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ENG INF

The Quarterly For BBC Engineering Staff

Direct Broadcasting by Satellite DE signs "Heads of Agreement"

Bryce McCrirrick signing the Heads of Agreement with Alan Jefferis, (left) Managing Director of United Satellites Limited.

On March 7th, Bryce McCrirrick, (DE), and Alan Jefferis, Managing Director of United Satellites Limited (Unisat), signed Heads of Agreement for provision by Unisat of two direct broadcasting by satellite television channels for the BBC DBS services due to start in 1986.

Unisat, jointly owned by British Telecom, British Aerospace and the General Electric Company, will be responsible for building and launching two satellites in 1986, the first to be operational and the second as a flying spare. A third spacecraft will be available on the ground as an additional safeguard. Launch will be by the European Ariane rocket or by the American Space Shuttle, the final choice to be made nearer the time. The satellites will be in geostationary orbit 36,000 km above the equator and will provide signals of sufficient power for high-quality reception by individual households, with suitable receivers and small dish antennas less than 1 metre in diameter, within a 'footprint' covering the United Kingdom and parts of Western Europe. The agreement covers a period of operation of the satellite service of at least seven years.

The satellite will carry transponders for two BBC DBS services; DBS 1 will be a Subscription Channel carrying feature films and other attractions; and DBS 2 will have an international flavour. There will also be a number of digital sound channels affording stereo sound with television and some high-quality radio channels.

The signing of the Heads of Agreement represents a notable landmark in the development of British broadcasting. It will be followed later by completion of a full Agreement covering the finer details.

In this edition of ENG INF

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►►Editorial◄◄

As the one millionth Teletext receiver reaches the showroom, the BBC has been awarded its third Queens Award to Industry for Technological Achievement, on this occasion jointly with the IBA, for the pioneering work on the development and transmission of Teletext, the basic concept of which has been adopted world-wide.

It is now ten years almost to the day that Research Department, then led by Mr. P. Rainger (now DDE), conducted tests after normal broadcasting hours to determine which lines in the field blanking period to use for a system called Ceefax. The results showed the preference for lines 17 and 18. A detailed specification was issued in April 1973, and there then followed a series of meetings at which a joint standard with the IBA emerged about a year later. This was followed by a unified standard specification in September 1974. In the meantime the BBC began an experimental service on BBC 2 using 32 identical pages (except for the page numbers) on 16th July 1973.

An editorial unit was set-up under Colin McIntyre on New Years Day 1974. Initially all he had were a photocopier, a typewriter and a telephone answering machine! This blossomed into a nine-person unit in a purpose built suite by April 1975; Ceefax was on the way to becoming a full service.

Our congratulations, therefore, to the BBC engineers, particularly those at Research and Designs Departments, who devised the system, made it work, and finally persuaded industry that it should invest in the new technology.

Two recent announcements from the Home Office have a special significance for BBC Engineering Division.

The first was the announcement that the remainder of vhf Band 2 be cleared of ancillary services to make way for two additional national radio networks. Once the fire, police, ambulance and other services have moved to other frequencies, the space created could be used for a national Radio 1 network, and an IBA network. The announcement has been greeted with both joy and sadness. Joy, because at last our most popular radio service, Radio 1, will have its own vhf service, and the annoying splits between Radio 1 and 2 will no longer be necessary. Sadness, because the new network will not be introduced until 1990, seven years away. By this time we will have had four years of digital sound systems from a satellite.

The second announcement was the closure of 405-line television service by the end of 1984, two years earlier than had originally been planned. It has been estimated that there will be about 90,000 people scattered around the UK who will be outside the range of uhf transmitters at the end of 1984. With the extension of Phase II of the uhf transmitter building programme, to bring a 625-line service to populations of 500 people or more, an estimated 60-70,000 people could still have been without a uhf service in 1986 when the 405-line service was scheduled to close anyway. Some of these, where there are 200 people or more, and where it is economical to build a station, will eventually receive an off-air service. For the remainder a "self-help" active deflector or wired system will be the only way of receiving uhf television.

The Home Secretary recognised that by bringing forward the closure date "there will be a hiatus before alternative provision for some 405-line viewers is available, while some others will be denied the service earlier than had been foreseen". He went on to add that "there is no alternative but to make these *(frequency)* bands available for land mobile services at the earliest possible date".

Alan Lafferty

Transmitters Opened

The following transmitting stations have opened since January:

Uhf tv
Abington, Strathclyde
Andoversford, Gloucestershire
Ascott-under-Wychwood, Oxon
Betws-yn-Rhos, Clwyd
Bury St. Edmunds, Suffolk
Frome, Somerset
Glasgow (West Central), Strathclyde
Glyndyfrdwy, Clwyd
Llanddulas, Clwyd
Ovingdean, E. Sussex
Penmaen Rhos, Clwyd
Portreath, Cornwall
Saltdean, E. Sussex
Vhf radio
Strachur, Strathclyde/Argyll
Local radio
Radio Cornwall
Radio Devon

Copies of the pocket booklet 'Television and Radio Stations 1983' are available by telephoning LBH 2921.

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METAL FILM RESISTORS AND IEC RECOMMENDATION

Sixth colour band shows temperature coefficient

By Margaret Crowther, Mullard Limited.

All MR25 and MR30 metal film resistors manufactured after August 1st '82 carry a sixth colour band to show the temperature coefficient of the product. This innovation brings the colour coding system of these resistors into line with the latest recommendations in IEC publication 62, and IEC115-1 clause 4.5. It also helps to emphasise that, although MR25 and MR30 metal film resistors are categorised as general purpose components, their performance is closely specified.

All performance details are given in a six-page data sheet available from Mullard Ltd., packed with information invaluable to the designer. This includes a very useful performance nomogram showing the relationship of the resistors' stability with power dissipation, ambient temperature and hot-spot temperature.

The temperature coefficient band is easy to spot - it is wider than the others and is located on the end-cap.

