The BBC Monitoring Service
- A Short Engineering History

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Abstract—At the end of World War II, the BBC had one of the most comprehensive radio monitoring centers in the world. The key to this success was the rapid and outstanding development of the engineering facilities for monitoring signals – this included an antenna farm and specially designed amplifiers, receivers, recorders and transcribers.

Index Terms—Antenna Engineering, Broadband Amplifiers, Broadcasting, History, Listening, Monitoring, Recorders, Receivers, Signal Reception.

I. INTRODUCTION

Before the outbreak of war in September 1939, the amount of monitoring of foreign radio transmissions undertaken by the British Broadcasting Corporation (BBC) was very limited. This took place in London where receivers were subject to comparatively high levels of electrical noise; in the case of weak signals, assistance came from the receiving station at Tatsfield, Kent, which was connected by landline to Broadcasting House (BH), London. However, in anticipation of the war, a limited number of telecommunication receivers were installed at the BBC training school at Wood Norton, near Evesham, Worcestershire. It had up to forty engineers, linguists, editors and intelligence experts. Technical facilities comprised one ‘T’ aerial, two Beverage aerials directed on Germany and Italy, a set of Bellini-Tosi crossed loops, fourteen all-wave radio receivers, six office-type electrical recorders and frequency-measuring equipment.

Receiver outputs were passed to the monitoring room some distance away on-site; there was also a connection from Evesham to BH London via a private landline.

Signals to be monitored were normally received and recorded by engineers on wax cylinders and carried by hand to the language monitors. The monitors, using commercial acoustical transcribing machines passed the recordings on to the ‘output department’. Interception facilities were in two parts: interception of strong short-distance transmissions using omni-directional aerials and interception of weaker long-distance transmissions using directional aerials. However, there were many serious drawbacks – in particular, the site was not electrically quiet and could not be easily expanded as the interception and monitoring load started to significantly increase; also there was a requirement to locate aerials remotely from the receiving and monitoring facilities and this required the early development of a so-called ‘all-wave amplified aerial system’.

As the problems surmounted it quickly became clear that a new receiving and monitoring site was necessary and the final choice was made after comparative radio site measurements. The paper will concentrate on the early history of the new engineering facilities with some detail given of the aerial system and the special amplifiers and receivers which were developed for the Service.

II. CAVERSHAM PARK, READING

The new site was chosen after an examination of road, rail and local landline systems, and an inspection of field strength contours of various British transmitters. As a result, Caversham Park, about 3-4 km north of Reading in Berkshire, was chosen (Fig. 1).

Caversham is about 56 km due west of London so the landline connection with the War Office (now the MoD) authorities was practicable; in fact, there was a direct hotline link to Prime Minister Churchill’s war office and also a link to FBI offices. Caversham Park (Fig. 2) covered 90 acres of land and was clear of built-up areas at the time.

Moreover, the main building (commandeered from the Oratory School in July 1942) was adequate in dimensions
and also layout to provide good working accommodation for the entire Monitoring Service [1].

It was decided to organize the Service at Caversham in a similar way to that at Evesham by locating the main monitoring and office facilities at the Park and providing separately a remote engineering interception station in an electrically quiet area with an extensive directional aerial system (antenna farm). A suitable site about 5-6 km away was chosen which satisfied the radio noise level and available aerial space criteria.

The technical problem of greatest complexity was the provision of an adequate aerial system and the means for conveying the radio-frequency (RF) signals from the aerials to a large number of conveniently grouped remote receivers. Standard RF amplifiers at the time did not cover the required frequency bands; in addition there was trouble because of unwanted cross- and also inter-modulation products from strong medium- and long-wave signals. Bridged 'T' rejector networks were tried but this produced too much attenuation near to the wanted tuned signals. As was pointed out by Charles J W Hill (the author’s father), who was the Engineer-in-Charge at Caversham during WWII and beyond, the solution was simple – “an amplified aerial system” [2]. Charles Hill was responsible for developing suitable octave amplifiers and the new transformer-coupled distribution networks.

