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Steven R. Cole  
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## PERSONAL RADIO SYSTEMS

By: R G Barrell

### Introduction

In 1965 the Home Office decided to use a frequency band within the UHF (Ultra High Frequency) part of the radio spectrum for police personal radio systems. These systems enabled personnel in towns and built-up areas to maintain direct two-way communication with a controlling base station by the use of small battery operated radio telephone transmitters and receivers. They were truly 'personal' in that their size allowed them to be slipped easily into a pocket in the clothing.

Such is the widespread use of these systems in Police application today that the small sets are almost as much a part of a policeman's equipment as his notebook and pencil.

Similar units are currently undergoing trials with their Fire Service colleagues.

### A review of systems

The first fixed systems comprised a single base station equipment - receiver and transmitter, with aerial - located generally near the centre of the area to be covered. A pair of private wires connected the base station to a radiotelephone controller equipment located remotely at the control point. Operating functions selected at the controller were 'receive', 'transmit' and 'talk-through'; the 'talk-through' function enabling one personal radio unit to talk directly to another, using the base station as an automatic relaying station. Transmitter power output available at the base station was 2-3 watts, and from the personal transmitter 50-80 milliwatts (0.05 - 0.08 watt). Diagram 1 illustrates a simple Police system of this type.

The need to control a number of base stations from one point resulted in the development by the Home Office of an accessory equipment to enable the selection of one station from a group of five. This 'Five-channel Monitor and Preselector Unit' - as it was designated - enabled all incoming signals to be monitored, and showed, by an indicator lamp system, when calls were waiting on a particular base station circuit.

Diagram 2 illustrates the addition of the five-channel monitor to a simple system.

About one year later second generation equipment became available which gave increased transmitter power outputs; 8-10 watts from the base station and 100 - 150 milliwatts (0.1 - 0.15 watt) from the personal transmitter. Duplication of the receiver and transmitter in the new base station provided a second set of equipment which could be selected remotely at the radiotelephone controller in the event of a fault arising in the equipment in service. A further important feature was the provision of automatic switching to prevent a complete loss of service should the mains supply to the controller fail, or the continuity of the private wire circuits be broken. In either of these eventualities the automatic switching provided 'talk-through' operation at the base station. Emergency control could then be effected using a personal transmitter and receiver.

Most of the equipment in use today is of this second generation, but changes in operational requirements have brought about considerable changes to the simple 'local cover' systems which were originally installed. Areas of radio cover need to be expanded, and access to systems is required at higher levels, ie Divisional Headquarters and Force Headquarters.

#### Range of cover

Early systems in built-up areas gave, typically, ranges of 1 - 3 miles from the base station, with aerial sites, eg police stations, civil buildings and schools, often chosen with a requirement for only very local cover in mind.

Resiting of aerials on high-rise blocks of flats and lofty property developments can return useful improvement in penetration and increased range. Rural areas, particularly open terrain, where range is typically double that obtained in a town, can be served well by careful choice of hill top or similarly elevated sites; a clear unrestricted view of the area to be served being the prime requirement.

Devices, mentioned in previous papers, which are now well tried and of proved value for supplementing cover, are the On-Frequency Repeater and Frequency-Changing Repeaters, UHF/VHF.

The On-Frequency Repeater can provide service for a sector of 150° extending outwards from a point on the perimeter of cover given by a base station. Outward range for a full power output repeater (5 watts) is slightly less than that from a similarly sited base station.

Diagram 3 illustrates the sector of supplementary cover available from an On-Frequency repeater.

#### Frequency-Changing Repeaters, UHF/VHF (Ultra High/Very High Frequency):

This type of repeater can provide a practical answer to the problem of remote or thinly populated areas in which it is not economical to instal a base station and private wires to a controller; or when coverage of an area is required on a short-term basis.

Operation offers a normal two-way local area system at UHF, and, through the 'repeater' principle direct contact with Force Headquarters over the Force-wide VHF system.

#### Control flexibility and Computer access

The move towards the requirement for access to personal radio systems from Police Divisional Headquarters level has been accelerated by the new aim to give a channel of inquiry from the policeman with personal radio to the Police National Computer at Hendon.

If selection of the base station is made by a multi-station controller at, for instance, Divisional Headquarters, then Divisional Headquarters will act as a 'routing centre' for all calls which have to be passed through to Force Headquarters for the Police National Computer. New integrated control systems which have been installed at some police force headquarters have provision for personal radio circuits direct from divisional stations. These circuits are presented as additional channel buttons to those of the force-wide VHF channels on the console panels. The interconnection of UHF and VHF circuits is possible within the system.

Diagram 4 illustrates the possible routes of personal radio traffic through a police system, and includes the route through to the Police National Computer.

