
600MHz Programme

Reference Offer Guide Book

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600MHz Reference Offer

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Document Details

General Detail	
Abstract	This Guide Book has been produced to provide potential 600MHz Multiplex Licensees with background information relating to the use of the 600MHz Reference Offers released by Arqiva during December 2011.
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1 Introduction

The Digital Switchover Programme, conducted over the period from 2008 to 2012, will allow a number of UHF channels to be made available for additional Digital Terrestrial Television services. It is understood that Ofcom will auction channels 31 to 37 during 2012 as part of the 'Digital Dividend' associated with the Digital Switchover programme.

Further to Ofcom's instructions, Arqiva has produced Reference Offers related to a relevant spectrum auction for UHF channels 31-37, referred to as the 600MHz band (frequency band 550 to 606MHz).

Arqiva has sought to provide a cost effective solution in respect of Network Access and Transmission Services. To this end, and in order to minimise the scope, duration and cost of the implementation programme, Arqiva has attempted to utilise existing infrastructure wherever possible. Whilst this will lead to reductions in available ERP at some stations (relative to that which would have been permitted by Ofcom) the network so provided will be more affordable and is expected to offer coverage to in excess of 85% UK population.

This Guide Book has been produced to provide assistance to potential 600MHz Multiplex Licensees in their understanding of the scope, purpose and relationship of the eight Reference Offers that have been produced relating to the proposed Ofcom 600MHz award. This Guide Book does not form part of any of the Reference Offers and potential customers should refer to the Reference Offers for details of full contractual terms and conditions.

Ofcom has defined 'hypothetical scenarios' which contemplate the provision of up to three DTT multiplexes from 80 DTT transmitter sites. These scenarios are defined in the Ofcom Provisional Specification in Appendix D and have formed the structure of the Reference Offer documentation set.

This Guide Book has been produced to provide potential 600 MHz Multiplex Licensees with background information relating to the use of the 600 MHz Reference Offers released by Arqiva during December 2011. While Arqiva has taken every effort to ensure that the information contained in this Guide Book is accurate, Arqiva does not make any representation or warranty as to the accuracy, completeness, or otherwise, in respect of the information contained in this Guide Book. The information contained in this Guide Book may be subject to change and Arqiva does not accept any responsibility, and does not give any commitment, to update the information contained herein. Arqiva shall have no liability whatsoever in respect of the information contained in this Guide Book and the only liability Arqiva shall have will be as set out under a formal contract based on the terms of the relevant 600 MHz Reference Offer. Nothing in this Guide Book shall form the basis of any contract and nothing contained in this Guide Book will be binding against Arqiva unless expressly agreed to by Arqiva under a formal contract based on the terms of the relevant 600 MHz Reference Offer.

Should interested parties require further information related to the Network Access Reference Offers, variations to the Network Access Reference Offers or related supplementary services they should contact Michael Giles (michael.giles@arqiva.com).

Should interested parties require further information related to the Transmission Services Reference Offers, variations to the Transmission Services Reference Offers or related supplementary services they should contact Steve Holebrook (steve.holebrook@arqiva.com).

2 Overview

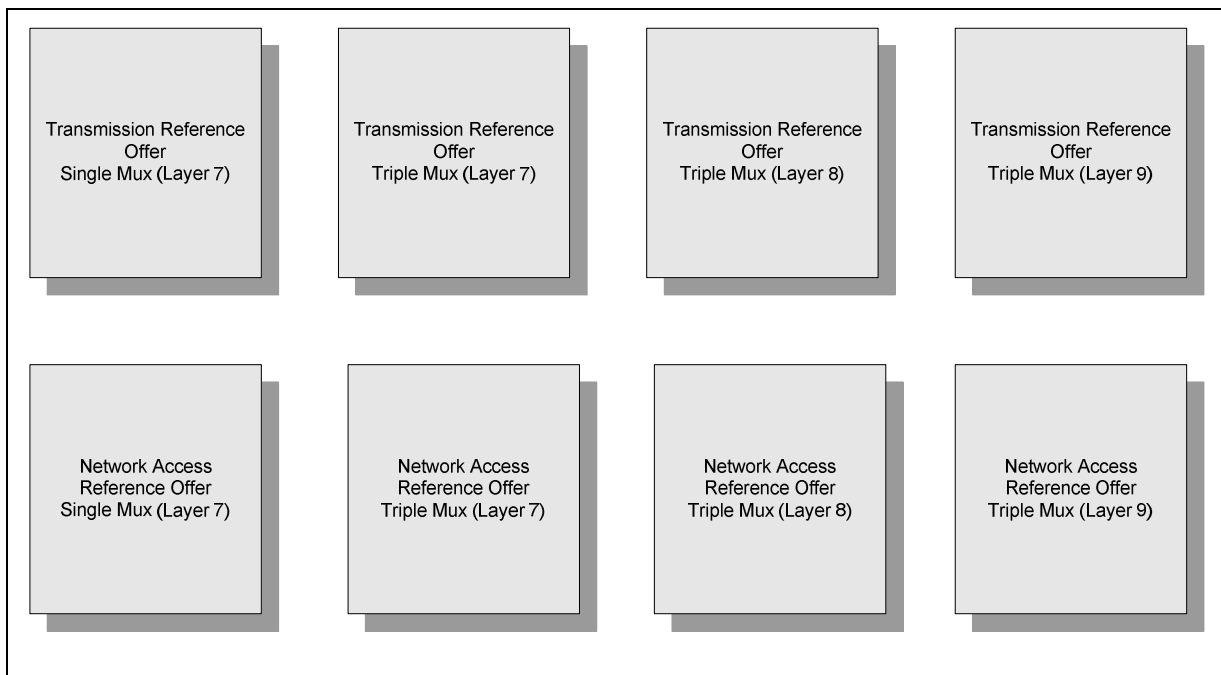
2.1 Reference Offers

In accordance with the scenarios defined by Ofcom, Arqiva has prepared Reference Offers related to the provision of services for the implementation and ongoing operation of Network Access and Transmission Services for potential 600MHz Multiplexes.

Network Access relates to the provision of shared or shareable facilities (including antenna systems, accommodation and power) at terrestrial transmitter sites across the UK to allow potential 600MHz Licensees to install and operate their own transmitters from the sites.

Transmission Services relate to the provision of a complete Transmission Service (including transmitters and auxiliary systems, monitoring and antenna systems) by Arqiva at terrestrial transmitter sites across the UK.

- Arqiva has produced eight Reference Offers related to the deployment of one multiplex either as the solitary multiplex (the Single Multiplex Environment) or as one of three multiplexes (the Triple Multiplex Environment) as shown in the diagram below. Ofcom has defined the technical parameters related to the three potential multiplexes as Layer 7, Layer 8 and Layer 9.



In the triple multiplex environment, the provision of services/facilities is based on the simultaneous and synchronous provision of facilities for the three multiplexes at each of the 80 sites. The Triple Layer Reference Offers are valid only in the situation where customers require either Network Access or Transmission for three multiplexes (i.e. in the event that one party were to require Network Access and two required Transmission this would lead to a requirement for revised offers). Provision of shared facilities (e.g. antenna systems) is dependent on the agreement of relevant specifications by all 600MHz customers.

Where multiple customers require 600MHz services then modifications to shared facilities, the number of stations required and/or the rollout plan required by any one customer may give rise to an alteration of fees for other customers. The Reference Offers are valid for the modelled scenarios only.

Agreement of specifications on a site by site basis, involving all customers, shall constitute the first stage of the programme. Once the specifications are agreed, where the customer or customers require alterations to the specification this shall be managed under a change control process.

Ofcom has outlined a potential alternative relating to the provision of transmission facilities to support five additional multiplexes (instead of the three contemplated above) at the top 20 UK stations by population. This alternative has not been modelled and would require considerable time and attention to develop a feasible solution, implementation plan and applicable costs. Initial considerations related to this alternative scenario are included in section 10.

2.1.1 Layer Definition

The current high power DTT network is based upon the requirement to transmit six high power digital multiplexes. In order to conduct the necessary technical analysis of the scenarios, Ofcom has defined a set of assumptions surrounding the parameters associated with each of the three potential additional multiplexes.

The parameters defined for each of the three multiplexes are referred to as 'Layers' within the context of the UK Frequency Plan (where 6 multiplexes i.e. six 'Layers' already exist) and are defined in *Table 1*.

Name	Type	Channels
Layer 7	Multi-frequency network with regional synchronisation of some transmitters	31, 32, 33
Layer 8	Multi-frequency network with regional synchronisation of some transmitters	34, 35, 37
Layer 9	Single frequency network	36

Table 1 Layer Definitions

The three 600MHz 'notional' multiplexes have been specified with a parameter set referred to as Layer 7, Layer 8 and Layer 9. Only the Layer 7 parameter set has been considered under the single multiplex scenario. The requirements of all three layers have been considered in the triple multiplex scenario, but the charges relating to a single multiplex (i.e. one for each of the Layers) are provided in three separate Reference Offers. Layers 7 and 8 are similar in their architecture but Layer 9 has been defined as a Single Frequency Network. For Layer 9 only 78 sites are required and, due to the requirements of an SFN architecture, signal processing equipment has not been included.

2.1.2 Site List

The 80 sites included in the Reference Offers are listed in Appendix A. This list has been defined in the Ofcom Specification. Arqiva has divided these into the Station Service Category A sites (Upper 50) and the Station Service Category B sites (Lower 30) sites. All these sites will radiate six high power DTT multiplexes as part of DSO by the end of 2012.

Due to capacity and/or planning issues the following site substitutions have been made to the Ofcom list:

- Sutton Coldfield replaced with Lichfield*
- Pontop Pike replaced with Burnhope
- Rowridge replaced with Chillerton Down**

* Arqiva may provide transmission from Sutton Coldfield in the event that Town & Country Planning issues may be resolved.