The temperature coefficients, together with other key data for MR25 and MR30 metal film resistors are given in the table below:

	Max. power at 70°C	value	temperature coefficient colour band
MR25 resistors			
1Ω to 4.99Ω ±1%	0.4W	100ppm	brown
5.05Ω to 1MΩ ±1%	0.4W	50ppm	red
1Ω to 1MΩ ±2%	0.4W	not applicable	
MR30 resistors			
1Ω to 4.99Ω ±1%	0.5W	100ppm	brown
4.99Ω to 1MΩ ±1%	0.5W	50ppm	red
1Ω to 1MΩ ±2%	0.5W	not applicable	

New Pebble Mill 'C' Control Room

Pebble Mill 'C' production and vision lighting control room

Refurbishments and improvements to the technical facilities at Pebble Mill continue, with the first project, "C" control room, nearing completion. The new gallery is on the site of the reserve network continuity suite. It will handle the familiar "lobby" programmes such as "Pebble Mill at One" or "6.55 Special" or in fact, any programmes requiring production facilities away from the more conventional studio A and B environments.

The production control room is co-sited with the vision and lighting control in a split level room, furnished in natural brick and wood. At the high-level is the production control desk housing a Grass Valley 1600 ZVPY4 mixer with full facilities. Here also is the TM's position, with own colour monitor and full communication facilities. A QWERTY keyboard has been installed to enable the Eastmead indicators, located under each of the production monitors, to be pre-programmed with picture source information. The keyboard could also be used when computerised source selection equipment is installed. In the small space to the rear of the production control desk, cinema-style tip-up seats have been provided.

At a lower level, in front of the production control desk, is the lighting and vision control equipment. A Strand Duet 2 lighting control system has been installed. Using computer style memory, it can handle up to 96 channels. To provide maximum flexibility, the dimmers can be switched for use in one or two areas.

One of these is the lobby, which is equipped with HMI lights for daytime use, and incandescent lights at night. Alternatively the lighting system can drive lights in radio studio 1, which doubles as a television studio for programmes such as "6.55 Special". Next to the lighting control position are the vision controllers for the cameras.

The gallery can handle a normal complement of four Link 125 cameras fitted with Schneider lenses plus one Ikegami HL79A light-weight camera, with an option to add either a fifth Link 125 or another Ikegami HL79A.

The monitor stack, specially made of aluminium by Pearl Electronics of Windsor, has been erected in the small space between the vision and lighting control desk, and an outside wall. This means that the six Melford colour production monitors and eighteen Melford black and white monitors can be repaired and maintained when necessary via the front of the stack. Special cable cupboards have been incorporated into the design to assist with rigging and de-rigging the monitors. To reduce stray magnetic fields that could upset the colour monitors (see Eng Inf No 97), in addition to the aluminium frame, the twin loudspeakers have been mounted in special mumetal screened cases.

Next to the production gallery is the sound control room, which is equipped with a standard Calrec 36-channel stereo mixing desk. Following the trend away from centralised echoplates, the sound control room will have the benefit of two AMS RMX 16 echo units. Six compressors/limiters are pluggable via miniature audio jackfields. A pair of LS5/8 loudspeakers are provided for monitoring purposes. The control room also houses a pair of gram decks and two B62 tape machines.

The new "C" control room will allow the production staff more flexibility when making programmes in and around the Network Production Centre.

Mike Cox, the SCPD project leader said "The gallery layout is a radical departure from traditional studio practice due to the nature of the Pebble Mill programmes and limited space available".

Pebble Mill 'C' sound control room

Towards the Digital Television Studio

"How can pieces of digital television equipment be connected together?" Although this seems to be a mundane question, it is one of the most important that remains to be answered. This is because, even though the major parameters of the digital television coding standard have been agreed, it has yet to be made into a practical system.

The question of interconnection is so important that the Production Systems Engineering Subcommittee of the EBU (European Broadcasting Union) set up an ad-hoc working group last year to look at it. This group is chaired by Mike Stickler of SCPD with David Bradshaw of Designs Department as a co-opt member.

The study is based on the 13.5: 6.75: 6.75 MHz digital coding standard for the luminance and two colour-difference signals with sampling at 8 bits per sample.

The early questions facing the group concentrated on the choice between serial and parallel interconnections. In a serial interconnection the eight bits of each sample are sent consecutively over one circuit whereas with a parallel interconnection separate circuits within a cable are used for the simultaneous transmission of the eight bits. Whilst the latter method of interconnection could operate using three separate cables for the luminance and the two colour-difference signals respectively, it would be impractical to install as it would involve at least 24 separate connections.

A slightly better method would be to time-division multiplex the two colour-difference signals and transmit them both on one cable at the same data rate as the luminance signal. It would be even better to multiplex all three components and transmit them on one multi-pair cable at 27 Mbytes per second, and this is the method that has been selected.

In a similar way a serial link could be formed from either up to three separate cables for the three picture components or, possibly, a single cable carrying time-division multiplexed signals. Although the latter method seems to be the most convenient it is by no means trivial to convert from parallel to serial and back, requiring operation at up to 280 Mbit/s. For this reason, and because of its instrumental simplicity, it was decided to pursue the parallel interface first.

Digital studio interface demonstration

The distance over which satisfactory operation can be expected is, clearly, a function of cable performance and so a number of tests were carried out in Designs Department to assess the performance and suitability of existing multiway cables. Two other European broadcasters have commissioned special cables at considerable cost. Bearing in mind that digital signals can be regenerated and that, the great majority of studio interconnections can be made with a near-standard cable.

To demonstrate this fact, Designs Department last year treated a somewhat bemused EBU group to multiplexed digital video components being transmitted at 27 Mbyte/s for a distance of over 100 metres on (PSN40/2M standard) audio multi-pair cable! This demonstration confirmed the feasibility of parallel distribution in studios.

Other questions that had to be decided included such things as whether or not sound signals should be carried within the video signal in studios and the way in which ancillary signals, such as timecode, should be incorporated in the digital datastream.

The original digital coding standard was established after considerable international collaboration and it was desirable that this should extend to the equipment interface. Close liaison has taken place between the EBU ad-hoc group and the SMPTE's digital working group which operates under the chairmanship of Ken Davies of CBC.

