Extracts from....
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British Post War Air Defence Radar

At 07:00 On 29th August 1949, the Steppes of northeast Kazakhstan were shaken by a huge explosion as the USSR detonated a nuclear test bomb as the culmination of *Operation First Lightning*, the first of the 456 Soviet nuclear tests destined to take place in that region over the following 40 years. Since July 1945, when the first nuclear bomb test was carried out in New Mexico, the USA had been the only country to possess a nuclear capability and the news that the USSR was now similarly equipped, stunned America. Relations between the USSR and Western governments had deteriorated rapidly following the end of the war with Germany and in a humiliating defeat of Joseph Stalin's attempts to isolate Berlin from the western Allied nations of Britain, USA and France, the Russian blockade of Berlin had only recently been lifted, in May 1949, defeated by the determined efforts of Britain and America to provide the beleaguered Berlin population with an unprecedented operation to supply the needs of the city by air. American concerns were highlighted further by their knowledge that the Soviets had the capability to make air strikes from USSR territory on US cities using nuclear armed Tupolev TU-4 long range bombers. The TU-4, code named Bull by NATO, was an identical copy of the US built B-29 Superfortress which the US Government had refused to supply to Moscow on Lend-Lease during the war. Three USAAF B-29's had made forced landings in Soviet Vladivostok while undertaking operations over Japan and despite repeated demands by the US Government for their return, the USSR refused to send them back. The B-29's were stripped and copied to the very last detail and reverse engineered to become the Tupolev TU-4 Soviet long range, high altitude strategic bomber. Eight Hundred and Forty Seven TU-4's were built and it was a TU-4 that dropped the first Soviet RDS-1 nuclear test bomb in Kazakhstan on that day in August 1949, echoing the first nuclear bomb strike on Hiroshima undertaken by USAAF B-29 Superfortress "Enola Gay" four years earlier.

The RAF Air Council viewed all of these developments with growing alarm and in the face of little enthusiasm from a government more concerned with re-building a shattered and bankrupted nation, they took the decision to upgrade the now obsolete Chain Home air defence radar network, which had been largely cobbled together, developed, modified and added to as the demands of war dictated, but which still formed the bedrock of British air defence capability in 1949. A report was commissioned, in which it identified weaknesses in detecting aircraft at high altitude, geographical areas that were inadequately covered, poor IFF systems, an outdated communications and reporting network and obsolete equipment with poor reliability, leaving Britain vulnerable to a Soviet nuclear attack. Even so, the possibility of high altitude Soviet TU-4s carrying 20 megaton nuclear bombs reaching British shores undetected was insufficient to motivate the government Treasury department to loosen their purse strings sufficiently for anything more urgent than a 10 year programme of renewal. This changed when the increasing possibility of hostilities breaking out with the USSR in Europe led the USAF to locate nuclear capable B-29 Superfortresses of the Strategic Air Command 2nd Bombardment Group at RAF Lakenheath in Suffolk. American air force commanders were scathing of Britain's outdated air defence radar network and asked Washington to put pressure on the British Government to instigate a more immediate upgrade plan, which came into being under the codename of ROTOR.

Since the beginning of the war in 1939, the Chain Home network had mushroomed to occupy 170 sites located throughout Britain. ROTOR, an intermediate solution to rationalise and improve Chain Home, was to utilise the more advanced existing equipment, which would be rebuilt to more exacting peacetime industrial standards to improve reliability and performance. The Marconi Wireless & Telegraph Company was awarded the contract to rationalise the entire air defence radar system down to 66 sites, with working ranges, serviceability and reliability of the re-manufactured equipments greatly improved. The Marconi contract included updating the infrastructure of the communications and reporting network and the development of a new centimetric early warning radar given the code name of "Green Garlic", which was subcontracted for development by Decca Radar. Green Garlic was intended to eventually replace the existing one megawatt Chain Home stations, now used to provide early warnings of approaching aircraft from up to 200

miles away, and the Type 7 Ground Controlled Interception radars, which provided a 360 degree 90 mile range display onto a plan position indicator for the operator, along with the Type 14 Chain Home Extra Low (CHEL) surveillance and Type 13 height finder radars. Work on ROTOR ONE began in 1950 with the reactivation of 28 WWII Chain Home Radar stations and the construction of 14 new Chain Early Warning and Chain Home Extra Low underground operations rooms with the newly re-engineered WWII designed equipment. This phase of ROTOR was completed by the summer of 1954 at a total cost of £55.1 million, an unprecedented expenditure on a single British defence contract at the time. Two further phases, ROTOR TWO and ROTOR THREE, which mostly involved the building of suitably protected operations rooms and improved radar coverage along the West Coast for the defence of Glasgow, Liverpool and Bristol, were scheduled for completion under the "1958 Plan" which included the planned deployment of "Green Garlic".

