

A transportable satellite earth station for television outside broadcast contributions

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Summary The BBC Television Transportable Satellite Earth Station was introduced into service in November 1981. It was designed to exploit available communications satellites to provide contribution vision and music circuits for television outside broadcasts.

Initially these would be via OTS (Orbital Test Satellite) but it is hoped that access will eventually be

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obtained to the ECS (European Communications Satellite) series of satellites.

This article describes some of the design constraints and BBC experience so far with such a terminal.

The BBC has licensed Marconi Communication Systems to manufacture transportable satellite terminals based on this design.



Introduction

The availability of communications satellites in Europe prompted the BBC to consider the feasibility of using satellites as a means of providing television outside broadcast sound and vision contribution circuits. The Orbital Test Satellite (OTS) was still serviceable after completing its initial two-year test programme and was then made available by Interim Eutelsat on an ad hoc basis (see figure 1 for footprints). The first of a series of five European Communications Satellites (ECS) would be launched in 1982/1983 with a prospect of the European Broadcasting Union leasing the exclusive use of two of its transponders.

BBC Research Department, in co-operation with Television Outside Broadcasts Department, considered the possibility of designing a practical transportable satellite earth station. It was important that any design should be compatible in all respects with exist-

ing units in the outside broadcast fleet, should have the necessary mechanical stability and be simple and versatile in operation.

Design features

Various forms of vehicle combinations and configurations were considered before deciding to adopt a two-axle trailer towed by a standard radio-link vehicle.

The dish antenna, together with a cabinet containing the r.f. equipment, is mounted on a turntable on the trailer to enable it to be panned through 360° azimuth.

This configuration allows the waveguide to be permanently connected and pressurized, and also minimizes its length and therefore its loss.

The size of the dish antenna is restricted to that which can reasonably be stowed on a road trailer for travel-

ling, without creating an excessive headroom problem at low bridges. It was not considered practicable to use a prefabricated dish and three metres emerged as an optimum size.

In order to saturate the satellite transponders with this size antenna it is necessary to employ a high power amplifier (h.p.a) of 600W. To this end, a compact and lightweight h.p.a was designed incorporating a travelling-wave tube, and an essential feature of the design is the ability to operate from a standard single-phase mains supply. Two such h.p.as are incorporated in a dual redundant mode.

The radio link vehicle houses all the metering and control equipment for the terminal, together with sound and vision monitoring. It is connected to the terminal via a single multicore cable (a separate power cable is also required) and can operate up to 400 feet away. The radio link vehicle can also be used to carry additional terrestrial radio links should it not be possible to park the satellite terminal at the programme source.

Acceptance testing

The Transportable Satellite Earth Station was completed at BBC Research Department in October 1981 and immediately went into a combined acceptance testing and training programme for operational staff, before being handed over to Television Outside Broadcasts. This was closely followed by a demonstration at the I.E.E., Savoy Place, London, and this was the first opportunity to check the system in an operational environment. Vision and sound signals were transmitted via OTS to the Goonhilly earth station and back to Savoy Place. This demonstration proved that the terminal could operate from two parking meter bays very satisfactorily. The opportunity was taken to check the safety aspect of operating in this way and it was found that wherever it was possible for people to gain access, the radiation hazard was nowhere near the maximum permissible.

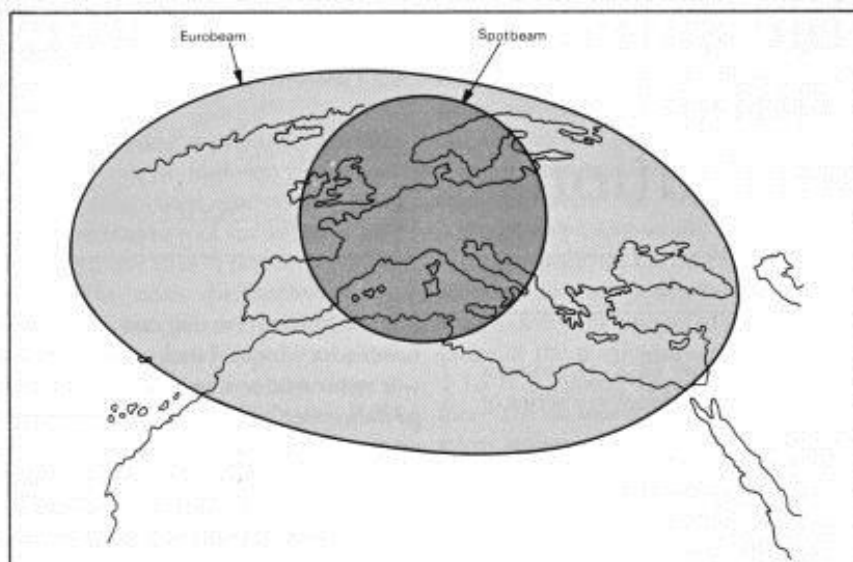


Fig. 1. Orbital Test Satellite-footprints

Operational experience

The first programme commitments were three live transmissions from the island of Guernsey: a 'Morning Service', a 'Nationwide' insert and 'Multi-Coloured Swap Shop'. It had initially been thought that the terminal would have to be sited centrally on the

island and that each programme would be linked into it. However, at the initial planning meeting it became apparent that, because of its small size, the terminal could easily be integrated with other OB vehicles on site and, as the dish elevation was 32° , the main beam was well clear of local houses