** Arqiva may provide transmission from Rowridge in the event that Town & Country Planning issues can be resolved.

2.2 Using the Reference Offers

Customers requiring a comprehensive service should refer to the Transmission Services Reference Offers.

Customers interested in installing their own transmission equipment at the stations should refer to the Network Access Reference Offers. These terms are explained in Section 2.3 - Network Access and Transmission Scope.

2.2.1 Pricing

Interested parties should note that pricing will depend upon the requirements of all customers and these Reference Offers are specific to the set of circumstances that have been defined therein.

In the case where a multiplex is deployed as one of three, the pricing is valid only for the simultaneous deployment of three multiplexes defined as Layers 7, 8 and 9 in accordance with the technical assumptions set out in the relevant Reference Offer and in the timeframe specified therein.

All the Reference Offers relate to facilities and charges for a single multiplex in either a single multiplex or triple multiplex environment.

In the case of a single multiplex, as the sole 600MHz deployment, the pricing is specific to Layer 7 only in accordance with the technical assumptions set out in the relevant Reference Offers and deployed in the timeframes specified therein.

Under circumstances where more than one multiplex is deployed the charges related to each of the multiplexes are dependent upon the collective requirements of all customers. The Reference Offer charges assume simultaneous deployment (on a site by site basis) of services/facilities for all three multiplexes at each of the 80 stations in the timeframe defined by the appropriate rollout plan.

2.2.2 Limitations

The Reference Offers are based upon the provision of services at the maximum ERP permitted by the antenna infrastructure.

In respect of the Transmission Services Reference Offers, Arqiva would provide transmission systems to allow the Maximum Permissible ERPs (as limited by the antennas) to be obtained.

In the Network Access Reference Offers, customers should note that the antennas would be capable of supporting the Maximum Permissible ERPs as stated in Network Access Reference Offer Schedule 11 during nominal operation and in emergency antenna mode, when transmitters are operating at their specified level. Customers would be free to operate transmitter systems with output powers which would allow ERPs up to the maximum specified to be developed.

In an effort to minimise the time and cost of deployment, Arqiva has sought to utilise existing antenna infrastructure where possible. This leads to a situation where the ERP that would have been permitted by Ofcom (as stated in the Ofcom Provisional Specification) will not be available from a number of sites under the Reference Offers.

Transmission powers may be limited by up to 10dB below the Ofcom provisional operating ERP at some stations under nominal operating conditions.

Arqiva believes that, under the nominal operational conditions, coverage should be available to in excess of 84% of UK homes (depending on the specific Layer, local conditions and the characteristics of domestic installations). However, the Reference Offers do not guarantee levels of coverage and interested parties should consult Ofcom for information on potential coverage.

It should be noted that, in some areas, the 600MHz channels shall not be in the traditional transmission band and domestic receiving aerial replacement may be required.

Note: Provision of compression services and signal distribution to the 80 sites is beyond the scope of the Reference Offers. Such services are available from Arqiva upon request.

2.2.3 Bespoke Solutions

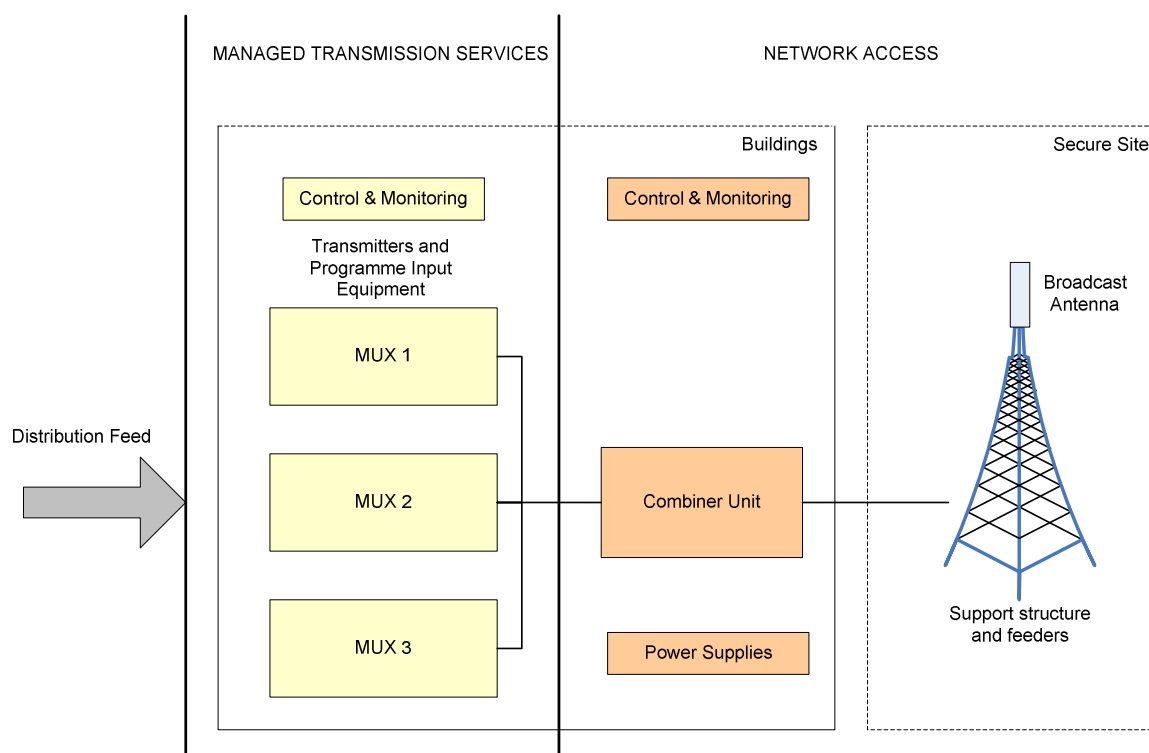
Should alterations be required to the technical specification at any of the 80 sites listed in the Reference Offer, e.g. increased ERP to improve coverage, or if a different number of stations are required, Arqiva will be able to provide estimates for such alternative requirements. Alteration of the

technical specifications at any station by any customer will give rise to a modification to the overall technical solution and relevant charges.

To request a variation to any of the Reference Offers please refer to the contacts in Section 1 - Introduction. Arqiva will provide a proposal, detailing charges and timescales, for the preparation of bespoke solutions.

2.3 Network Access and Transmission Scope

Arqiva has produced 'Reference Offers' related to 'Transmission Services' and 'Network Access' and the scope of these terms is identified in the following paragraphs.



2.3.1 Transmission Services

This is the provision of a Transmission Service for a single digital terrestrial TV multiplex from the 80 transmitter stations listed in Appendix A and comprises both the Managed Transmission Service and Network Access elements shown in the diagram above. At each station, Arqiva would be responsible for the following:

- Provision and use of dedicated signal processing equipment
- Provision and use of dedicated transmitter systems
- Provision and/or use of shared antenna systems
- Fault management and rectification by Arqiva's nationwide Transmission Service Team
- 24 x 7 monitoring and control
- Comprehensive service reporting

For the avoidance of doubt the following facilities, although available from Arqiva, are *not* within the scope of the Transmission Services Reference Offers.

- Playout facilities
- Compression systems

- Signal distribution to terrestrial transmitter sites

2.3.2 Network Access

This relates to the provision of facilities, at the 80 transmitter stations listed in Appendix A to allow the customer to locate their own transmitter system at the stations. Arqiva would, at each of the 80 stations, provide.

- Provision and/or use of shared antenna systems
- Accommodation
- Provision of power facilities
- Site security
- Facilities monitoring
- Facilities maintenance

For the avoidance of doubt the following facilities, although available from Arqiva, are *not* within the scope of the Network Access Reference Offers.

- Playout facilities
- Compression systems
- Signal distribution to terrestrial transmitter sites
- Signal processing equipment
- Transmitter systems

2.4 Rollout Plans

Appendix B contains Rollout Plans showing key milestone dates and activities for the single and triple multiplex deployment.

The rollout plans have been produced based upon the prioritisation of sites in maximum population coverage order and antenna requirements, i.e. commencing with sites where antenna works are not required. Services are planned to launch in 2014 and 2015 at the majority of Stations. Where three multiplexes are deployed, the rollout plan will continue into 2016.

The following tables are approximations of potential coverage and Arqiva provides no guarantee or warranty whatsoever in respect of coverage. Population coverage will vary for each of the Layers and potential 600MHz Multiplex Licensees should consult with Ofcom for further details.

The tables indicate the number of sites planned to be deployed and the estimated population coverage for the duration of the programme.

In the single layer environment, where one multiplex is deployed, the existing infrastructure is expected to be able to support the single additional multiplex at 56 sites and new antennas are expected to be required at 24 sites. The table below shows purely indicative coverage based upon theoretical antenna patterns for new stations and the use of existing antennas where possible. Where existing antennas are used, it has been assumed that the ERP may be limited due to antenna power handling limitations at some sites. The Table is based on Layer 7.

Year	Number of sites	Approximate Coverage (Cumulative)	Year	End
2014	36	72%		
2015	44	90%		

Table 2 Single Layer Site Deployment

In the triple layer environment, where three multiplexes are deployed, the existing infrastructure is expected to be able to support the three additional multiplex at 50 sites and new antennas are expected

to be required at 33 sites*. A greater number of new antennas are expected to be required compared to the Single Layer.

The table below shows purely indicative coverage based upon theoretical antenna patterns for new stations and the use of existing antennas where possible. Where existing antennas are used, it has been assumed that the ERP may be limited due to antenna power handling limitations at some sites.