#### Frequency allocation

Initially personal radio systems were assigned frequencies on the basis of 50 kHz (kilohertz) between adjacent channels, and a minimum separation of 20 miles between systems on the same channel. The very large number of systems installed in some areas soon made the issue of a "clear" channel for a new system completely impossible. When frequencies in the 450-470 MHz band were made available to private mobile radio generally, however, assignments were made on a 25 kHz channelling basis and equipment to that specification became available. Consequently the Directorate initiated a conversion programme from 50 to 25 kHz channelling on existing installations. A start was made in the area covered by Romsley Wireless Depot and conversion in that area is almost complete. Re-assignment of frequencies is in progress in other areas also to enable other urgent operational requirements to be met.

#### The presentation of personal radios

The bulk of UHF personal radios provided to date by the Home Office have separate transmitters and receivers. However police authorities have always stated their preference for single unit sets, when these could be provided with the necessary facilities and performance, and of acceptable dimensions. Developments in solid-state technology and battery manufacturing techniques have enabled greater packing densities to be achieved without loss of performance, providing combined, 3-channel, units of size comparable to the separate transmitter or receiver.

An accompanying feature is the use of the same aerial for transmit and receive functions. The relative inefficiency of the present receiver aerial is sometimes a limiting factor.

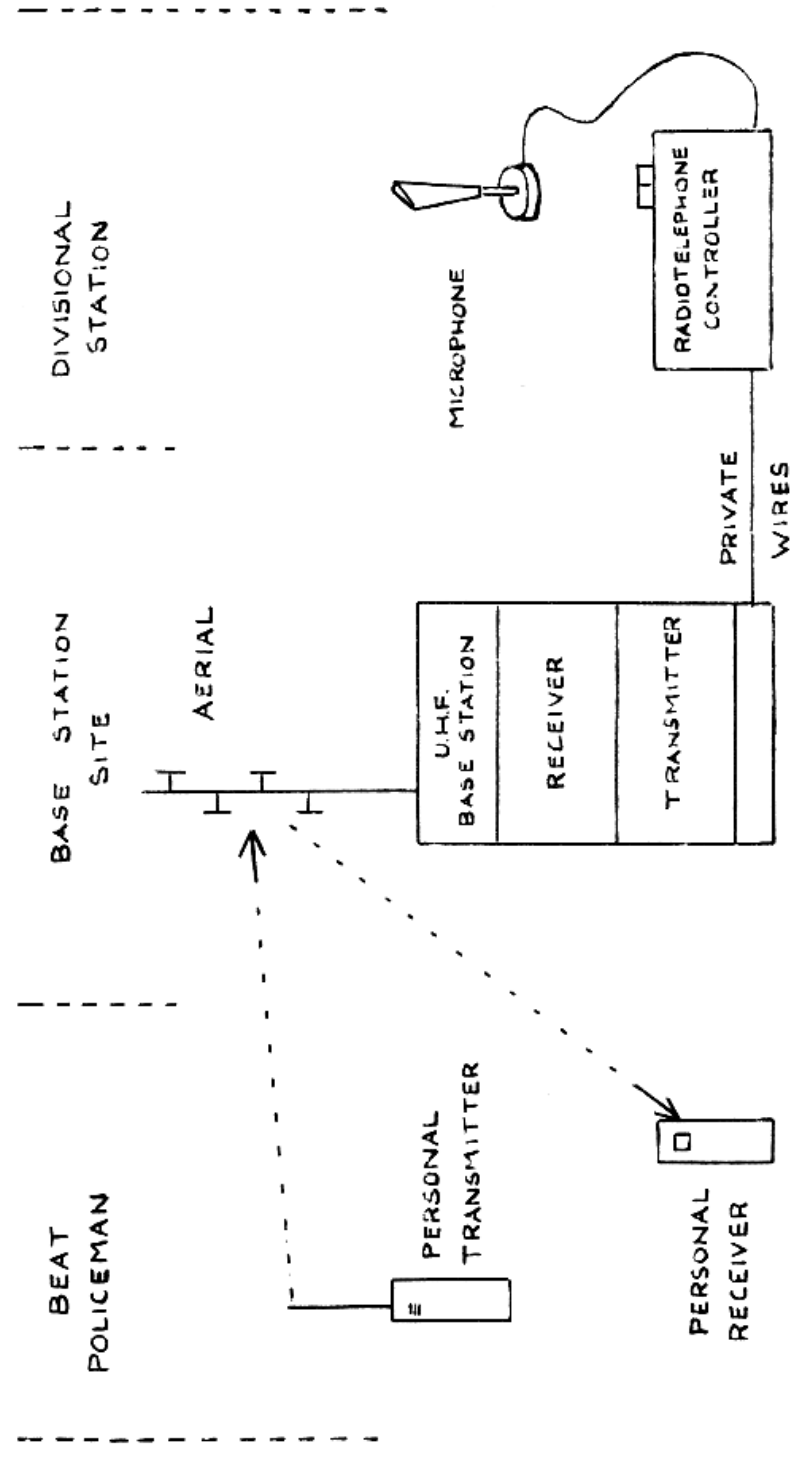
#### Field trials of new equipment

New models of personal radio equipment from several manufacturers are currently being prepared for Home Office trials. These are all single-unit, 3-channel sets for 25 kHz channelling. Completion of deliveries of trial sets is expected towards the end of 1971.

