aerials were set up, one for transmit and the other for receive, for tests on wavelengths between 17m and 6m. Watson-Watt had found that short pulses of radiated energy provided improved ranges of detection and utilised the National Grid frequency to trigger a 25μS pulse transmitting at peak transmitted power of up to 20Kw, enabling aircraft to be detected at 17 miles (27Km) just 4 months after the "Daventry Experiment". Further research and development work by Taffy Bowen produced peak power levels of 100Kw and by 1936 the range of detection had extended to 100 miles (160Km), enough for the Government of Prime Minister Stanley Baldwin to approve expenditure for the rapid implementation of an air defence system for the United Kingdom.

.

Watson-Watts' research and development team were well aware that shorter wavelengths would provide more accurate and reliable results, less vulnerable to variations caused by propagation and weather, but having successfully established the principals of aircraft detection at lower frequencies Watson-Watt was tasked by the Air Ministry with developing an air defence capability in the shortest possible time, using technology that was readily available and which did not require lengthy development times. Development had focussed on the use of frequencies between 22Mc/s and 55Mc/s with the resultant Chain Home system established in the 12 metre band. By 1937 five Chain Home stations had been set up, at Bawdsey Manor, Great Bromley near Colchester, Canewdon near Burnham on Crouch, Dunkirk in Kent and Dover, which constituted the preliminary air defence system for London. As soon as they were established the RAF undertook a series of air exercises, continuing into 1938 and 1939 to calibrate the new stations and to test their effectiveness with the recently innovated ground based command and control systems, which included the newly introduced filter rooms and plotting tables that were to become so familiar during the war. In all, 20 Chain Home stations were established along the coasts of Great Britain, with the completed chain becoming fully operational on Good Friday in 1939, after which a 24 hour, seven days a week defensive watch was kept on our skies.

While in service, the system was developed further. The first Chain Home stations (AMES Type 1 – Air Ministry Experimental Station) operated on four frequencies between 20Mc/s and 55Mc/s but were quickly modified to use frequencies between 20Mc/s and 30Mc/s. Using 20μS pulses at a repetition frequency of 25 and 12.5 cycles per second locked to the National Grid, the early transmitters radiated 350Kw peak power which was increased, first to 750Kw and ultimately to 1Megawatt from horizontally polarised aerials, providing a detection range of up to 200 miles (320Km).

WAAF Chain Home RDF operator – Official British Government Photograph. Crown copyright expired.

Several nations were simultaneously working on the development of radar in the 1930's but Watson-Watt's unique contribution was the creation of a viable and effective aircraft detection system which was harnessed to a superb defensive Command and Control system set up by the RAF under Air Marshall Sir Hugh Dowdings' patronage. Without the contribution of Arnold Wilkins and Robert Watson-Watt there would have been no Chain Home aircraft detection network to warn of approaching attacking aircraft and the Battle of Britain would probably have had a different outcome. In one of those neat quirks of historical coincidence, on the very same day that

the “Daventry Experiment” took place Hitler, in defiance of the Versailles Treaty, secretly signed a decree authorising the full establishment of the Luftwaffe and appointed Great War Deutsche Luftstreitkräfte air ace Hermann Goering as its Commander in Chief. It’s interesting to compare the two events, both of which would prove to have significant impacts on the war, with all the pomp and arrogance of an aggressive industrial and military leviathan ultimately defeated by the actions of a few men experimenting in a cold and wet Northamptonshire field with some basic equipment inside a dilapidated converted ambulance.

Pity Sir Robert Watson-Watt,
strange target of this radar plot
And thus, with others I can mention,
the victim of his own invention.
His magical all-seeing eye
enabled cloud-bound planes to fly
but now by some ironic twist
it spots the speeding motorist
and bites, no doubt with legal wit,
the hand that once created it

Sir Robert Watson-Watt on the occasion of his prosecution for exceeding a speed limit in his car, having been trapped by a policeman wielding a hand held radar gun.

Sources

PRECURSORS TO RADAR — THE WATSON-WATT MEMORANDUM
AND THE DAVENTRY EXPERIMENT
B. A. AUST IN
Department of Electrical Engineering and Electronics, University of Liverpool,

CHAIN HOME & THE DAVENTRY EXPERIMENT

Presentation by Andy Tyler made on 75th anniversary, 26th February 2010