Year	Number of sites	Approximate Coverage (Cumulative)	Year	End
2014	34	58%		
2015	37	85%		
2016	8	88%		

Table 3 Triple Layer (Layer 7) Site Deployment

Year	Number of sites	Approximate Coverage (Cumulative)	Year	End
2014	33	56%		
2015	38	82%		
2016	9	85%		

Table 4 Triple Layer (Layer 8) Site Deployment

Year	Number of sites	Approximate Coverage (Cumulative)	Year	End
2014	33	62%		
2015	36	90%		
2016	9	94%		

Table 5 Triple Layer (Layer 9) Site Deployment

The site and population figures shown in the above tables are based upon the assumption that, where new antennas are required at main stations (i.e., the 'Upper 50' in terms of population coverage), such stations would (in the majority of cases) go into service towards the end of the second year following the start of antenna installation in the previous year. Two build seasons have been assumed for new antenna builds to overcome delays which may arise due to inclement weather. If antenna installations are complete by the end of the first build season then it might be possible to commence transmission at an earlier date subject to the agreement of all 600MHz Multiplex Licensees.

It should be noted that some main stations (which require new antennas) are shown in the rollout plans as going into service at the end of the first build season (Sandy Heath and Chillerton Down for Single Layer 7, Sandy Heath for Layers 7 and 8 in a Triple Environment and Sandy Heath, Divis and Presely for Layer 9 in a Triple Environment). Arqiva hopes to allow such sites to come into service after the first build season but, since antenna builds are weather dependent, such stations may slip into the second build year.

It should also be noted that, since Layer 9 will require a new antenna, and to allow simultaneous launch of all three multiplexes, services are not scheduled to launch at Divis and Presely until early 2015. In the event of an antenna installation delay, the launch of Layer 9 may be delayed.

* (Hannington Reserve, Divis and Presely account for the extra three antennas)

In order to meet these rollout plans, transmitter system and antenna designs by Arqiva will have to commence in January 2013 and any delay in the start of the design programme will lead to a similar delay of the service launch date at sites where antenna works are not required. Any delay in the start of design works for new antenna systems may lead to a greater impact on service launch dates due to the seasonal dependency of antenna works. Transmitter orders shall need to commence in Q1 2013 to allow services to launch in accordance with the rollout plans.

Arqiva anticipates that the party/parties who successfully secure 600MHz licences will wish to launch services as rapidly as possible. Therefore Arqiva proposes that the successful party/parties should enter into an 'Advance Design Agreement' and an 'Advance Equipment Procurement Agreement' to allow Arqiva to commence design work and procurement of relevant infrastructure during Q1 2013 whilst other contractual discussions may be ongoing. Refer to Section 11 - Advance Design and Advance Equipment Procurement Agreements for further details.

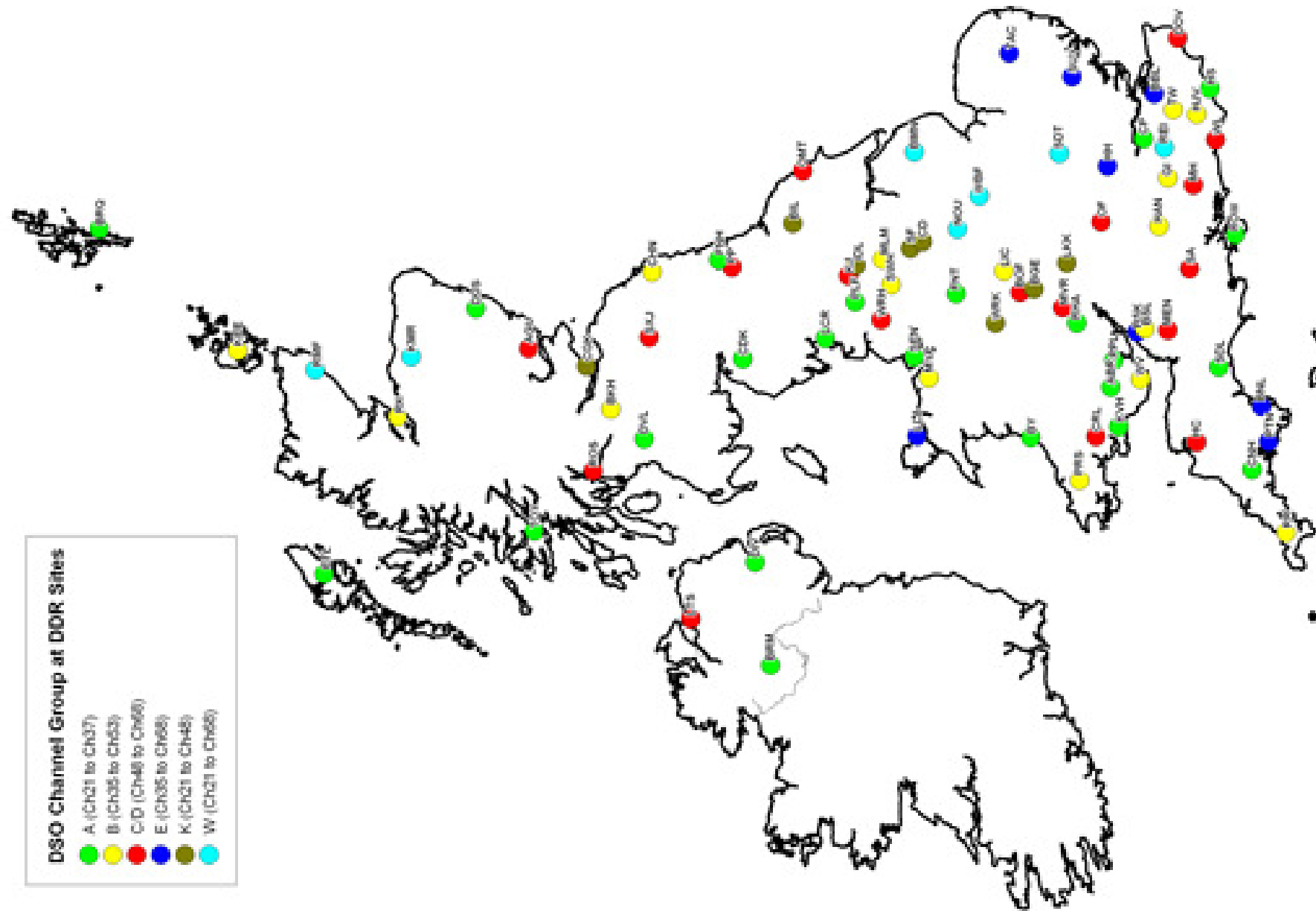
Throughout the design process, the 600MHz Multiplex Licensees will be required to approve antenna and transmitter designs. Failure to agree designs by the required deadline dates will result in a delay to the overall programme. Relevant milestone dates are shown in Appendix B.

3 Coverage

Customers should consult with Ofcom in respect of expected coverage on a nationwide or station-by-station basis. Arqiva makes no warranties, claims or guarantees in respect of coverage and reception since these depend on issues outside of Arqiva's control.

Successful reception depends upon local conditions and the limitations of domestic equipment. Please note that as the 600MHz channels are outside the traditional UHF TV band in a number of areas, domestic aerials may need to be replaced.

The map below illustrates the 'historic banding' of domestic aerials in the UK. The aerials are banded by channel and, where C/D group aerials are installed upgrades will be required. Band B and E aerials may also experience service degradation.



4 Network Access Reference Offers

This section describes the Network Access provision where interested parties wish to install transmitter equipment in a single and triple multiplex environment.

4.1 Network Access Reference Offer – Single Layer (Layer 7)

Under the terms of the Single Layer Network Access Reference Offer, Arqiva will provide accommodation for transmitter systems, access to power facilities and access to the shared or sharable antenna infrastructure for the purposes of allowing transmission of the Layer 7 multiplex at 80 sites. Layer 7 will utilise channels 31, 32 and 33 in a Multi-Frequency Network (MFN) Configuration. This would be in accordance with the Roll Out plan detailed in Section 2.4.

The key cost and duration factor in respect of the Network Access Reference Offers relates directly to the number of new antennas that will be required. Arqiva has sought to minimise the duration of the build programme and associated costs by utilising existing infrastructure wherever possible.

4.1.1 Potential Coverage

Arqiva has provided information to Ofcom regarding the Maximum Permissible ERP from each of the 80 transmitter stations in support of Layer 7 as the sole 600MHz multiplex. Arqiva would expect that the proposed Network Access facilities could allow the Layer 7 Multiplex (as the sole 600MHz multiplex) to achieve coverage of up to approximately 89% UK population. But note, however, that this would require the transmitter systems being provided by a third party to allow the maximum permissible ERP to be developed from each of the 80 sites. Antenna patterns relating to existing antennas which are proposed to be used for 600MHz are available on request.

4.1.2 Single Layer Technical Specifications

Under the Single Layer scenario, Network Access will be provided as follows:

4.1.2.1 Antenna Systems

In the preparation of the Single Layer Network Access Reference Offer, 56 existing antennas have been proposed where the Layer 7 multiplex could be supported at power levels of greater than 10dB below the ERP stated in the Ofcom Provisional Specification.

In some cases, due to power/voltage handling limitations or antenna pattern restrictions the maximum ERP available from an antenna system may be limited. This will lead to a 'Maximum Permissible ERP' from a station and a 'Maximum Permissible Transmitter Power' to achieve that ERP. Customer transmitter systems will be allowed to operate up to this limit. The Maximum Permissible ERPs are shown in Network Access Schedule 11 on a site by site basis. The Maximum Permissible ERP may be achieved by the installation of transmitters with output powers as stated in Network Access Schedule 11.

Where existing antennas are proposed to be used for the 600MHz service, potential 600MHz Multiplex Licensees should satisfy themselves that such antennas will provide the pattern and ERP that they require. The maximum ERP which may be supported by the main and reserve antennas (where provided) shall vary as detailed in Network Access Schedule 11. Information on existing antennas is available from Arqiva on request.