These field trials have been planned to enable both operational and engineering evaluation of selected equipments, and questionnaires have been prepared for the use of participants in the reporting of their findings. From the picture which evolves from analysis of these returns should come the pattern of the next generation of personal radio sets.

Mr Barrell is engaged in the Police Equipment and Systems Section of the Directorate, writing technical specifications and arranging field trials of manufacturers' equipment. Until May 1971 he was responsible for the allocation of frequencies for personal radio use, and assisted in the development of UHF personal radio services with integrated control systems.

AGRAM 1. A SIMPLE POLICE DIVISIONAL  
PERSONAL RADIO SYSTEM.



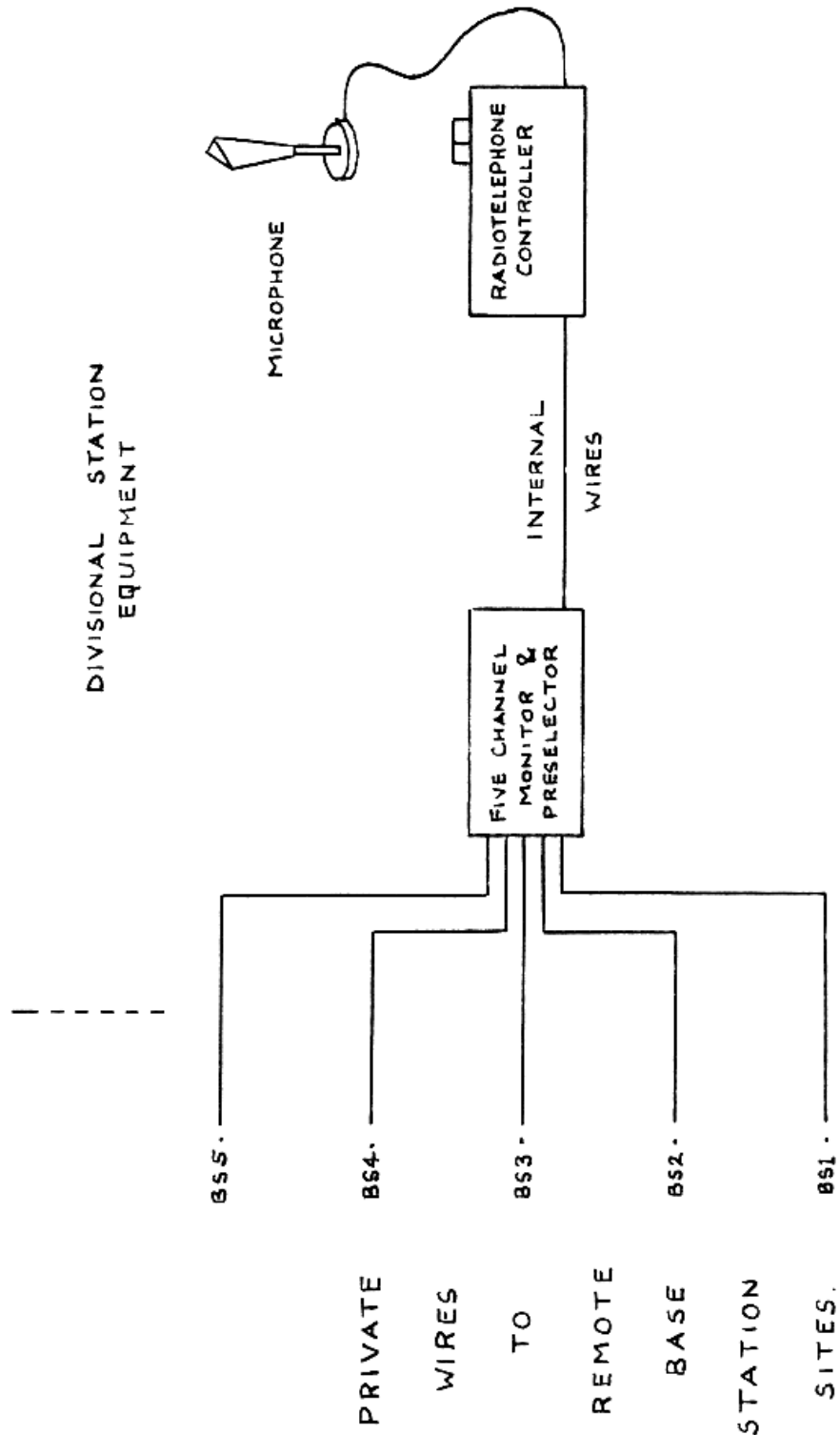


DIAGRAM 2. THE ADDITION OF A FIVE CHANNEL MONITOR TO A SIMPLE SYSTEM.