II. AERIALS AND AMPLIFIERS

The strength of the signals at the aerial terminals of the monitors’ receivers was of the order of 10 dB less than that available at the remote aerial terminals so, as stated above, an aerial amplifier system was required. The use of a number of separate amplifiers, each one covering a bandwidth ratio of 2:1, was termed an ‘octave-band’ amplifier system; this system required co-axial cable networking and RF switching. In order to cover the normal broadcast frequency spectrum, 7 octave amplifiers and one further near-octave band amplifier was required. Additionally, to reduce the amount of cabling, some means of combining the outputs of the 8 amplifiers was needed. As paralleling was impractical because of expected poor performance at contiguous frequencies, it was decided to split the 8 octave amplifiers into 3 groups, viz., two groups each containing 3 amplifiers and the third group with 2 amplifiers but with amplifiers of each group spaced apart by at least two the pass-bands of the octaves. This resulted in just three co-axial cables and with acceptably small mutual interaction and degradation of the individual signal channels. At the receiving end of the cables, the new transformer-coupled network gave around one-half the attenuation of simple resistive distribution networks and this resulted in a much higher output to the individual monitors’ receivers.

The plan at Caversham Park was to have some 100 receivers operated by monitors located in the (electrically noisy) main building. Aerial feeds for all these receivers, at normal broadcast frequencies (100 kHz to 27 MHz), would come from the amplified aerial system comprising omni-directional aerials and RF amplifiers placed in a relatively interference-free area. At the remote station, the receivers would also be in an interference-free area within the electrically quiet park. This aerial system was to be installed at various locations away from the interception building. RF cables at both sites were required to connect aerials to amplifiers, amplifiers to receivers and of course also for internal networking in the various buildings. It was decided to use screened balanced cables which gave enhanced attenuation to unwanted signals and interference than co-axial cables but these were still used in electrically quiet areas as they gave less loss. All receivers were kept at ground-floor level and cables buried wherever possible.

III. THE CAVERSHAM AMPLIFIED AERIAL SYSTEM

After WWII the engineering facilities of the monitoring service were further developed and the aerial site had to be somewhat modified because a local housing estate was planned. Operationally it was necessary for all Caversham receivers to be able to get signals from all directions and at all broadcast frequencies [3]; a block schematic of the aerial amplifier building is shown in Fig. 3.

This requirement was met by using a combination of aerials and associated filter amplifiers. The octave aerial amplifiers further reduce any square-law intermodulation terms since the products are automatically placed outside the wanted octave bands.

Nine omni-directional aerials were supported by four stayed 100-ft masts arranged in a 220-ft square. Three of the aerials were horizontal ‘V’ consisting of wire cages cut to the upper high-frequency (HF) bands (Fig. 4).

The next five aerials are simple long-wire semi-vertical units covering the lower two HF bands plus octaves at
500, 200 and 100 kHz; the ninth aerial is for frequencies below 150 kHz and was made as a 'T' antenna structure.

Aerial coupling units are required for connection to the amplifiers and these are operated remotely from the main building to enable the aerials to be connected to either of two sets of amplifiers, one operative and the other spare. The two sets of amplifiers have their outputs paralleled together to form two separate grouped outputs per set. Each group carries four alternate non-adjacent octave bands to avoid any mutual degradation. Reference [3] gives more technical detail about the main building termination and distribution system. At the time the octave amplifier design was entirely novel. The 2-stage amplifier was based upon prototype impedance transforming band-pass filters linked together by thermionic valves (Fig. 5).

All filter components were adjusted before assembly to within ±2% of their nominal value and only very minor adjustments were required after construction even in the higher band of 16-27 MHz; the gain was of order 25 dB as demanded by cable losses and noise.

Very low-frequency signals are occasionally received at Caversham using small multi-turn loop aerials. These are either directly coupled to receivers via tuned transducers or tuned across high-impedance grids of single-stage push-pull amplifiers.

IV. THE RECEIVERS

British made general purpose communications receivers were employed and conventional single-superheterodyne receivers were generally used; this was the GEC BRT 400 as shown in Fig. 6.

There were 14 valves in this receiver which covered in six switched bands all the signal frequencies between 150 kHz and 30 MHz; the frequencies between 385 KHz and 510 kHz were omitted. The circuit consisted of 2 RF stages, frequency changer and separate local oscillator, 2 455-kHz IF stages, detector, audio and output stages; there were RF and IF AVC delays, an AVC amplifier, a noise limiter and a beat-frequency oscillator. This receiver was outstanding in its price range and was particularly good for monitoring voice signals.