One topic that provoked considerable discussion was that of a synchronisation component. In digital studios, video signals are expected to be processed as 'packets' of data and an indication of the start of video data will be more appropriate than some kind of digital representation of a conventional sync. pulse. What has been agreed are digital labels that precede and follow each packet of video data, effectively providing a video start/finish indication. Again, demonstrations of this type of synchronisation were given at Designs Department during an EBU meeting in London.

The EBU ad-hoc group has now completed its work on the parallel interface specification and it is hoped that it will be approved by the EBU Technical Committee when it meets in Copenhagen in April.

Some of the important parameters of the interface are:

- Video data is sent as a time-division multiplex of 8-bit luminance and chrominance components at 27 Mbytes/s. A clock signal is sent with the data at 27 MHz.
- Eight balanced pairs are used for video data, plus one pair for clock, using ECL-compatible signal levels and 110 ohms cable impedance.
- The connector is the minature 25-way, type-D socket on equipment and plug on cable. Cable screening is recommended.
- Television lines 23 and 623 are not blanked at all in the digital system but 'analogue' blanking will be applied when conversion to analogue form takes place.
- Ancillary signals are multiplexed into the data stream on lines 20, 21, 333 and 334. (Not endorsed by the SMPTE, they want freedom to put ancillary data anywhere in blanking but the numbers would be different for 525 lines anyway).
- No provision in the specification for carrying a sound signal.

With the completion of work on the parallel interface, the Group is turning its attention to the serial interface (for longer, inter-area links) and the format of the ancillary signals.

Further investigations into low-cost cables for digital studios using lengths of custom-built cable are being undertaken in Designs Department. Two manufacturers are supplying lengths of prototype cable which it is hoped will prove to be acceptable on the basis of size and flexibility as well as electrical performance and cost. The limiting factor in cable performance for digital parallel transmission tends to be differential delay errors between the different pairs – the maximum error between the clock and any data signal due to the cable is specified at only 5 nanoseconds.

Consideration is now being given to some of the 'building blocks' that will be required for interconnections in digital studios, the most complex of which is probably the routing matrix.

Radio OBs New Base - On Display

Radio OB's recently moved to a new base at Concord Road, Acton, opposite their television counterpart at Kendal Avenue. The new base, three large units on an industrial estate, will house the latest OB vehicles, and provide base maintenance, storage and office accommodation. Duncan MacEwan, (CERB) said, "The new Base will bring together probably the biggest and most comprehensive fleet of fitted Radio Outside Broadcast vehicles anywhere in the world".

BBC Radio have been transmitting outside broadcasts for over sixty years. In January 1923 there was one from the Royal Opera House, Covent Garden of Mozart's "The Magic Flute". In those days, and until quite recently, it was the practice to transport the mixers and special line amplifiers to the location as separate units, unload them and then connect them together as required. The complexity of modern equipment and the increasing demands for high-quality broadcasts has meant that the equipment now has to be mounted into purpose-built vehicles. The new OB base is intended to house these.

With the expansion of stereo radio in the 1970's, the "Stereo Control Vehicle" (or SCV) has become the main vehicle in the fleet. It has been designed in three different styles: the Type 'A' with a fully-comprehensive Calrec MKII desk or SSL computer assisted desk; the Type 'B' with a 40-channel Calrec desk; and the smaller 15 cwt Type 'C', with a Glensound MX6/3 mixing desk.

The specialist vehicles in the fleet range from the large Mobile Studios (see Eng Inf No 9) to the smaller multi-track recording vehicle, digital recording vehicle, foreign commentators vehicle, and, most importantly, the radio link communication vehicles.

For the future, an expanding-side articulated trailer has been given special acoustic treatment by Research Department. This will house the world first all-digital sound mixing desk manufactured by Neve Ltd, and incorporating the Research Department designed COPAS (Computer for Processing Audio Signals) system.

In this special feature article, we examine each vehicle in turn, the technical facilities provided, and the part it plays to make the Radio Outside Broadcast fleet the best in the world.

The Solid State Logic (SSL) computer-assisted control desk inside a Type A stereo control vehicle

Type A

The introduction of stereo radio to the majority of listeners in the 1970s prompted the need for a dedicated control vehicle, with sophisticated technical facilities and listening standards compatible with a modern production studio. The Type A stereo control vehicle fulfilled these needs and has been accepted as one of the most versatile and operationally convenient vehicles in the fleet.

The earlier vehicles (SCV 1 and 2) are based on a Luton-type body, fitted to an 11 ton Bedford chassis. In developing the specification for the vehicle, the valuable experience gained by BBC engineers designing television vehicles was drawn on. The successful three-skin, high-sound-insulation body construction was used. For maximum sound absorption the outer cavity is filled with glass fibre and the intermediate skin is of jute-based sound barrier mat. The inner cavity is filled with fire-retardant absorbent foam, retained by perforated steel plate which forms the inner skin of the vehicle and is covered with an acoustically-absorbent plastic material.

The Calrec MkII outside broadcast mixer, which was specially designed for the BBC, is mounted across the rear of the vehicle. The normal in-line configuration is used, with fortyeight input channels, eight stereo groups and a twenty-four track monitor/mixer which is coupled to an input/output monitor.

The latest versions of the vehicle (SCV 3 and 4) have been equipped with Solid State Logic (SSL) computer assisted 40-channel mixers. Using 4000-series software, the desk operates in real time, allowing total recall. Forty separate input amplifiers are installed and thus up to eighty different microphones can be mixed. The size of the desk is such that doors have been fitted to the side of the vehicles for ease of access.

Both types of vehicle are fitted with a pair of high-quality monitor loudspeakers to the latest BBC design, LS5/8. They are mounted either side of the control desk to allow the operator the maximum stereo effect within the limitation of the confined space. Provision has been made for a television camera and a monitor/receiver for use on complicated productions such as operas and pop concerts. A colour monitor displays the SSL computer control settings.