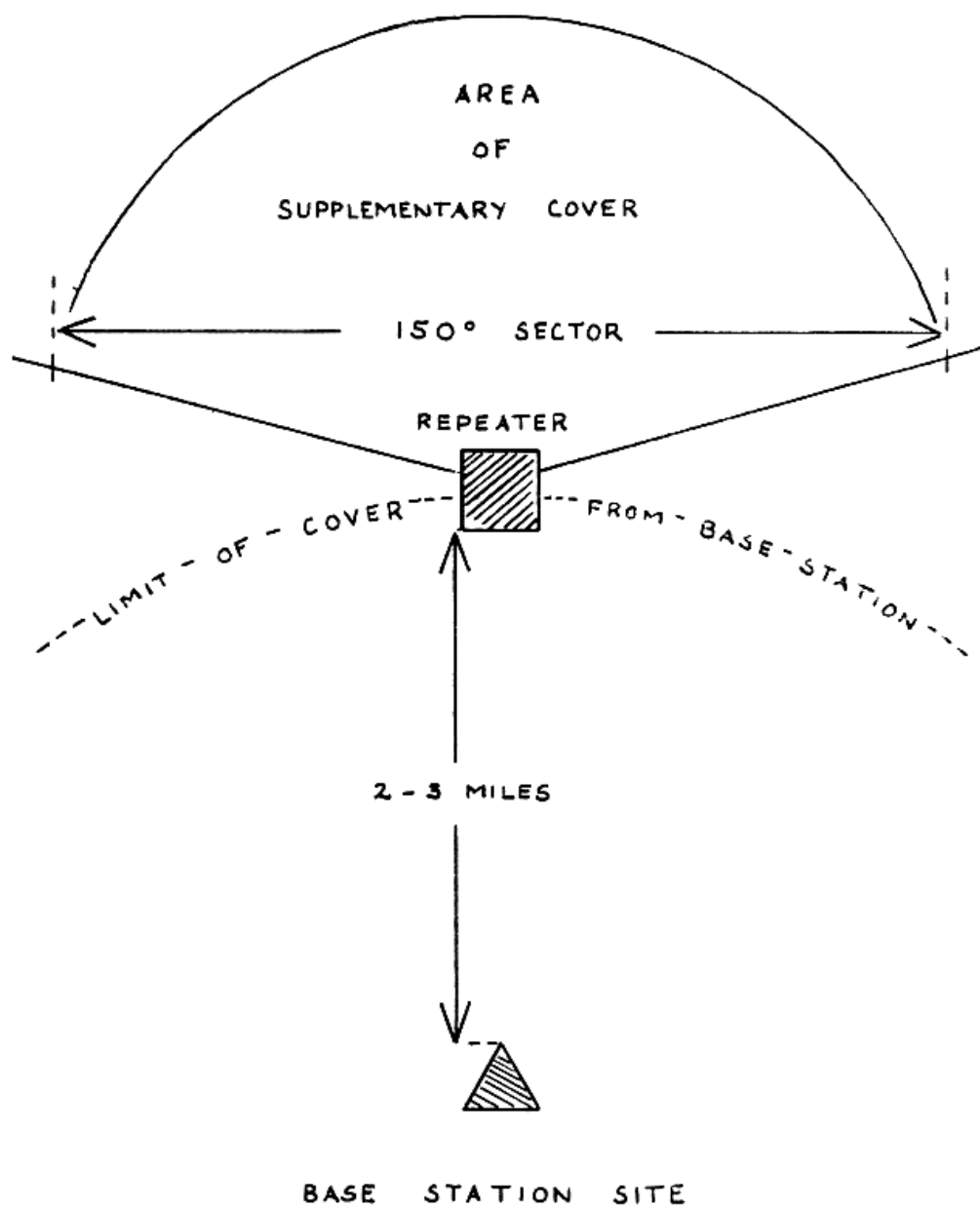


DIAGRAM 3. SECTOR OF SUPPLEMENTARY  
COVER AVAILABLE FROM AN O.F.R.