Fig. 2. Satellite earth station with a standard radio-link vehicle



Fig. 3. Satellite earth station in use (checking stray radiation)

only tens of feet away. Power requirements are small (7kVA single-phase) and so the initial tests could be carried out before mains power was available using a small trailer-generator. The vision circuit test was conducted satisfactorily using the OTS Channel 4 spot-beam transponder to Goonhilly and a second test was conducted to confirm that Channel 2, Euro-beam to Goonhilly, was also acceptable.

Tension mounted as line-up time approached, 30 minutes before the first transmission. Apparently there had been a booking error and the Channel 4 transponder booked by the BBC was already in use and could not be cleared. However, a French booking on Channel 2 was kindly made available and, because of the versatility of the terminal, the frequency could be changed in seconds and we were able to establish vision and music circuits through Goonhilly to London with less than five minutes to go. The 'Morning Service' transmission that followed was completely satisfactory.

The terminal was not moved to Guernsey Harbour until noon on the day of the 'Nationwide' transmission. During the afternoon the terminal was parked, levelled, the dish panned onto the beacon and a circuit test conducted to London, all in plenty of time to meet the 18.00 hours transmission. Two days later, a circuit was established from Guernsey Harbour to the IBA Headquarters at Crawley Court as a demonstration to an EBU Sub-Group T7 delegation. Again there had been an error in the satellite booking and it was necessary to transfer to the alternative polarization of Transponder 4 at the last moment, an operation which was completed in under one minute. For the final transmission from Guernsey, the vision and music circuit was linked from the mobile control room to the satellite terminal using a conventional single-hop terrestrial link. The weather conditions were appalling, torrential rain and Force 8 gales yet, despite the terminal being in a very vulnerable position at the end of the harbour jetty, the transmission was completed entirely satisfactorily, a credit to the stability and durability of the unit.

In February last year, the terminal was used to link the 'Ben Nevis Climb' to London and though finally the climb had to be called off because of bad weather conditions, all the circuits were established entirely successfully.

It was anticipated that the unit would have to operate in extremely low temperatures and so before travelling to Scotland it was taken to the British Aerospace Test Centre, where all systems were checked after 24 hours with the air temperature outside the equipment cabinet at -20°C . All systems were found to be working satisfactorily.

Going from one temperature extreme to another, the terminal was taken to Spain later on in the year to cover World Cup football. Here it travelled to many venues over the five-week period and completed 24 separate transmissions successfully. Temperatures as high as 49°C were recorded in the cabin and yet, despite this, the equipment – if not the staff! – survived the heat.

Other outside broadcasts have included St. David's Cathedral, Wales, for the Maundy Service; Hawick Rugby (this was undertaken during the actual time OTS was being moved from 10°E to 5°E with no problems); and Canterbury Cathedral for the Pope's visit. Our experiences to date show that the terminal can be parked and locked onto the OTS satellite comfortably within one hour.

So far, in just over a year, we have completed over 180 hours on transmission through OTS without breakdowns and have covered 9500 road miles.

At the time of writing, the terminal has just returned from Northern Italy where it successfully relayed skiing for RAI.

Conclusions

The BBC is hoping to continue to use the terminal to provide circuits that would otherwise be impossible using