At the front of the vehicles provision has been made for three twin-track tape recorders such as the Studer B62 and for a multi-track tape recorder such as the Studer A800 or Lyrec. In SCV 3 and 4 the front of the vehicle houses the computer and floppy disc drive unit.

Outside the vehicles there are connections for up to 120 microphones and patch panels connecting to the mixer and tape recorders.

Other features include Dolby M/6 noise reducers, peak programme meters (PPMs), a six-line manual telephone exchange and an ample supply of recording and line up tapes.

'continued over'

Radio OBs New Base

A Calrec 40-channel mixing desk inside a Type B stereo control vehicle

Type B

For the majority of Outside Broadcast applications the sophistication provided by the larger Type A control vehicles is not required. For programmes such as "Any Questions", "Gardeners Question Time", many music programmes and most sports programmes, a control vehicle such as the Type B is used.

The vehicle is equipped with a Calrec 40-channel mixing desk, mounted across the rear, and a pair of LS 3/7 loudspeakers which provide monitoring facilities. The desk is not fitted with limiters, echo and delay lines, etc., but portable units can be plugged in as required. Up to four stereo tape machines such as Studer B62s can be mounted across the front of the vehicle, with line connections and tape monitoring facilities on a nearby jackfield bay.

The Type B is used for all types of Outside Broadcasts, both live and recorded, where a central control and monitor point is required.

Type C

The smallest of the range of SCV's is the Type C, based on the Dodge 18 cwt van. The vehicles are intended to cover small outside broadcasts such as church services. The advantage of their small size allows them to be engineer-driven, but the disadvantage is that little acoustic treatment can be applied to the interior of the vehicle.

The Type C vehicles, of which nine are in service, have two Glensound MX6/3 mixers, two Nagra MK IV stereo tape machines, and a pair of LS 3/5A loudspeakers for monitoring.

Internal wiring is via a pre-wired harness to a patch bay: connections to the vehicle can be made via standard 26 way connectors and then to the patch bay. Programmes can either be recorded on-site or fed to wide-band music lines supplied by British Telecom.

Digital Stereo Control Vehicle

Recognising the trend towards all-digital processing and distribution techniques, Research Department has developed a novel all-digital processing system, COPAS, which has been incorporated in a mixing desk under development by Neve Limited. To house the new equipment, and test it under various operating conditions, a new outside-broadcast vehicle has been designed, known as the Digital Stereo Control Vehicle.

Once installed in the vehicle, the new 48 channel digital mixing desk will perform all the normal processes such as fading, mixing, filtering or compression. In additon, it will provide real-time delay in every channel and comprehensive signal routing.

The channel processor design is based on the work done by engineers at Research Department, who developed COPAS. The powerful architecture of the processor has enabled the production of versatile software which implements all the ncessary digital audio functions.

To accommodate the desk and allow improved listening conditions a vehicle incorporating expanding sides has been developed by the SCPD, and the coach builders, C.M.A. Coachbuilders Ltd..

The centre part of the articulated trailer expands to 1.2 metres beyond the normal road width. Mounted across the width of the vehicle will be the new desk Television Monitors and VDU's will face the operators, and on either side a pair of modified LS 5/8 loudspeakers will allow them to take full advantage of the superb acoustics engineered by Research Department experts.

To the rear of the expanded "control room" will be an equipment area. Here will be located a mixture of digital multi-track tape recorders, and stereo digital and analogue machines.

It is hoped that this combination will provide both comprehensive facilities, and an ideal test-bed, from which valuable operational experience can be gained.

Radio 1 Roadshow

One of the most popular radio outside broadcasts is the summer season "Radio 1 Roadshow". A new special articulated trailer has been converted to carry the show quickly to more than thirty different locations during the short summer period from mid-July to September. At other times the unit features at public shows in selected towns or at sports events such as motor racing.

Once on site, the centre of one side of the trailer opens out 3 metres to form a stage. Hydraulically operated rams move both stage floor and roof together, the operation taking about an hour to completely rig. At one end of the trailer is a storage space for records, cartridges and small equipment. On site this area doubles as a small hospitality room with water heater, coffee machine, sink and fridge. Access to this area is via the stage or from an outside door.

At the other end of the vehicle is the control cubicle. Here a twelve

OB staff inspect the new expanding side digital stereo control vehicle

Radio OBs New Base

Radio 1 Roadshow

channel Glensound MX 6/3 mixer is used for the main programme output; this is supplemented by a Glensound MX 6/2 mixer for public-address use. A pair of LS 3/5A loudspeakers are used for monitoring in the control cubicle, whilst Shure 711 speakers are used for the public address. Standard British Telecom lines carry the signals back to London for transmission.

On stage the disc jockey has two EMT 950 turntables equipped with Shure SC35C cartridges for playing records, and three ITC/SP tape-cartridge machines for "jingles" and "trails". The trailer also comes equipped with a radio microphone that allows the DJ or an assistant to move among the many people who watch the show being produced.

Mobile Studios

The mobile radio studios have been designed for a variety of outside broadcasts anywhere in the United Kingdom where complex facilities are required. They have already proved valuable at sporting events like The Derby and for state events like the Pope's visit. They are also suitable for reporting important conferences where temporary and comprehensive studio facilities are required close to the event.

Full details of these vehicels have been described in Eng Inf No. 9 (Summer 1982). Briefly they consist of a studio area at the front of the vehicle, operational area, with a Glensound 30-channel mixer, in the centre, and a radio communication link area at the rear.

Foreign Commentary Vehicle

At large outside broadcasts, such as State Visits and major sporting events where there is international interest, the BBC provides facilities for foreign broadcasters. To accommodate the extra facilities required, a dedicated vehicle has been built to house the mixing and control equipment.

From separate commentators' boxes, the individual signals are fed to the foreign commentators' vehicle. Inside there are four Glensound mixers, each with five control positions, allowing a total capacity of twenty commentary circuits. Each control position can accommodate two commentators. A single feed of effects is used for all twenty positions. The mixer offers all of the normal signal processing facilities as well as the faders.