Where the use of existing antennas is not possible, new antennas have been proposed and as a result, for Single Layer 7, 24 split antenna systems shall be provided. These new antennas will be specified to support the Layer 7 multiplex at Maximum Licensed ERP (as allowed by Ofcom) except where stated otherwise in Network Access Schedule 11. In the event of an antenna failure, half antenna operation will be available to support the service. To rectify an antenna fault, services may need to be supported in a temporary antenna system during which time coverage and available ERP may be restricted.

The proposed antennas and the resultant maximum permissible available powers at the 80 sites, relative to the maximum licensed ERP, are shown in Network Access Schedule 11. These powers are

quoted under nominal conditions where the antennas and transmitters are used in the absence of any faults.

The ERP when operating in the 'fallback antenna condition' (i.e. from the reserve antenna or from one from one half of a split antenna) may be degraded relative to that when operating from the 'nominal operational' antenna conditions. The potential degradation to ERP when operating in the 'fallback antenna condition' is shown in Network Access Schedule 11. It should be noted that the transmitter power required to obtain the ERP quoted in Network Access Schedule 11 may differ between the nominal and reserve antenna conditions.

Where new antennas are required, Customers will be required to approve antennas as part of the Antenna Selection Process. This Antenna Selection Process is discussed in Appendix C.

4.1.2.2 Combiner Systems

Combiner units (CU) will be required to either combine services into a new antenna or existing antennas.

Additional combiner modules will be provided at 56 sites and new dual combiner systems and patch panels will be provided at 24 sites. At the Upper 50 sites where an existing antenna is used, a bypass system will allow isolation of the 600MHz services.

At sites where half antenna operation shall be available, two combiners shall be provided, one for each half antenna. In an antenna failure condition, each combiner shall be able to support sufficient power to allow the transmitted ERP to be sustained at -3dB relative to nominal.

4.1.2.3 Accommodation

Accommodation will be made available at the 80 transmitter sites to house transmitter systems in accordance with the terms of the Reference Offer. Such accommodation will be for the sole use of the customer at the Upper 50 sites and accommodation will be shared at the Lower 30 sites.

At the Upper 50 sites, accommodation will be provided as a segregated secure dedicated area with isolated A and B mains supplies. Distribution boards, domestic power and lighting within the Customer Dedicated Area will also be provided.

At the Lower 30 sites the space within the shared accommodation will allow for one rack to be installed to house transmitters of the size permitted to allow the maximum permissible ERP to be achieved.

Network Access Schedule 15 lists the type of transmitter system accommodation, either sole occupier or shared, at each site.

Customers will be required to confirm their accommodation requirements by the 'Network Access Facilities Specification Date' milestone defined in the applicable Rollout Plan.

4.1.2.4 Transmitter System Feeders

The following transmitter system – to – combiner unit feeders will be provided into the dedicated area for use by the customer's transmitter systems:

- For dual antenna sites a single feeder will be supplied to each antenna and two feeders provided from the transmitter system.
- For single antenna sites a single feeder will be provided to each half of the antenna and two feeders provided from the transmitter system

The customer will be responsible for the provision of RF power to feed each half of the antenna system. It should be noted that the customer will be authorised only to feed RF power to the antenna or half antenna as specified by Arqiva depending upon prevailing operational conditions.

The type of interface connector employed will depend upon the nominal transmitter power and will be stated by Arqiva.

4.1.2.5 Power System

Dual or single incoming supplies will be available at the sites as detailed in Network Access Schedule 15 with generators available at all sites.

4.1.2.6 Telecom Facilities

The provision of telecom services is outside the scope of the Reference Offers. However the BT MPLS network is available at all high power DTT sites and the Reference Offers provide for dual ASI feeds to be provisioned from the BT Telecoms room to the transmission system accommodation. The BT MPLS System is not currently available at Burnhope, Lichfield and Chillerton Down.

In the event that the Customer requires alternative distribution arrangements, alternative proposals can be provided.

Satellite reception systems have not been included in the Reference Offers. However these systems are available from Arqiva on request.

4.1.2.7 Telemetry

Arqiva will provide telemetry to the customer based on the status of Network Access infrastructure as follows:

- Site Access
- Fire
- Environmental
- Antenna Monitoring & Protection
- Mains Power
- Generator

4.1.2.8 Monitoring and Protection

An output power monitoring point, located after all channel combining units or filters, will be made available to the customer who has a multiplex radiated on that antenna. This will represent the total signal as radiated from the antenna and will carry samples of any other multiplex which shares the antenna.

Arqiva will provide an antenna Monitoring and Protection (M&P) system which, in the event of an 'Over Power Alarm' will cause the transmitter system to close down. An M&P tailback will need to be wired directly into the customer's transmitter system. The customer will be responsible for the provision of the interface to the transmitter system to allow this close down to occur.

To prevent the customer's transmitter powering into a faulty antenna interlocks will be provided.

4.2 Network Access Reference Offer - Triple Layer

Under the terms of the Triple Layer Network Access Reference Offer, Arqiva will provide accommodation for transmitter systems, access to power facilities and access to the shared or sharable antenna infrastructure for the purposes of allowing transmission of the multiplex at 80 sites as part of the simultaneous deployment of facilities for Layers 7, 8 and 9. This would be in accordance with the Roll Out plan detailed in Section 2.4.

The key cost and duration factor in respect of the Network Access Reference Offers relates directly to the number of new antennas that will be required. Arqiva has sought to minimise the duration of the build programme and associated costs by utilising existing infrastructure wherever possible.

4.2.1 Potential Coverage

Arqiva has provided information to Ofcom relating to the maximum permissible ERP from each of the 80 transmitter stations in support of Layer 7, Layer 8 and Layer 9 in the triple multiplex scenario. Antenna patterns relating to existing antennas which are proposed to be used for 600MHz are available on request.

Arqiva would expect the proposed Network Access facilities to achieve the following population coverage.

- Layer 7 – 88%
- Layer 8 – 85%

- Layer 9 – 94% (National SFN)

But note, however, that this would require transmitter systems being provided by a third party to allow the maximum permissible ERP to be developed from each of the 80 sites.

Customers should consult with Ofcom in respect of expected coverage on a nationwide or site-by-site basis.

4.2.2 Triple Layer Technical Specification Details

Under the Triple Layer scenario, Network Access will be provided as follows:

4.2.2.1 Antenna Systems

In the preparation of the Triple Layer Network Access Reference Offer, 47 existing antennas have been proposed where the Layer 7, Layer 8 and Layer 9 multiplexes could be supported at power levels of greater than 10dB below the ERP stated in the Ofcom Provisional Specification

In some cases, due to power/voltage handling limitations or antenna pattern restrictions the maximum ERP available from an antenna system may be limited. This will lead to a 'Maximum Permissible ERP' from a station and a 'Maximum Permissible Transmitter Power' to achieve that ERP. Customer transmitter systems will be allowed to operate up to this limit. The Maximum Permissible ERPs are shown in Network Access Schedule 11 on a site by site basis. The Maximum Permissible ERP may be achieved by the installation of transmitters with output powers as stated in Network Access Schedule 11.

Where existing antennas are proposed for use for the 600MHz service, potential 600MHz Multiplex Licensees should satisfy themselves that such antennas will provide the pattern and ERP that they require. Information on existing antennas is available from Arqiva on request.

Where the existing High Power DTT main and reserve antenna are able to support the additional multiplexes then antenna redundancy will be available (potentially at reduced ERP).

At some sites a combination of both existing and new antennas will be used.

Where the use of existing antennas is not possible, new antennas have been proposed and as a result 33 new antennas are expected to be required. These new antennas will be specified to support the Layer 7, Layer 8 and Layer 9 multiplexes at maximum licensed ERP except where this is not possible. At some sites multiple antennas may be required to serve all three multiplexes. In the event of an antenna failure, half antenna operation will be available to support the service and to rectify an antenna fault. Services may need to be supported in a temporary antenna system during which time coverage and available ERP may be restricted.

The proposed antennas and the resultant Maximum Permissible ERP at the 80 sites are shown in the Network Access Reference Offers, relative to the ERP stated in the Ofcom Provisional Specification shown in Appendix D. These powers are quoted under nominal conditions where the antennas and transmitters are used in the absence of any faults.

The ERP when operating in the 'fallback antenna condition' (i.e. from the reserve antenna or from one from one half of a split antenna) may be degraded relative to that when operating from the 'nominal operational' antenna conditions. The potential degradation to ERP when operating in the 'fallback antenna condition' is shown in Network Access Schedule 11. It should be noted that the transmitter power required to obtain the ERP quoted in Network Access Schedule 11 may differ between the nominal and reserve antenna conditions.

Where new antennas are required, Customers will be required to approve antennas as part of the Antenna Selection Process. This Antenna Selection Process is discussed in Appendix C.

4.2.2.2 Combiner Systems

Combiner units (CU) will be required to either combine services into a new antenna or existing antennas.

Additional combiner modules will be provided at 47 sites where existing antennas will be used and new dual combiner systems will be provided at 33 sites. At the Upper 50 sites where an existing antenna is used, a bypass system will allow isolation of the 600MHz combiner modules.

At sites where half antenna operation is available, the input power will be limited to the normal full antenna power and reconfiguration of the antennas for half antenna operation will be a manual operation.

4.2.2.3 Transmitter System Feeders

Refer to Single Layer Technical Specification for details.

4.2.2.4 Accommodation

Refer to Single Layer Technical Specification for details.

4.2.2.5 Power Systems

Refer to Single Layer Technical Specification for details.

4.2.2.6 Telecom System Access

Refer to Single Layer Technical Specification for details.

4.2.2.7 Telemetry

Refer to Single Layer Technical Specification for details.

4.2.2.8 Monitoring and Protection

Refer to Single Layer Technical Specification for details.