The arrival of the long awaited "Green Garlic" radar in 1953, by now designated as the AMES Type 80 radar, changed everything. The Type 80 developed by Decca operated in the "S Band" at 2.35GHz and 3.050GHz . Using research data from the Radar Research Establishment and from its predecessor TRE, Decca developed the "Green Garlic" Type 80 to operate a one megawatt magnetron, (two megawatts in later versions), with an aerial array radar reflector measuring 75ft wide (22.9m) x 25ft high (7.6m) which provided an acceptance angle of 0.33 degrees, enabling operators to distinguish two targets a mile apart (1.6Km) at a range of 150 miles (241Km). Transmitted pulses were selectable at 2 to 5 microseconds duration at a Pulse Repetition Rate (PRF) of 270 per second. The massive aerial was rotated through 360 degrees by up to four 50hp motors which were automatically selected as wind resistance varied. The Type 80 radar had a reliable range of 250 miles (402Km) and the console operators were provided with a large 360 degree plan position indicator screen and a much improved Identification Friend or Foe (IFF) interrogation and marker facility. Alongside the Type 80's, American General Electric AN/FPS-6 Height Finder radars were installed. These were 4.5 Megawatt radars operating in the 2.7GHz to 2.9GHz frequency range and sweeping a 360 degree azimuth while "nodding" vertically between -2 degees and +32 degrees to provide target information at 200 miles up to an altitude of 75,000 feet.

Under the ROTOR programme, the ground control for RAF Fighter Command was to be re-organised into six Sector Operational Commands (SOC) in the following locations:-

Barnton Quarry near Edinburgh, R4 SOC Caledonian
Bawburgh, near Norwich, R4 SOC Eastern
Box, at Corsham in Wiltshire, SOC Southern
Kelvdon Hatch, near Brentwood in Essex, R4 SOC Metropolitan
Shipton, near York, R4 SOC Northern.
Longley Lane, near Preston, Lancashire, SOC Western.

The designation R4 indicates the type of defensive bunkers built to house the ROTOR SOC's. Those built to R4 standard, of which there were eventually only four, not the six originally planned, were on three levels and had 10ft (3m) thick concrete floors, walls and ceilings, their own independent water supply from a bore hole, generators and specially filtered air conditioning systems. R3 bunkers had a similar specification, but on only two levels and both R4 and R3 bunkers were designed to protect the operations rooms from a close proximity 20 Megaton nuclear strike. Under the ROTOR programme the SOC's were linked to the 60 radar sites situated around the country but the arrival of the Type 80 radar quickly made the original ROTOR plan obsolete because it provided both much longer range at high to low altitude coverage and improved accuracy from a single installation, replacing the Chain Early Warning and Ground Control Intercept radars. Some reorganisation was made to ROTOR when it was found that the number of operations rooms required was significantly reduced, thereby simplifying the communications and reporting network. This became part of the "1958 Plan" which now called for a total of nine sectors, comprehensively equipped as Master Radar Stations with Type 80 and Height Finding radars, but with many fewer reporting outstations, all connected by an advanced data handling system. Many of the bunkers constructed for the ROTOR network were never fully commissioned or were shut down after only a short period in operation and handed over to local authorities for Civil Defence use.

Linesman/Mediator: 1960's & 70's Air Defence Radar – RAF Neatishead

By the early 1960's a new air defence radar plan had been developed under the planning name of "Ahead" and involved the Royal Air Force working with the Royal Radar Establishment, (soon to change its name to The Royal Signals & Radar Establishment), The Ministry of Transport & Civil Aviation (1953-1959) and UK defence

contractors in a joint enterprise to form "Linesman/Mediator". In 1962 the civil aviation aspects of the project were taken over by the newly formed National Air Traffic Control Services (NATCS) with a group of British defence contractors which included Plessey, Ferranti, Cossor, Marconi, AEI and Elliot Automation, among many other great British company names. Originally, Linesman/Mediator was intended to provide complete UK Air Defence Zone radar coverage for early warning and GCI, while utilising part of the same integrated system for full UK civil aviation radar and ground control coverage. It was expected that in the event of a major war, the civilian Air Traffic Control Officers could be promptly transferred, along with their equipment to Air Defence duties, but in order to delineate the two activities, the RAF Air Defence part was known as Linesman and the Civilian part as Mediator. The project was subjected to continual changes caused by political interference, budget cuts and alterations in defence strategy and tactics, the latter caused by developments in technology which enabled the use of ICBM's as well as aircraft to deliver nuclear weapons. The eventual network, which bore only a faint resemblance to that of the original plan, was controlled by a single Primary Station known as Linesman One (L1), located at West Drayton, near Heathrow Airport and adjacent to the civil ATC functions. Into L1 was computer fed data received from four locations, at RAF Neatishead in Norfolk, RAF Staxton Wold in Yorkshire, RAF Boulmer in Northumberland and RAF Bishops Court in Northern Ireland covering the northern sector and from six southern civilian radars located at Ash, Ventnor, Clee Hill, Burington, London 1 and London 2. Other inputs were added later, from RAF Saxa Vord, RAF Benbecula, RAF Buchan and RAF Portreath in Cornwall, which supplied data from patrolling AEW Shackleton aircraft. All stations were linked by secure microwave or telephone communications, but budget constraints meant that the later additions to the L1 reporting network had no computer feed linking them and had to report information manually by voice and teleprinter as they had done during the Battle of Britain. Each station was capable of operating independently and in conjunction with other stations, but it was assumed that L1 would be destroyed in any first nuclear strike. The combined inputs provided a 1,900 mile x 1,900 mile block of radar coverage onto a single display and fed to huge "Dr Strangelove" screens in the Operations Rooms at RAF High Wycombe, RAF Bentley Priory and HMS Northwood as the General Situation Display (GSD). There were also data feeds from NATO and French radar into L1 to extend the coverage where necessary, and a link with the Defence Early Warning "DEW Line" at Fylingdales. The radar network was planned to have its full operational capability up to "first strike", after which coverage would be provided by all remaining stations.