The vehicle also has two television monitor/receivers and four LS 3/5A monitor loudspeakers. These allow the engineers to monitor events outside the vehicle. The facilities on the vehicle are similar to those used by BBC Television Outside Broadcasts.

Individual units are demountable and may be used remotely from the vehicle.

The twenty-position control desk inside the foreign commentators vehicle

Radio Link Vehicle

At some outside broadcast locations it is difficult to obtain wide-band 'music lines' to convey the signals back to Broadcasting House for transmission. Where this is a problem a radio link vehicle is used.

The vehicle is a small 15 cwt van converted to house the radio link equipment. A 9 metre pneumatic mast is mounted in the centre of the vehicle, with the different aerials for the radio transmitters and receivers mounted as required. One side of the vehicle houses the communications equipment with a small bench underneath to house a mixer and monitor.

For each outside broadcast the communications equipment, which is normally stored between broadcasts, is loaded; the type and frequency range depends on the vehicle's location. In some parts of the country one frequency of operation is acceptable, whilst in others it may be subject to interference, so an alternative frequency, and hence equipment will be used.

The equipment can operate from mains or, at remote locations, from two sets of batteries fitted in the rear of the vehicle. This facility is also useful when the programmes are made 'on the move'. The presenter can travel with the vehicle, doing interviews and introducing records as they go. These are played from the Continuity Suite in London to save the cost of stereo circuits and in the interest of quality.

The vehicle can also be used at locations where the main commentary box is obscured from some of the action. For example, at race courses a second commentator can view the start of a race from the link vehicle, handing over the commentary when the field is in view of the main commentary box.

A radio-link vehicle, with its mast extended, outside the new Radio OB base at Acton

Digital Recording Vehicle

The first Radio Outside Broadcast use of digital tape recorders was in 1979 when the Christmas Carol service was recorded at King's College, Cambridge, using the Sony PCM 1600 and two Umatic video tape recorders and broadcast from London on Christmas Day. This first field experiment with audio digital recorders quickly demonstrated the need for a dedicated vehicle for experimental recording work that would not be subject to the normal hurly-burly of radio production recordings.

Radio OBs New Base

Interior of the digital recording vehicle. The two Mitsubishi/Telefunken recorders are at the rear (centre right).

The vehicle chosen was a modified Type C vehicle with an extended roof housing small windows, and equipment mounting racks and benches.

Two Telefunken/Mitsubishi MX80 recorders (second generation equipment) are now mounted at the rear of the vehicle. A standard Glensound MX 6/3 mixer is fitted together with a DK 2/20 mono monitor facility and DK 2/21 stereo monitor facility. LS 3/35A loudspeakers allow the engineer/operator to monitor the incoming signal.

Only one vehicle is in service, based in London, it can be called on to travel to any part of the UK or the Continent.

Radio Taxi

For the most comprehensive work in the field of radio news reporting, the BBC has for many years used a radio car. The Radio Taxi was introduced in 1967 because it offered many advantages over more conventional vehicles, combined with reliability and long intervals between engine overhauls.

Based on the familiar British Leyland London taxi, the vehicle has been modified to meet the needs of radio reporting. The rear compartment of the vehicle has been retained for use by passengers, and has been equipped with permanently installed microphones as well as loudspeakers and headphones for cue and talkback purposes. Tinted glass has been fitted to allow privacy to interviewee and interviewer.

The centre of the vehicle has been adapted with a 6 metre pneumatic mast equipped with vhf programme link aerials. A sunshine roof has been fitted to allow work on the mast when retracted, and to offer a reasonable vantage point from which the reporter can observe events and commentate, if needs be.

The normal luggage compartment of the vehicle, to the driver's left, has been converted to house the technical equipment. The controls face the engineer, who also drives the vehicle, so that he can operate the equipment without leaving his seat. Included in the equipment are a reel-to-reel recorder, cassette machine and small mixer; tape editing can be done on the spot.

A 40W vhf frequency-modulated transmitter allows the programme to be relayed to one of three intermediate base stations in London, and then back to Broadcasting House; a 5W transmitter is provided for standby working. Editorial control is exercised using a standard uhf radio-telephone system and a car receiver is used for checking the broadcast programme.

The boot houses a battery compartment for the technical equipment and a store for drums of microphone cable for remote working. The equipment works on a mixture of 12V and 24V batteries which are re-charged when the vehicle returns to base.

Radio Caravan

For some outside broadcast applications where complicated communications and mixing facilities are not required, eg. for tape editing, news reporting etc., Radio Outside Broadcasts use a converted caravan.

The interior has been divided into three compartments with an entrance into the middle one. Fixed wiring interconnects the three areas via standard XLR-series sockets and equipment is normally installed and de-rigged for each broadcast. This arrangement provides great flexibility in practice.

For most applications one end of the caravan becomes a studio and the other acts as the control cubicle. The intervening space houses recording equipment. On other occasions, such as the State Opening of Parliament, one end is used for the *ceremonial** mix position and for distributing this (to the Television service, for example). The other houses the Radio commentator and mixes his commentary with ceremonial output to provide the programme. The central part of the caravan is used for standby recording facilities.

Multi-track Recording Vehicle

For specialist recording applications Radio Outside Broadcasts use analogue multi-track recording techniques. A single dedicated vehicle has been constructed to accommodate the expensive and complex multi-track recorders, and is designed to work alongside a stereo control vehicle (SCV).

The vehicle houses two Studer A800 24-track tape machines which can be remotely controlled from the SCV. A pair of LS 5/8 loudspeakers are provided for monitoring purposes at the rear of the vehicle. Line-up and technical monitoring is accessed via a technical bay.

Multi-track recording vehicle

The tape machines are not permanently installed in the vehicle, being used in studio locations or in the stereo control vehicles (SCV1 or 2) at other times. To ease the installation and removal of the machines the vehicle has been fitted with double rear doors and a tail lift.

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* *Ceremonial* mix is the name given to *programme-without-commentary,* an arrangement used for ceremonial events so that several alternative commentaries can be added separately to a common background to provide a number of services for television, radio and other broadcasters.