5 Transmission Services Reference Offers

The Transmission Services Reference Offers encompass the provision, by Arqiva of Network Access (Antenna systems) and Transmitter Systems to provide a full Transmission Service at each of the 80 sites.

Network Access facilities will be provided as described in the Single Layer and Triple Layer environments and Arqiva will, under the Transmission Services Reference Offers, provide transmitter systems, signal processing equipment and telemetry systems. Under the terms of the Transmission Services Reference Offers, Arqiva will provide transmitter systems to allow operation at the 'Maximum Permissible ERP', as limited by the antenna systems, to be provided from the Stations.

The Transmission Services Reference Offers relate only to Layer 7 in the single multiplex environment. Transmission Services Reference offers for Layers 7, 8 and 9 are provided in the triple multiplex environment. Layer 7 and Layer 8 are a Multi-Frequency Network (MFN) and similar in architecture to the existing six DTT high power multiplexes. Layer 9 is an SFN and, as a result, special attention is required in a number of areas (refer to section 9.2).

5.1 Transmission Technical Specification

The Transmission Services Reference Offers have been based upon the DVB-T2 standard. Whilst DVB-T2 could, under certain operating conditions, allow greater capacity to be supported by a multiplex and support the use of H.264 to support HD services, use of DVB-T would provide access to a greater population of set-top boxes (although the number of DVB-T2 compatible receive systems continues to rise).

In the event that Customers require DVB-T operation, Arqiva shall make the appropriate modifications to the design and adjust the price accordingly.

The Reference Offers assume that the customer will provide BT line distribution to all sites in the network. It may be possible to provide off air feeds to some sites via rebroadcast links (RBLs). The use

of RBLs would avoid the use of lines but may give rise to implications for the rollout plan and lead to complications in respect of SFN networks (refer to section 9.1).

The following paragraphs describe the systems in the Transmission Services Reference Offers.

5.1.1 Network Access Facilities

Refer to the single or triple Network Access Reference Offer details in Section 4.1 or Section 4.2 for further details of the following sub systems:

- Antenna Systems
- Combiner Systems
- Accommodation
- Power Systems

5.1.2 Transmitter Systems

Transmitter Systems shall be provided to allow the Maximum Permissible ERPs which can be supported by the Antenna Systems.

The transmitter sizes (i.e. approximate maximum available power at the output from the transmitter) and consequent proposed ERP for Layer 7 in the single and triple scenarios are shown in the Transmission Services Reference Offers. In the event of a transmitter fault (assuming nominal antenna operation), the ERP will be sustained at no less than 3dB below the nominal ERP level except where otherwise stated.

The Transmitter Systems which are included in the Transmission Services Reference Offers are based, for the majority of Upper 50 sites on the use of parallel transmitter systems. These allow single points of failure to be avoided, as requested in the Ofcom guidelines, and allow services to be maintained at a high level of availability. These systems are similar to those which have been deployed in a number of UK DTT networks to date.

It should be noted that alternative transmitter configurations are available (full passive reserve, single thread) and Arqiva would be able to provide alternative transmitter configuration proposals if so required. Any variation in transmitter configuration would impact charges, service availability and the SLA. Charges are currently based on the assumption that all transmitters are provided by the same manufacturer and, in the case of the Triple Layer, that three similar transmitter systems are installed simultaneously on a site-by-site basis.

The transmitter systems that will be provided under the terms of the Transmission Services Reference Offers will be based on those available at the time of preparation. Developments in transmitter technology may lead to the availability of new systems prior to the deployment of systems as contemplated herein. In the event that such systems become available, Arqiva shall conduct an assessment of such products and may offer an alternative product as a result of such evaluations. It should be noted that, whilst new technology may claim to offer advantages in respect of efficiency and performance, early adoption may be costly in respect of initial procurement and ongoing maintenance as 'new technology' issues come to light.

5.1.3 Service Information Processing

The Customer will be required to obtain access to a Central Service Information (CSI) feed to the sites to allow Arqiva to produce the appropriate Service Information (SI) for the transmitter system. CSI is generated by DMOL for all current multiplex operators and is processed either at the Stations or at intermediate points to provide a 'regional variant' of the Service Information to allow viewers to access schedule information for the all channels which are receivable in their area.

The Transmission Services Reference Offers relating to Layer 7 and Layer 8 will be similar in respect of Service Information requirements and processing. Arqiva will provide Service Information Processing for all sites (except SFN sites) for Layers 7 and 8.

Layer 9 (National SFN) is expected to have alternative Service Information requirements and Service Information Processing equipment will not be provided by Arqiva under the terms of the Layer 9 Transmission Services Reference Offer. Following clarification of the Service Processing requirements relating to a national SFN, Arqiva would be pleased to provide a proposal for this additional service.

5.1.4 Telemetry Systems

The existing DSO telemetry systems will be expanded to accommodate additional transmission systems.

5.1.5 Managed Service

The following support services are provided:

- 24 x 7 monitoring and control. In addition off-air monitoring will be provided at thirteen of the main stations.
- 24 x 7 field force
- Fault rectification

5.2 Exclusions

For the avoidance of doubt the following facilities, although available from Arqiva, are *not* within the scope of the Transmission Services Reference Offers.

- Programme distribution
- Compression systems
- Service Information processing (Layer 9)
- Everything listed under Customer Responsibilities, (see section 8)

6 Operational Costs

Whilst the Reference Offers include charges relating to operation and ongoing maintenance of the Transmission Systems, electricity charges are NOT included. Electricity charges will be metered and customers will be charged for electricity based on actual consumption and prevailing tariffs.

7 Points to Note

Potential 600MHz Multiplex Operators should note that the Reference Offers are valid only under the specific conditions outlined therein. The Single Layer Reference Offers are valid solely for Layer 7 and the Triple Layer Reference Offers are valid only for Network Access or Transmission respectively in circumstances where all three multiplex operators require the same level of service to all 80 sites.

The Reference Offers are based on the provision of infrastructure to operate at the Maximum Permissible ERP levels as limited by existing antenna infrastructure where such infrastructure is offered. The level of ERP offered may be up to 10dB below that specified by Ofcom but it is expected that, even at this reduced level, reasonable levels of coverage should be possible. Arqiva makes no claims or warranties in respect of coverage/reception and potential 600MHz Multiplex Operators should consult Ofcom for further information.

8 Customer Responsibilities

In order to allow Arqiva to provide Transmission and/or Network Access facilities by the dates indicated in the applicable Rollout Plan, customers will be required to procure the following (for certain of these items there are applicable dates which must be adhered to set out in the relevant schedules of the Reference Offers.

1. Agreement to Antenna Design Specifications (ADS) in accordance with the requirements of the applicable Rollout Plan.

2. Participation in meetings with other multiplex operators to agree the technical specification of shared equipment.
3. Agreement to transmitter specifications in accordance with the requirements of the applicable Rollout Plan.
4. Provision of compression systems to produce customer signals.
5. Provision of DVB-T2 Gateways where required.
6. Provision of distribution systems to provide customer signals to transmitter sites.
7. Provision of Centralised Service Information (CSI) and provision of CSI feeds to the sites.
8. SFN timing information to be provided on a site by site basis.
9. International co-ordination of sites.
10. WTA licences.
11. Ofcom consents where applicable.
12. DMOL consents where applicable.
13. Freeview consents where applicable.
14. Public communications.
15. Public assistance (re-rescanning of set-top boxes and aerial issues).
16. Obtaining the consents and agreements of other multiplex operators related to DTT service issues.
17. Agreement of rules related to Service Information where a national SFN is required.

9 Network Design Considerations

9.1 Single Frequency Network Requirements

The transmission reference offers are based on the provision of DVB-T2 systems. This section discusses SFN networks and presents information related to both DVB-T and DVB-T2 networks purely for completeness.

Whilst Layers 7 and 8 are Multi-Frequency Networks (MFN), there are a number of locations where a single frequency is employed to maximise coverage in specific areas. In the table below, channels 31, 32 and 33 relate to Layer 7 and channels 34, 35 and 37 relate to Layer 8. Layer 9 operates as a UK wide Single Frequency Network (SFN).

SFN	Parent transmitter in SFN	Daughter transmitters in SFN	Channels
1	Tacolneston	Sudbury	31,37
2	Carmel	Preseli	32,35
3	Crystal Palace	Reigate, Guildford	33,35
4	Lichfield	Bromsgrove, The Wrekin	33,35
5	Winter Hill	Saddleworth, Storeton	31,37
6	Emley Moor	Chesterfield	32,34
7	Wenvoe	Kilvey Hill, Pontypool	31,37
8	Waltham	Nottingham	31,37
9	Mendip	Bristol Ilchester Crescent, Bristol Kings Weston	33, 35
10	Chillerton Down	Salisbury, Midhurst	31,37
11	Llanddona	Moel-y-Parc	32
12	Heathfield	Hastings	32,34

Single Frequency Networks (SFNs) use the same basic transmission architecture as Multi Frequency Networks (MFNs) but are required to be time co-incident (within the guard interval) and frequency co-incident (within 1Hz).

For a DVB-T based regional SFN, the transport stream passes through an SFN Adaptor which inserts timing information in the form of a Megaframe Initialisation Packet (MIP). The insertion of this information allows all SFN modulators to deterministically generate the signal to be broadcast. In a DVB-T situation, use of an SFN would have the following implications:

Playout Centre

- SFN adaptor: this inserts the Megaframe Initialisation Packet (MIP) which amongst other things provides the timing reference, the Synchronisation Time Stamp (STS), and sets the network delay which is the time all stations must wait before transmitting (subject to any adjustments to the static delay on the individual transmitter sites)
- GPS receiver: Provides 1 PPS for timing information to the SFN adaptor.