As one of the six radar stations feeding data to L1, RAF Neatishead was a Master Radar Station equipped first with a Marconi AMES Type 84 Surveillance Radar operating in the "L" Band at 1.2GHz with a radiated power of 2.5 Megawatts and with a General Electric AN/FBS-6 Radar for height finding radar nearby. The Type 84 radar failed to meet its original promise because of technical problems with the planned 6 Megawatt magnetron, resulting in very poor performance against the original design specification. It made an impact with locals though, albeit it an unpopular one, by causing TV pixilating type interference at every 15 second sweep of the scanner, accompanied by the characteristic "zip" of audio interference from radar. A new radar, the ATI built AMES Type 85, known as Blue Yeoman, was installed, operating in the "S" Band with a 500MHz bandwidth covering 2.75GHz – 3.25GHz using twelve water cooled 4.5 Megawatt transmitters. Designed to defeat Electronic Counter Measures, each transmitter had frequency agility, changing its frequency on each transmitted pulse. As an additional ECM protection, this design also gave the Type 85 the capability of transmitting composite pulsed beams made up of several frequencies up to 300MHz apart with each of the individual pulses changing frequency on transmission, either randomly or controlled actively in response to ECM jamming. The twelve transmitter pulses were 0.5 degree beam width, overlapping, and 1 degree vertical beam height.. This arrangement gave considerable protection against Soviet ECM activity at the time. Operated in conjunction with the Type 85, the Decca HF200 Height Finder radar was installed to replace the ageing AN/FBS-6. HF200 and provided improved target discrimination over distances in excess of 200 miles and at high altitude. In the Operations Room was a Comcen containing Creed 7B teleprinters linked to the outside world by GPO telephone lines and microwave links

Neatishead operated in its new role for three years until 16th February 1966, when Leading Aircraftman John Cheeseman deliberately started a fire in the Technical Stores area of the R3 Operations bunker – "The Hole" – which quickly got out of control. The RAF station fire crew were unable to bring the blaze under control and local

fire services were called in to assist. Three of the local fire fighters died in the fire and all the operations equipment installed in the R3 bunker was destroyed and the bunker severely damaged. LAC Cheeseman received a seven year custodial sentence but questions were raised with the Under-Secretary of State for Defence for the Royal Air Force (Mr. Merlyn Rees), in the House of Commons as to why Cheeseman had been allowed into the secure area without any security clearance. Immediately following the fire the Neatishead Master Radar Station operations were transferred to RAF Bawdsey in Suffolk which took feeds from the undamaged radar installations at Neatishead.

Today RAF Neatishead remains an important integrated Remote Radar Head (RRH), one of five which feed radar, communications and data to the UK Air Surveillance and Control System (UK ASACS) which in turn is linked to other NATO networks. The other four feeds are at RRH Portreath in Cornwall, RRH Buchan in Aberdeenshire, RRH Staxton Wold, in Yorkshire and RRH Brizlee Wood in Northumberland and they are each linked to Control and Reporting Centres (CRC) at RAF Scampton in Lincolnshire and RAF ASACS HQ at RAF Boulmer in Northumberland. There are also links with Royal Air Force Sentry AEW aircraft and Royal Navy ships which can adopt the roles of mobile CRC's when required. ASACS is also linked to the Ballistic Missile Early Warning System (BMEWS) at RAF Fylingdales which provides high level radar coverage 3,000 miles into Eastern Europe. Immediately next door to RAF Neatishead is the impressive RAF Air Defence Radar Museum and it is hoped that as many of you as possible will be able to attend the VMARS AGM being held there on July 18th and see for yourself the fascinating Cold War air defence systems that were in place.

For a preview of the RAF Air Defence Radar Museum at Neatishead follow this link http://www.radarmuseum.co.uk/

Scources:

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Below: The Cold War air defence radar operations room at Neatishead in Norfolk

A regular Cold War event in the 1960’s. A Soviet Tupolev TU-95 “Bear” reconnaissance aircraft bristling with Electronics Intelligence gathering equipment is intercepted by a Royal Air Force English Electric Lightning F6 of 23 Squadron, based at RAF Leuchars in Fife. The Soviets were regularly gathering ELINT on British Air Defence Radar systems and testing the RAF’s Quick Reaction Alert responses (QRA). Despite contemporary news reports of aircrews waving to each other, these were often far from friendly encounters and the Red Top missile mounted on the weapons rail of the Lightning makes clear the possible outcome of these engagements.