Tread Safely — On Ladders

A second article by Dennis Turner, the BBC's Engineering Safety Adviser on a subject of importance to all staff called upon to work at heights.

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Ladders are used a great deal in the BBC for access to such places as camera platforms, lighting points, masts and towers, as well as during construction and maintenance.

BBC safety regulations say a good deal about the safe use of ladders – particularly General Safety Regulation No. 10. In this article, however, I am singling out the do's and don'ts of ladder safety. Most important of all is that we must remember that anyone planning a job of work must always remember the question of safe access and this may include the use of ladders. When ladders are used they must be of the right length and there must be enough of them.

With the exception of secured vertical ladders, all ladders in use should be placed at the optimum angle of 75 degrees, i.e. for every four units of vertical height the ladder should be placed one unit out at the base. The ladder chosen should be of sufficient length that it can be used at this angle and can also provide hand-hold when the user is as high as he need to go. All ladders except secured vertical ladders must be positioned on a firm base.

Ladders used as acoess to a working platform, walkway or landing should be fixed so that they reach far enough above the landing place to enable the person using the ladder to have a good hand-hold while he is transferring to or from the ladder – usually ladders should reach at least 1m above the landing place.

Except where they are used vertically, ladders must not be extended by being lashed together. Rungs in any overlap of ladders used vertically should be in line and the overlap on the higher ladder should be placed adjacent to the structure.

The rungs of ladders should not be used as a support for scaffold boards, etc. Ladders must not be positioned so that a rung is used as a means of support for the ladder.

When there is some form of high tower, the need to use several ladders as a means of access will arise. There must be landings in such a ladder system. These will enable the person climbing the tower to rest and transfer to the next section without difficulty or danger. Landings should be of a reasonable size and should be equipped with guard-rails and toeboards.

Openings in landing places through which ladders pass should be as small as practicable but large enough to enable a person to transfer to the landing place or to the next ladder section without difficulty of danger.

Never use improvised ladders. All components of any ladder system must be properly fixed and a check made to ensure that parts are secure prior to the ladder being used as an access way.

In cold and wet conditions check the ladder for ice and wet. If there is any doubt as to its safety, the ladder should not be used and its condition should be reported to the supervisor.

Ladders should not be painted, as this can obscure defects. Every ladder should be regularly inspected. A preliminary inspcetion of the ladder before using it should include a check to see that the rungs are fit for use. Ladders with rungs not correctly fixed to the stiles, or with rungs that are broken or missing must not be used. If a ladder is found to be defective it should be removed from service and the necessary repairs carried out before it is returned into service. If a defective ladder is beyond repair it should be removed from site and destroyed.

A high proportion of ladder accidents occur because the ladder slipped in use. The only sure method to prevent a ladder from slipping sideways is to secure the ladder at the top. Using sandbags at the foot of the ladder or stationing a second person to foot the ladder may be reasonably effective against preventing the bottom of the ladder slipping outwards, but it is not much use in preventing sideslip. Tying the ladder off at the top or using a device such as the Smith Ladder Limpit will be necessary.

In some circumstances it may be necessary to resort to bottom support for the ladder together with lateral guys, but this is very much second best to a ladder secured near the top. Where the stiles of ladders do not rest on the ground or on a platform, e.g. in the case of two or more vertical ladders lashed together, each stile should be lashed at the top with a 'round turn' and similarly at the bottom wherever it is practicable to do so.

Anyone intending to use a ladder should ensure that their footwear is in good condition and free from grease, mud and other contaminants before they start to use the ladder. Smooth 'polished' soles on footwear can be particularly dangerous. Grease and mud on footwear could cause you to fall and will create a slippery surface on the rungs leaving a dangerous condition for others.

Before using a ladder, you should also see that any grease or mud, etc. on your hands or gloves is cleaned off as far as possible. Both hands should be used when climbing or descending a ladder. The rungs should be gripped in preference to the stiles because the hook action of the hands on the rungs is more likely to hold your weight if you slip. A grip on the stiles is not as efficient in this respect.

Tools should be carried slung from a belt or containers. 'Frogs' used for podger spanners, hammers or similar tools should be made so that they prevent displacement of the tools. Tools and equipment which is bulky or heavy should not be carried up by anyone on a ladder but should be lifted separately by a hoist line or other appropriate lifting appliance.

A ladder should not be used as a workplace unless the provision of a separate platform is inappropriate. Where a ladder has to be used as a temporary working place, and the ladder does not extend for sufficient distance above the rung being stood on to provide adequate handhold, another form of secure handhold must be provided.

A ladder should never be left unsecured in a standing position where it could be knocked over. A ladder that has been used in a temporary position should be removed to its storage place as soon as the work has been completed. It should not be left where it can be used in an unauthorized manner.

Climbing Wrotham's new mast

BBC Starts Fibre Optic Cable Television

Since December 1982, a fibre optic cable has been used to carry television pictures from the Television Centre to the nearby Topical Production Centre at Lime Grove, the home of Breakfast Time, Nationwide and Newsnight. The BBC already uses over twenty conventional coaxial circuits between the two sites. But this was not enough. The new fibre cable, the result of co-operation between Communications Department and British Telecom, will allow for four additional circuits. Although sophisticated digital terminal equipment for the fibre has been developed by engineers from Designs Department, the fibre was first used in a series of experiments by Research Department.

The optical fibre cable contains eight graded-index multimode fibres, and was installed in the existing ducts between the studio centres, a path length of about 800 metres. In the Research Department experiment signals were carried on a single fibre, the basic bit rate of 216 Mbit/s being increased to 280 Mbit/s by channel coding. A direct modulated 820 nm laser transmitter was used, the power launched into the fibre being 600μW.

As the television signal was carried in separate component form, pictures of original RGB quality were obtained at the receiving terminal. This avoidance of intermediate PAL coding will allow remote down-stream processing, e.g. colour separation overlay and special effects, to be done with a precision which has hitherto only been achieved at the source itself.