Transmitter Site

- SFN Modulator: this is usually the same modulator as an MFN but with SFN functionality switched on. This unit allows the transmitted signal to be made time co-incident with all other ones in the network (subject to any local static time settings) taking into account the network delay setting and actual distribution delays
- GPS Receiver: Provides 1 PPS for timing information to the modulator and 10MHz reference for the transmitter local oscillators.

On any station in an SFN it is important that GPS lock is remotely signalled and any loss of lock should cause a switchover to any redundant equipment. Consideration should also be given to muting the output of any station where the GPS reference totally fails.

During commissioning, the transmitter sites must be checked to ensure the measured margin (difference between SFN adaptor network delay and distribution system delay) is adequate but not excessive, the frequencies are confirmed to be within 1Hz of nominal and the static time delay is set as per pre-defined calculations. Final measurements of coverage and network timings will then need to be completed in areas of overlapping coverage between sites to ensure destructive interference is not occurring.

The Transmission Services Reference Offers are based upon the provision of a DVB-T2 Transmission System.

The use of DVB-T2 would require the provision of a T2-Gateway at the 'centre' of the network (if the whole network were to be served with one national feed). It should be noted that T2 Gateways are not included as part of the Transmission Services Reference Offers since they are likely to be close to the source of the multiplex.

The use of DVB-T2 in an SFN environment would require line feeds to all sites (unless On Channel Repeaters were to be used which would obtain their feeds from a parent station). Due to the practical issues associated with the use of On Channel Repeaters, their use has not been contemplated at this time and line feeds, to be provided by the Customer, are currently assumed to all sites.

The requirements of an SFN and the use of DVB-T2 would restrict the available transmitted payload (relative to an MFN) and a higher line speed that would be required to accommodate the T2-MI signalling.

If DVB-T were used for Layer 9 (National SFN) the T2-MI issues would be avoided, however the use of DVB-T for a national SFN is expected to lead to interference problems. Several countries have attempted to produce National SFNs based on DVB-T, without success, especially at the higher modulation orders needed for high data rates.

The maximum guard interval available on DVB-T (8K FFT) leads to a situation where high power transmitter signals within a 70km radius would be ignored by receive systems however, transmissions

outside of this range could lead to interference; this is likely to lead to problems based upon the UK Network design. With DVB-T2, the available modes would allow this potential interference signals from stations within a radius of 160km to be ignored so minimising the chances of interference.

The use of such a stream could have implications for any route switching within the distribution network. Practical implementations of seamless TS switching may not be designed to handle T2-MI streams, so their behaviour with such streams would need consideration.

In addition, any non seamless switching could potentially cause up to two T2 Frames duration of non synchronous operation in a subsequent T2 modulator, resulting in the output being muted for a far greater period than the original disturbance.

9.2 Layer 9 Considerations

Layer 7 and Layer 8 are multiple frequency networks (MFN) and Layer 9 is a national single frequency network (SFN). Whilst transmitter powers and costs are expected to be of a similar order of magnitude, customers should note the following points relate to Layer 9 specifically.

Since Layer 9 is a national SFN, Service Information processing will have to take place centrally and is outside the scope of the Layer 9 Transmission Services Reference Offer. Arqiva does not propose to provide any equipment related to Service Information Processing for Layer 9.

In order for Layer 9 to operate correctly as a national SFN, the use of DVB-T2 is thought to offer the most pragmatic solution (see section 9.1).

Irrespective of the broadcast technology used, the operation of a national SFN would require the generation of the underlying Transport Stream (TS) to take place at a single common point, and all transmitters in the network to emit the same data stream.

The use of a national SFN has implications for the regionality available to broadcasters, and potentially to the way Service Information (SI) can be cross carried.

9.2.1 Service Information

The current DTT networks are required to cross carry information regarding the services that are available on other transmissions (multiplexes) that are emitted from the same site. This uses a mechanism known as SI_Other tables.

Because this cross carriage is managed at a "network" level (i.e. at the level of each transmitter site or relays from the same main station) the regional variations in services (e.g. BBC Look East in East Anglia, BBC London News in London) can be signalled as independent programmes, with a minimum of data overhead.

The issue for a national SFN is that if the same mechanism is used, and since the signals transmitted from each site have to be identical for the SFN to operate correctly, the transmitted multiplex would have to carry all of the data corresponding to all of the potential regional variations on the other multiplexes, with a careful allocation of Service_Ids to allow a receiver to discriminate between services.

This would not only require additional bandwidth within the multiplex but the allocation of Logical_Channel_Numbers (LCNs) could have implications for receivers, as the method they are supposed to use to store different Services with the same LCN could be overloaded.

Therefore the data rate that the SFN operator needs to allocate to the SI is up to 29 times that used on the other multiplexes, and potentially this could require high data rates.

In addition the effect of such high data volumes, and the absolute number of services that a receiver would have to filter would need careful testing on the population of receivers in the UK, as all receiver designers make assumptions about memory resources etc when designing their products.

Version 7 of the DTG D Book specifies that a DVB-T receiver must be capable of storing up to 256 unique services, and a T2 receiver up to 800.

Any alternative mechanism of handling other services in such an environment would need to be incorporated into the D-Book to ensure such an approach is supported in new receivers. This would however potentially leave legacy receivers unable to decode the relevant SI.

This issue is known to have been discussed within the DTG Group but is yet to be resolved. Resolution of this issue and any subsequent requirements thereof is excluded from the scope of the Reference Offers.

9.3 Re-Broadcast Links

In the current Reference Offers it has been assumed that RBL paths would not be used from the Upper 50 to the Lower 30 sites and therefore RBL Receive systems have not been provided at the Lower 30 stations. The following limitations have been considered:

- Although the use of RBLs would avoid the use of lines to some sites, the network would be dependent upon the interference environment (which would dictate the feasibility or otherwise of such a link).
- The use of RBLs would create a situation where the parent station would need to be available prior to the daughter site - this could lead to an impact on the Rollout Plan.
- The use of RBLs would have limitations where Single Frequency Networks are required which would have implications for Layers 7 and 8 in a number of localised SFNs.

Where the parent station and daughter sites are within the same SFN, the use of RBLs will not be possible unless 'On Channel Repeaters' are used. On Channel Repeaters (see section 9.4) have not been assumed within the Reference Offers at this time. Consequently line feeds will be required where the parent and daughter stations are within the same SFN. Where daughter stations are in an SFN and the parent is on a separate channel the use of RBLs may be possible.

If DVB-T modulation is being employed, the use of RBLs may be possible in this situation. The daughter sites would be fed off-air and transmissions would be time stamped to allow SFN synchronisation to be realised. The use of DVB-T for Layer 9 (National SFN) is not thought feasible (see Section 9.1).

Should customers wish to consider the use of RBLs, Arqiva would be able to reconsider their use once the requirements of all potential users are known. The use of RBLs could then be introduced under Change Control.

9.4 On Channel Repeaters (OCR)

In theory, assuming sufficient isolation is available, it is possible to implement an On Channel Repeater from a receive antenna, feeding a small amplifier, which in turn feeds a transmit antenna. This could allow Single Frequency Networks to operate without the requirement for lines to all sites.

However, a number of issues exist relating to the use of OCRs such as:

- Design of OCR
- Input Power and Signal to Noise ratio from parent station
- Output Power of relay
- Isolation between receive and transmit antennas
- Effect on Self Interference of network in the presence of an OCR.

All of these issues would need careful consideration once the overall requirements of the network are understood and technical data related to each of the Stations can be accurately assessed. For example, placing a receive antenna on one side of a tower block with a clear line of sight to the parent transmitter, with a low power amplifier and transmit antenna on the other side of a lift housing, to cover a very small shadow from the tower block itself may work. However, for a more generic solution a more complex implementation is required.

Such a solution will require some form of echo cancellation in order to decrease the isolation needed between input and output. Even where sufficient isolation is theoretically achievable, it should be noted that the actual figure achieved is not always static, due to reflections and mast / tower dynamics. Whilst the former is most problematic at low structure heights, the latter becomes a problem on high structures. These issues can also significantly affect the echoes present on the OCR's input, which may affect the ability of the unit to achieve the degree of echo cancellation claimed. The ability of an OCR to track these changes in isolation will be important.

Several manufacturers offer such solutions, but they add significant complexity and hence cost, to a simple relay design.

Most of the OCRs on the market at this time are based on transposer technology (i.e. do not re-modulate the incoming signal) but it is unclear whether all of them are agnostic as to the source modulation in terms of their echo cancelling technology (e.g. the use of pilots to perform channel estimation in the echo canceller could be technology specific). This could be especially significant if the source signal is DVB-T2 with extended carriers. Work is needed in this area to confirm the ability of commercial products to support DVB-T2.

As a result of the above issues, coupled with the fact that the use of rebroadcast links is not contemplated at this time, the use of On Channel Repeaters (for SFN applications) has been excluded from the scope of the Reference Offers at this time.

10 Alternative Configurations

During early discussions with Ofcom related to possible uses of the 600MHz spectrum, the potential deployment of up to five additional multiplexes at the 'Upper 20' sites (i.e. beyond the current six) was considered. Arqiva was asked to comment on the potential implications and feasibility of such a deployment and the results of such considerations are presented below.

Any requirement to deploy additional multiplexes at the 'Upper 20' sites (in respect of PSB population coverage) would involve the following stations:

- Crystal Palace
- Winter Hill
- Lichfield (Sutton Coldfield)
- Emley Moor
- Black Hill
- Sandy Heath
- Chillerton Down (Rowridge)
- Mendip
- Belmont
- Bilsdale
- Burnhope (Pontop Pike)
- Divis
- Craiggelly
- Waltham
- Hannington
- Wenvoe
- Tacolneston
- The Wrekin
- Oxford
- Ridge Hill

Arqiva has conducted a preliminary study into the feasibility or otherwise of existing antenna infrastructure being able to support five additional multiplexes in the 600MHz band at PSB equivalent ERPs.