A small number of double-superheterodyne receivers from a second manufacturer was used for the reception of morse signals and the type (Marconi) is shown in Fig. 7.

This receiver also had 14 valves and covered in four switched bands all frequencies between 2 MHz and 32 MHz. The IFs were respectively tuned to 1600 kHz and 465 KHz all normal controls were provided; in addition, there were AVC and second IF outputs and provision for diversity operation in which two or more units could be fed from an external (crystal controlled) oscillator.

A small number of unconventional special-purpose receivers (Racal RA17) was used for the interception of HF radio-teletype signals. This receiver is shown in Fig. 8.

The receiver had 23 valves and covered all frequencies between 500 kHz and 30 MHz but with slight degradation in performance below 1 MHz. There were three frequency changers and associated band-pass IF filters. No band switching is involved as it operates on a decade system with the first VFO selecting a MHz band and the second VFO providing accurate tuning over the selected band. Aerial inputs are complicated and comprise a 5-position switched aerial attenuator which is followed by input tuning arrangements consisting of a 7-position aerial range switch which has one wide-band position and six tunable positions covering the above monitoring band in 5 octave bands and one near octave band. It had good frequency accuracy and stability in receiving teletype signals and
had great value for signal search and also supervisory purposes; the speed of band change was a great asset.

V. RECORDERS AND TRANSCRIBERS

There were several hundred recordings of foreign news bulletins, with average duration of 15 minutes and varying between 10 to 30 minutes or more each day; all recordings required accurate transcription in whole or in part.

Requirements for the recorder were that it must be provided with AVC, be suitable for recordings exceeding 15 minutes, provide good intelligibility and must have remote operation; Fig. 9 shows the interior of the recorder.

![Fig. 9. The modified recorder unit](image)

Likewise the transcriber unit must be provided with foot operated start-stop and backspace facilities, rapid finger selection of passages of interest and a speed control.

Standard British- and American-made office dictation equipments available in 1951 met these requirements well and, following operational tests, the British-made unit was selected and replaced the worn wax-cylinder equipment obtained before and after the war.

A few good tape recorders were also used for special purposes, including the recording of morse signals for later copying; these units could be run substantially unattended and had tape speeds from 7½ to 1¼ in. per sec.

VI. THE MAIN LISTENING ROOM

Forty receiving positions, in five groups of eight, were provided in one large room for monitoring voice signals received either by the monitors themselves or, in the case of weak long-distance signals, by engineers at the remote station. A part of this room is shown in Fig. 10, in which can be seen monitor-benches and the supervisory console.

Each monitor position was provided with an aerial feed, communications receiver and recorder, and each pair of positions shared an audio switching panel; this gave the monitors a 12-position rotary switch which, with the tie-lines to a central console, enabled him to listen either to the output of his own receiver or to signals fed by line from the remote station. When connected to the remote lines, the monitors could select, book or use any free recorder in the groups of eight units each. A few transcribers were used in the listening room, but most were used singly, or in pairs, in small quiet cubicles.

Except for two hellschreiber positions in the main listening room, all morse, hellschreiber and radio-teletype services were copied to other rooms; technical details are given in [3]. Arrangements were made for monitors at Caversham to be able to tune signals from the remote station.

![Fig. 10. The main listening room at Caversham](image)

In cases where the remote signals were being recorded at Caversham for later copying, the equipment could still provide tuning facilities although delayed in time.

The radio listening engineering facilities at the remote station are still somewhat classified but the technical detail of directional aerials (rhombics, beverages, and Bellini-Tosi loops), the signal distribution units, receivers and other various auxiliary equipments, including frequency measurement equipment, are described in [1] and [3].

VII FINAL REMARKS

To briefly bring the discussion up-to-date, the BBC Monitoring Service now receives, selects and translates information from radio, television, press, news agencies, satellite and the internet from around 150 countries and in more than 100 languages – much of this is available via an internet database; recent developments are given in [4]. The service has remote operations in Egypt, Russia and Georgia as well as Uzbekistan, Azerbaijan and Ukraine.

It is emphasized that BBC Monitoring is confined to open sources and does not listen to military, diplomatic or other restricted networks of any kind. The internet database carries annually of the order of a quarter million stories and embodies a very clever and powerful search engine which is user-account and password protected.

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REFERENCES