This experimental optical transmission forms part of a Research Department study into methods of interconnecting digital television studios. The recent International agreement on digital sampling standards for component coded video signals has prompted Designs Department to investigate digital engineering techniques in the 200-300 Mbit/s range. The inherent wide bandwidth of the optical fibre makes it an attractive proposition for use at these very high transmission rates. Designs Department have therefore developed some new terminal equipment for use on the fibre optic cable.

Since the operational need for component coded transmission is still some way in the future, however, the terminal equipment now in use has been designed to transmit two composite coded channels over one fibre at a transmission rate of 280 Mbit/s. The equipment can be modified to carry a single component coded signal when the need arises.

Charles Sandbank (HRD) discusses the signals carried on the fibre optic cable with Richard Marsden (right).

The two fibres in use are of the graded index type, and the total loss of fibre and connectors is about 15dB. The optical connectors used are butt-jointed connectors of the 'epoxy and polish' type. Light is launched into the fibre by a semiconductor laser and the mean power launched is less than the Research Department experiment being 500μW. About 15μW is received at the end of the fibre and a PIN diode is used to convert the optical signal back into its electrical form.

Two analogue to digital convertors (ADCs) in the transmitter convert the incoming composite-coded video signals into 8-bit digital words. Each input is sampled at 14MHz. The sampling frequency is not locked to line or subcarrier frequency, and the equipment is not limited to PAL coded signals, it will handle NTSC and SECAM signals as well. The 8-bit words from the ADCs are reconverted into 10-bit words for transmission so that the serial bit-stream will contain adequate information for framing and clock recovery at the receiving end.

The 10-bit words are then serialised into a 280 Mbit/s data stream. The receiving end reconstructs the 8-bit video samples from the recovered electrical signal and two digital to analogue converters (DAC's) regenerate the original video signals. The ADCs and DAC's are standard BBC designs.

Many of the devices used in the equipment operate with sub-nanosecond gate delays and careful attention has to be paid to their interconnection. The critical parts of the transmitter and receiver use three layer boards in which the central layer is used as an earth plane. This allows interconnections to be treated as microstrip transmission lines, but retains the flexibility of a conventional double-sided board.

The new 2-channel PCM equipment has been proved over a 1km cable, but should be capable of operation for distances over 4km.

The development of the high-speed digital transmission equipment, and the use of optical fibres, is producing valuable experience of the use of these two technologies in an operational broadcast environment. The optical fibre cable, together with the associated terminal equipment, provides a high quality transmission path in which the signal distortions are limited to those encountered in the ADCs and DACs.

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FM TV Stereo Sound OK But Digital System may be Better

Towards the end of last year Research Department conducted over-air tests to establish whether a two-carrier sound-with-television system can be compatible with normal uhf reception. These tests, (see Eng Inf No 10), took place out of normal service hours and were observed by staff from the BBC, ITV and receiver manufacturers in the area served by the Crystal Palace transmitter. A total of 414 questionaires were completed, and the analysis of these is now complete.

The system tested is a variant on that used for stereo tv sound in Germany, in which the additional sound signal is carried on a second fm carrier set at around 7 dB below the main sound carrier and separated by some 300 kHz from it.

The results confirmed the expectation that crosstalk from the second sound signal into the first is not a problem, and that patterning caused by beats between the sound carriers can be kept to a tolerable level if the amplitude of the main sound carrier is reduced a little. They also showed, however, that buzz-on-sound can be a problem with existing receivers, regardless of the level of the second carrier, and that this buzz problem is increased by turning the main sound carrier down. Buzz is to some extent receiver-dependent, but the main factors affecting it are multi-path propagation, which can cause the received sound-to-vision carrier ratio to vary by ±5 dB or more, and the spectral content of the picture. All in all it appears that a system of this type might give a largely satisfactory service, but investigations are continuing into alternative possibilities.

Stereo tv sound will be available from 1986 via DBS in digital form, and broadcasts of this sort might precede terrestrial two-channel sound with television. It is thus important to establish whether a digital sound package could satisfactorily be received from terrestrial transmitters as perhaps a better alternative to a second fm carrier. Preliminary assessments indicate that the digital option could give a better compromise between compatibility and ruggedness. A thorough examination of the digital method has therefore begun, and this will call for further over-air tests in due course.

Howard Jones of Research Department presented a paper explaining the results of the tests in greater detail to an IEE Colloquium on "Dual Channel TV Sound: Terrestrial Broadcasting and Reception" on 18th April.

Italian Sports OB uses BBC Satellite Ground Station

Television OB Communication's mobile satellite ground station was recently loaned to RAI (Radiotelevisione Italiana), the Italian State television service, for use at the International Slalom Ski event held at Bormio, Italy, late last year. The ground station was used, from this most difficult outside broadcast site, because a terrestrial network would have required five microwave radio links. The operation was most successful with pictures of excellent technical quality being sent via satellite to the fixed ground station at Milan for local and European distribution.

The satellite terminal has been in service with Tel OBs since 1981 and has been used successfully at various OB locations in the United Kingdom. This is not the first time the ground station has been used abroad. It was taken to Spain for coverage of the recent World Cup where it was used to send back exclusive pictures of the English, Scottish and Northern Ireland teams.

The terminal is engineered as a compact trailer-mounted installation for operation in conjunction with standard towing vehicles. A transportable case, which can be carried in the towing vehicle, houses the transmitter remote control and monitoring equipment and the baseband video and audio interfaces. This enables operation of the terminal with the trailer completely unmanned. The four-wheeled trailer accommodates a platform mounting the dish antenna and a lightweight, compact equipment container. A maximum antenna diameter, consistent with trailer headroom constraints, coupled with a new efficient transmitter design, enables the terminal to operate on a single-phase a.c. mains supply, an important advantage in OB service.

The standard 3-metre dish antenna has a single polarisation feed with provision for precise polarisation adjustment to prevent interference with other channels on the other polarisation. Antenna movement is by electric actuators for azimuth and elevation, controlled either from the trailer cabinet or from the remote control panel. Initial azimuth alignment is by manual rotation of the antenna platform, thus avoiding any need for critical positioning of the trailer when setting up.