It has been concluded that **none** of the existing 'Top 50' antenna systems would be able to support 5 additional multiplexes at full PSB ERP (i.e. as implied by the Ofcom 600MHz provisional specification).

If support of five additional ERPs at any power level (i.e. in excess of 10dB below PSB power at some stations) were acceptable, the existing antennas could support five multiplexes at 13 stations at between 3dB and 14dB below equivalent PSB power (5 stations being below -10dB). In this scenario, new antennas would be required at 7 stations. Where new antennas are required, mast strengthening is likely to be required and would be subject to further analysis.

If nominal operation at power levels below 10dB were unacceptable then further analysis, which would be likely to lead for a requirement for additional new antennas, would be required. The procurement and installation of additional antennas may lead to a requirement for mast strengthening.

Any requirement to support 5 additional multiplexes at FULL ERP power would require additional antennas and potentially significant mast strengthening at all 'Top 20' sites. The scope of such activities would require further detailed analysis to determine the extent, scale and associated costs.

In all such alternative configurations, the impact on accommodation and power facilities has yet to be assessed.

11 Advance Design and Advance Equipment Procurement Agreements

Since customers are unlikely to secure a 600MHz licence (by virtue of the auction process) until late 2012 and, in order to allow services to launch in early 2014, Advance Design Agreements will be required to be entered into to allow design work to commence in early 2013. Advance Design Agreements would be required for both Network Access and Transmission Services.

The Advance Design Agreements would cover Arqiva's design costs until such time as full commercial agreements based on the relevant Reference Offers are put in place. To allow the required advance design work to take place, all customers will be required to enter into Advance Design Agreements.

Advance Equipment Procurement Agreements will also be required to cover Arqiva's costs for equipment orders which will need to be placed in order to allow services to be available in accordance with the Rollout Plans included herein (again until such time as full commercial agreements based on the relevant Reference Offers are put in place).

11.1 Network Access Advance Design Agreement

The agreement will cover the cost of design work and procurement preparation activities from the date of signature in January 2013 and apply for 6 months.

The design work will encompass:

- Provision of Antenna Specifications (existing antennas)
- Production of Antenna Design Proposals and Specifications (New Antennas)
- Accommodation Design Work
- Power Design Work

Payment for these services will be invoiced and paid on a monthly basis.

The customer would be required to work with Arqiva to agree specifications in accordance with the milestone dates defined in the Rollout Plan.

Where ultimately no Network Access Agreement is entered into the Customer will be liable for all costs incurred.

11.2 Transmission Services Advance Design Agreement

The agreement will cover the cost of design work and procurement preparation activities related to long lead time items from the date of signature in January 2013 and apply for 6 months. The costs will be provided prior to signature.

The design work will encompass:

- Provision of Antenna Specifications (existing antennas)

- Production of Antenna Design Proposals and Specifications (New Antennas)
- Provision of proposed Transmitter System designs
- Accommodation Design Work
- Power Design Work

Payment for these services will be invoiced and paid on a monthly basis.

The customer would be required to work with Arqiva to agree specifications in accordance with the milestone dates defined in the Rollout Plan.

Where ultimately no Transmission Services Agreement is entered into the Customer will be liable for all costs incurred.

11.3 Network Access Advance Equipment Procurement Agreement

The agreement will cover the cost of procuring equipment and/or third party services from the date of signature in January 2013 and apply for 6 months.

The procurement may include:

- antenna systems and ancillaries
- power works and generators
- accommodation works

Payment for these services will be invoiced and paid on a monthly basis.

The customer would be required to work with Arqiva to agree procurement in accordance with the milestone dates defined in the Rollout Plan.

Where ultimately no Network Access Agreement is entered into the Customer will be liable for all costs incurred.

11.4 Transmission Services Advance Equipment Procurement Agreement

The agreement will cover the cost of procuring equipment and/or third party services from the date of signature in January 2013 and apply for 6 months.

The procurement may include:

- transmitter systems and ancillaries
- antenna systems and ancillaries
- power works and generators
- accommodation works

Payment for these services will be invoiced and paid on a monthly basis.

The customer would be required to work with Arqiva to agree procurement in accordance with the milestone dates defined in the Rollout Plan.

Where ultimately no Transmission Services Agreement is entered into the Customer will be liable for all costs incurred.

Appendix A Site List

600MHz Upper 50 Sites	
Site Number	Site Name
12300	Angus
13600	Beacon Hill
12000	Belmont
11600	Bilsdale
10500	Black Hill
13500	Blaenplwyf
15800	Bluebell Hill
13402	Bressay
15100	Brougher Mountain
10900	Burnhope
13700	Caldbeck
13100	Caradon Hill
11900	Carmel
15500	Chatton
10800	Chillerton Down
14700	Craigkelly
10100	Crystal Palace
15200	Darvel
10700	Divis
11300	Dover
11200	Durriss
15400	Eitshal
10400	Emley Moor
12500	Hannington
13900	Heathfield
13800	Huntshaw Cross
13400	Keelylang Hill
15300	Knockmore
10200	Lichfield
13000	Limavady
11800	Llanddona
11000	Mendip
12500	Midhurst
14500	Moel y Parc
11700	Oxford
12900	Presely
14100	Redruth
14900	Ridge Hill
15600	Rosemarkie
14800	Rumster Forest
12400	Sandy Heath
16100	Selkirk
13200	Stockland Hill
11500	Sudbury
11400	Tacolneston
12100	The Wrekin
10510	Torosay
11100	Waltham
10600	Wenvoe
10300	Winter Hill

600MHz Lower 30 Sites	
Site Number	Site Name
10606	Aberdare
10203	Brierley Hill
11008	Bristol Ilchester Crescent
11007	Bristol Kings Weston
10206	Bromsgrove
10405	Chesterfield
10903	Fenham
10211	Fenton
10101	Guildford
13902	Hastings
10105	Hemel Hempstead
10413	Idle
10407	Keighley
10601	Kilvey Hill
10335	Lancaster
10208	Lark Stoke
10207	Malvern
11101	Nottingham
12002	Olivers Mount
10302	Pendle Forest
13105	Plympton
10615	Pontypool
10103	Reigate
15211	Rosneath
10306	Saddleworth
10801	Salisbury
10403	Sheffield
10307	Storeton
10104	Tunbridge Wells
10805	Whitehawk Hill