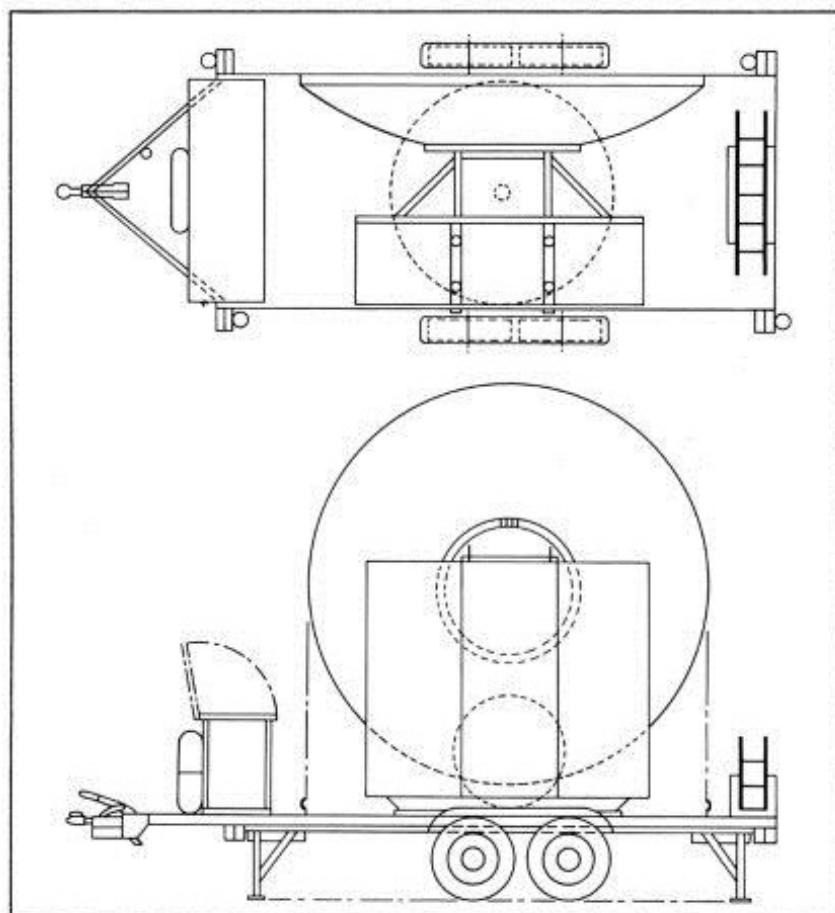


Fig. 4. Plan and side elevation of the satellite earth station

conventional terrestrial links, or where the use of these links would be prohibitively complicated. Even in the relatively short time the terminal has been in service it has proved how viable the whole concept is and the ingenuity of the design has produced an extremely practical operational unit. The key features of the terminal that have contributed to this conclusion are the dual-redundant h.p.a, frequency agility, single-phase mains, and easy integration with existing OB vehicles.

The BBC has licensed Marconi Communication Systems to manufacture transportable satellite terminals based on this design.

Acknowledgements

The author would like to thank Mr M. W. Harman and his colleagues of BBC Research Department for designing and manufacturing such a successful unit. Also thanks to the Director of Engineering of the BBC for permission to publish this article.

RÉSUMÉ

La station terrestre de satellite transportable de télévision de la BBC a été mis en service au mois de novembre 1981. Cette station a été conçue pour exploiter les satellites de télécommunications disponibles afin de fournir des circuits de contribution d'image et de son musical pour les émissions de télévision en extérieurs.

Initialement ces émissions étaient réalisées par l'intermédiaire d'OTS (Satellite d'Essai Orbital) mais on espère obtenir accès par la suite aux ECS (le satellite de télécommunications européen), les satellites en série.

Cet article décrit quelques contraintes de l'étude ainsi que l'expérience de la BBC jusqu'à présent, avec un terminal de ce type.

La BBC a donné autorisation à Marconi Communication Systems de fabriquer des terminaux de satellite transportables conçus sur cette étude.

ZUSAMMENFASSUNG

Die transportierbare Erdsatelliten TV-Station der BBC nahm im November 1981 ihren Dienst auf. Diese Einrichtung bezweckte die Nutzung bestehender Satelliten, um Bild- und Tonschaltungen beizutragen.

Anfänglich würden diese über OTS (Orbital Test Satellite) geführt werden, es wird jedoch gehofft, daß künftig auch Zugriff auf die Reihe der europäischen Kommunikationssatelliten (ECS) möglich sein wird.

Dieser Aufsatz beschreibt einige der Konstruktionsbedingungen sowie die bis zum gegenwärtigen Zeitpunkt von der BBC gesammelten Erfahrungen.

Marconi Communication Systems hat von der BBC die Lizenz zum Herstellen von transportierbaren Satelliten-Endstationen erhalten, die auf dieser Konstruktion basieren.

RESUMEN

La estación terrestre transportable de comunicación con satélites de la televisión de la BBC, fue introducida al servicio en noviembre de 1981. Fue diseñada para explotar los satélites de comunicaciones disponibles, con la finalidad de proporcionar circuitos de imagen y musicales de contribución a tomas exteriores de televisión.

Inicialmente, éstos se lograrían vía OTS (Satélite de Prueba Orbital), pero se espera que, con el tiempo, se obtenga acceso a la serie ECS (Satélite de comunicaciones europeas) de satélites.

Este artículo describe algunas de las restricciones del diseño, y la experiencia hasta aquí adquirida de la BBC con este terminal.

La BBC ha dado licencia a Marconi Communication Systems para fabricar terminales transportables de satélites basados en este diseño.