The trailer container, housing the transmit and receive cabinets, has good access for equipment line-up and servicing. The cabinets house the following principal items: Two 600 W air-cooled 14 GHz TWT high power amplifiers, with redundancy switching; six-channel crystal controlled 70 MHz to 14 GHz up-converter; a test translator 14-11 GHz with switching to facilitate monitoring the transmitter signal, or as received at 11 GHz through the satellite. There is also a control panel with channel selection for transmit and receive frequencies; antenna azimuth and elevation controls; sensitive beacon receiver; six channel crystal-controlled 11 GHz – 70 MHz converter; wide band satcom TV modulator and demodulator; power supply units and a mains distribution panel.

The mobile satellite ground station was built by engineers from Research Department. Designs details have recently been released under licence to Marconi Communication Systems for them to use in their new B4500 Transportable Satellite Terminal Equipment.

The BBC satellite ground station, seen here at Brighton, during IBC 82.

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Modular Audio Storage System

Designs Department engineers have produced a novel device to assist with line identification in control rooms, switching centres and at complex outside broadcasts. Known as MASS (Modular Audio Storage System) it can replay repetitive passages of sound, such as line identification messages or on-air 'jingles' without the use of conventional endless-loop magnetic tapes. Solid-state digital memory is used as the storage medium, giving the advantages of no deterioration in signal quality with time, no mechanical moving parts, no cleaning required, and no wow and flutter.

The audio signal is converted into digital form using 8-bit A-law coding, which provides adequate quality for speech, and some types of musical material. The signal is sampled at either 8 kHz or 16 kHz dependent on the type and length of message to be recorded. Different plug-in cards provide blocks of memory which can store separate messages in various formats; for example, one card allows the option of one channel with 3.25 kHz bandwidth, and 32.8 seconds duration; a second option accommodates one channel with 6.5 kHz bandwidth, and 16.4 seconds duration. The third option provides two channels with 8.25 kHz bandwidth and 8.2 seconds duration, the component package density of this card preventing longer duration messages. There is a space in the mounting frame for five cards in any combination.

Each channel can be selected individually for recording, and the message will subsequently be replayed continuously on a repetitive basis. Alternatively, the channel can be set so that once it has delivered the message, it switches to an external source for an equal length of time; this allows bursts of line-up tones, etc., to be included in the output. The digital data for each message is stored in up to 256 bytes of Dynamic Random Access Memory (DRAM). The memory devices are volatile, so a standby battery unit is included that will allow the messages to be stored for several hours. The batteries are trickle charged during normal mains operation, and cut in automatically should the mains fail.

The first prototype equipment was designed by a Designs Department team led by John Robinson, and hard-wired by Radio Technical Services. It was used for the Royal Wedding in 1981. A second prototype was made by SCPD and will be used to provide the 'jingles' for the Open University programmes in the early mornings.

A third prototype was constructed using computer aided design (CAD) techniques for the printed circuit boards. PCB Assistants Roger Benfield and Karen Jones were responsible for the new layouts. This prototype was installed in the International Control Room at Television Centre just before the European and Commonwealth Games in 1982.

More recently John Robinson has modified the equipment for a variety of different uses. For example, it can be used as an audio delay line. This could be useful for phone-in programmes when it could act as an obscenity delay.

By an ingenious arrangement using a Designs Department 'ADZE' Z80 micro computer board, MASS has been used for audio logging. For example, it was used to find out the frequency and timing of disturbing clicks on a contribution circuit from Birmingham to London. The clicks were converted to logic pulses and used to trigger ADZE, which, in turn, controlled the operation of a stereo cassette recorder. At the same time the programme, complete with clicks, was fed to MASS, configured to give a 16 second delay. The output was fed to one channel of the stereo tape recorder, which was by then already running in the record mode. Thus there was a complete recording of the programme, from just before, until just after, the click. The second record channel was wired to the speaking clock, so that an accurate time check was available when the recording was re-played for analysis. ADZE was also used to count the total number of clicks. The computer inhibited the operation of the cassette recorder when the cassette was full, and prevented accidental manual operation of the recorder controls.

Remote Control Standardisation

An EBU G5 Sub-committee, concerned with the remote control of broadcast equipment, has been working in close co-operation with a similar subcommittee of the SMPTE in order to produce a specification that would be acceptable to both industry and broadcaster a like. At a recent SMPTE conference in San Francisco the EBU subcommittee, chaired by Mike Stickler, who was accompanied by fellow SCPD engineer Paul Jarrett, reached agreement with the SMPTE on a proposal for a common specification for the remote control and networking of broadcast equipment. The proposal has been passed to the EBU full Technical Committee for its approval.

Agreement on a common standard is significant since the SMPTE includes industry as well as broadcasters. Equipment manufacturers in Japan, Israel and Australia, as well as those in Europe and the United States will all benefit.

So why have a common standard anyway? At the moment each manufacturer provides his own remote control mechanism. Although equipments made by the same manufacturer may be interchangeable, only providence would allow, say, one make of VTR to be plugged into the remote controller for another and actually work. A common standard will allow greater interchangeability of equipment, and even for commonality of simple control functions such as START and STOP.

How is this achieved? The proposal lays down the specification for a local network, and also defines a bit stream for each discrete control function, which will be the same for any 'machine' or piece of equipment of the same generic type - VTR, TK, pulse generator etc.

The bit rate, form, and location of control characters in the data stream will always be the same. The 'message' will pass over the network from the remote controller to a 'virtual machine' which will interpret the common standard and pass this information to the equipment's own control system. Virtual machines would be incorporated in new equipments, but could also be added to existing machines to bring them into line with the common network standard. 'Gateways' from each local area will feed a common interface 'bus'. Thus additional remote devices can be assigned to the network via the appropriate gateway, to supplement or replace existing local machines.

What does the new standard actually say? Full details can, of course, be obtained from the EBU, but in summary it fully defines the network supervisory protocol, access method and linkage mechanism; and also defines the data interchange required between the controlling and controlled devices during each operational session.

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