B.2 Triple Layer

600MHZ TRIPLE LAYER - PLAN B3

600MHZ TRIPLE LAYER - PLAN B3										Layer 7												2013												2014												2015												2016											
PROVISIONAL ROLLOUT PLAN November 30th 2011										LAYER 7		LAYER 8		LAYER 9		Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4																																																					
										Target Start Date	%Pop	Target Start Date	%Pop	Target Start Date	%Pop	Jn Fb Mr Ap My Jn Jl Au Sp Oct Nv Dm																																																					
Upper 50 Sites - No Antennas	Antenna ADS Approval	MTS Lockdown Date	NA Facilities spec date	Site Access Date	Power Test Obligations	Target Start Date	%Pop	Target Start Date	%Pop	Target Start Date	%Pop																																																										
Upper 50 Sites - No Antennas Group US0-1, 32 Sites		TSD - 13 months	MTS lock +1 month	TSD - 5 months	TSD - 2 months																																																																
CRYSTAL PALACE	N/A	Jan-13	Feb-13	Sep-13	Dec-13	Feb-14	15.01	Feb-14	13.62	Feb-14	16.77																																																										
WINTER HILL	N/A	Feb-13	Mar-13	Oct-13	Jan-14	Mar-14	10.07	Mar-14	9.80	Mar-14	10.45																																																										
LICHFIELD	N/A	Mar-13	Apr-13	Nov-13	Feb-14	Apr-14	7.53	Apr-14	7.51	Apr-14	7.86																																																										
BELMONT	N/A	Mar-13	Apr-13	Nov-13	Feb-14	Apr-14	2.71	Apr-14	2.78	Apr-14	3.18																																																										
CRAIGSKELLY	N/A	Apr-13	May-13	Dec-13	Mar-14	May-14	1.72	May-14	1.72	May-14	1.70																																																										
WENVOE	N/A	Apr-13	May-13	Dec-13	Mar-14	May-14	1.57	May-14	1.52	May-14	1.57																																																										
HANNINGTON	N/A	May-13	Jun-13	Jan-14	Apr-14	Jun-14	1.43	Jun-14	1.50	Jun-14	1.62																																																										
THE WREKIN	N/A	May-13	Jun-13	Jan-14	Apr-14	Jun-14	1.00	Jun-14	1.04	Jun-14	1.20																																																										
BAILEY MOOR	N/A	Jun-13	Jul-13	Feb-14	May-14	Jul-14	5.15	Jul-14	5.01	Jul-14	5.07																																																										
TACOLENSTON	N/A	Jun-13	Jul-13	Feb-14	May-14	Jul-14	0.98	Jul-14	1.05	Jul-14	1.36																																																										
RIDGE HILL	N/A	Jul-13	Aug-13	Mar-14	Jun-14	Aug-14	0.85	Aug-14	0.92	Aug-14	0.95																																																										
BLUEBELL HILL	N/A	Jul-13	Aug-13	Mar-14	Jun-14	Aug-14	0.78	Aug-14	0.71	Aug-14	0.98																																																										
DURRIS	N/A	Aug-13	Sep-13	Apr-14	Jul-14	Sep-14	0.67	Sep-14	0.64	Sep-14	0.64																																																										
CARADON HILL	N/A	Aug-13	Sep-13	Apr-14	Jul-14	Sep-14	0.57	Sep-14	0.60	Sep-14	0.66																																																										
DIVIS	Layer 7 & 8	Sep-13	Oct-13	Aug-14	Nov-14	Jan-15	1.74	Jan-15	1.74	Jan-15	1.74																																																										
FRESLEY	Layer 7 & 8	Sep-13	Oct-13	Aug-14	Nov-14	Jan-15	0.20	Jan-15	0.19	Jan-15	0.20																																																										
MOEL Y PARC	N/A	Dec-13	Jan-14	Sep-14	Dec-14	Feb-15	0.51	Feb-15	0.49	Feb-15	0.49																																																										
DARVEL	N/A	Dec-13	Jan-14	Sep-14	Dec-14	Feb-15	0.46	Feb-15	0.45	Feb-15	0.45																																																										
MIDHURST	N/A	Jan-14	Feb-14	Oct-14	Jan-15	Mar-15	0.38	Mar-15	0.39	Mar-15	0.46																																																										
REDRUTH	N/A	Jan-14	Feb-14	Oct-14	Jan-15	Mar-15	0.38	Mar-15	0.25	Mar-15	0.45																																																										
CARMEL	N/A	Feb-14	Mar-14	Nov-14	Feb-15	Apr-15	0.28	Apr-15	0.27	Apr-15	0.30																																																										
ROSEMARKIE	N/A	Feb-14	Mar-14	Nov-14	Feb-15	Apr-15	0.25	Apr-15	0.25	Apr-15	0.24																																																										
HEATHFIELD	N/A	Mar-14	Apr-14	Dec-14	Mar-15	May-15	0.24	May-15	0.19	May-15	0.41																																																										
BLACKHILL	N/A	Mar-14	Apr-14	Dec-14	Mar-15	May-15	3.77	May-15	3.75	May-15	3.76																																																										
LLANDDONA	N/A	Apr-14	May-14	Jan-15	Apr-15	Jun-15	0.20	Jun-15	0.13	Jun-15	0.18																																																										
LMAVADY	N/A	Apr-14	May-14	Jan-15	Apr-15	Jun-15	0.16	Jun-15	0.16	Jun-15	0.00																																																										
KNOCKMORE	N/A	May-14	Jun-14	Feb-15	May-15	Jul-15	0.11	Jul-15	0.11	Jul-15	0.12																																																										
BROUGH MOUNTAIN	N/A	May-14	Jun-14	Feb-15	May-15	Jul-15	0.10	Jul-15	0.09	Jul-15	0.10																																																										
EITSHAL	N/A	Jun-14	Jul-14	Mar-15	Jun-15	Aug-15	0.04	Aug-15	0.04	Aug-15	0.04																																																										
KEELVANG HILL	N/A	Jun-14	Jul-14	Mar-15	Jun-15	Aug-15	0.04	Aug-15	0.04	Aug-15	0.04																																																										
TORIOSAY	N/A	Jul-14	Aug-14	Apr-15	Jul-15	Sep-15	0.03	Sep-15	0.03	Sep-15	0.03																																																										
BRESSAY	N/A	Jul-14	Aug-14	Apr-15	Jul-15	Sep-15	0.02	Sep-15	0.02	Sep-15	0.02																																																										
Upper 50 Sites - New Antenna Sites Mid Risk, New Antenna ONLY Group US0-3, 21 Sites																																																																					
SANDY HEATH	Layer 9 Only	Jun-13	Sep-13	Oct-13	Jun-14	Sep-14	Nov-14	3.62	Nov-14	3.58	Nov-14	3.87																																																									
HANNINGTON (RESERVE)	Layer 9 Only	Apr-13	May-13	Jun-13	Aug-14	Nov-14	1.37	Nov-14	1.37	Nov-14	1.37																																																										
DIVIS	Layer 9 Only	Jul-13	Sep-13	Oct-13	Aug-14	Nov-14	0.00	Nov-14	0.00	Nov-14	0.00																																																										
FRESLEY	Layer 9 Only	Jul-13	Sep-13	Oct-13	Aug-14	Nov-14	0.00	Nov-14	0.00	Nov-14	0.00																																																										
MENDIP	Layer 9 Only	Aug-13	Oct-13	Nov-13	Aug-14	Nov-14	3.09	Sep-15	3.06	Sep-15	3.42																																																										
CHILLERTON DOWN HP	Layer 9 Only	Aug-13	Oct-13	Nov-13	Aug-14	Nov-14	3.05	Sep-15	2.92	Sep-15	3.32																																																										
BILSDALE	Layer 9 Only	Sep-13	Oct-13	Nov-13	Sep-14	Aug-15	2.71	Oct-15	2.69	Oct-15	2.79																																																										
BURNHOPE	Layer 9 Only	Sep-13	Nov-13	Dec-13	Sep-14	Aug-15	2.25	Oct-15	2.23	Oct-15	2.20																																																										
WALTHAM	Layer 9 Only	Oct-13	Nov-13	Dec-13	Oct-14	Aug-15	2.03	Oct-15	2.01	Oct-15	2.06																																																										
CHIFFORD	Layer 9 Only	Oct-13	Nov-13	Dec-13	Oct-14	Aug-15	1.58	Nov-15	1.18	Nov-15	1.58																																																										
DOVER	Layer 9 Only	Nov-13	Dec-13	Jan-14	Nov-14	Sep-15	0.89	Nov-15	0.81	Nov-15	1.02																																																										
ANGUS	Layer 9 Only	Nov-13	Dec-13	Jan-14	Nov-14	Sep-15	0.68	Nov-15	0.68	Nov-15	0.67																																																										
STOCKLAND HILL	Layer 9 Only	Jun-14	Sep-14	Oct-14	Jun-15	Jul-16	0.62	Sep-16	0.50	Sep-16	0.62																																																										
CHILDECK	Layer 9 Only	Jun-14	Sep-14	Oct-14	Jun-15	Jul-16	0.52	Sep-16	0.49	Sep-16	0.52																																																										
SILSBURY	Layer 9 Only	Jul-14	Sep-14	Oct-14	Jul-15	Aug-16	0.49	Oct-16	0.71	Oct-16	1.24																																																										
BEACON HILL	Layer 9 Only	Jul-14	Sep-14	Oct-14	Jul-15	Aug-16	0.43	Oct-16	0.35	Oct-16	0.49																																																										
HUNTSBURY CROSS	Layer 9 Only	Aug-14	Oct-14	Nov-14	Aug-15	Aug-16	0.18	Oct-16	0.16	Oct-16	0.21																																																										
SELKIRK	Layer 9 Only	Aug-14	Oct-14	Nov-14	Aug-15	Aug-16	0.12	Oct-16	0.12	Oct-16	0.12																																																										
RUMSTER FOREST	Layer 9 Only	Sep-14	Oct-14	Nov-14	Sep-15	Sep-16	0.09	Nov-16	0.09	Nov-16	0.09																																																										
BLAENRHYF	Layer 9 Only	Sep-14	Nov-14	Dec-14	Sep-15	Sep-16	0.09	Nov-16	0.08	Nov-16	0.09																																																										
CHATTON	Layer 9 Only	Oct-14	Nov-14	Dec-14	Oct-15	Sep-16	0.06	Nov-16	0.07	Nov-16	0.08																																																										
Lower 30 Sites - No Antennas - 18 sites Group L30-1, 10 Sites																																																																					
SHEFFIELD	Strengthening	N/A	May-13	Jun-13	Jan-14	Mar-14	Apr-14	0.50	Apr-14	0.50	Apr-14	0.56																																																									
HEMEL HEMPSTEAD	Strengthening	N/A	May-13	Jun-13	Jan-14	Mar-14	Apr-14	0.42	Apr-14	0.42	Apr-14	0.42																																																									
KILVEY HILL	Strengthening	N/A	Jun-13	Jul-13	Feb-14	Apr-14	May-14	0.42	May-14	0.40	May-14	0.42																																																									
FENTON	Strengthening	N/A	Jun-13	Jul-13	Feb-14	Apr-14	May-14	0.38	May-14	0.38	May-14	0.38																																																									
FENHAM	Strengthening	N/A	Jul-13	Aug-13	Mar-14	May-14	Jun-14	0.38	Jun-14	0.38	Jun-14	0.44																																																									
PENDLE FOREST	Strengthening	N/A	Jul-13	Aug-13	Mar-14	May-14	Jun-14	0.34	Jun-14	0.34	Jun-14	0.35																																																									
REIGATE	Strengthening	N/A	Jul-13	Sep-13	Apr-14	Jun-14	Jul-14	0.29	Jul-14	0.29	Jul-14	0.30																																																									
LANCASTER	Strengthening	N/A	Aug-13	Sep-13	Apr-14	Jun-14	Jul-14	0.25	Jul-14	0.25	Jul-14	0.29																																																									
NOTTINGHAM	Strengthening	N/A	Sep-13	Oct-13	May-14	Jul-14	Aug-14	0.23	Aug-14	0.22	Aug-14	0.22																																																									
LARK STOKE	Strengthening	N/A	Sep-13	Oct-13	May-14	Jul-14	Aug-14	0.22	Aug-14	0.22	Aug-14	0.25																																																									
KEIGHLEY	Strengthening	N/A	Oct-13	Nov-13	Jun-14	Aug-14	Sep-14	0.17	Sep-14	0.17	Sep-14	0.18																																																									
IDLE	Strengthening	N/A	Oct-13	Nov-13	Jun-14	Aug-14	Sep-14	0.18	Sep-14	0.18	Sep-14	0.18																																																									
CHESTERFIELD	Strengthening	N/A	Nov-13	Dec-13	Jul-14	Sep-14	Oct-14	0.17	Oct-14	0.17	Oct-14	0.16																																																									
BRISTOL KINGS WESTON	Strengthening	N/A	Nov-13	Dec-13	Jul-14	Sep-14	Oct-14	0.13	Oct-14	0.13	Oct-14	0.13																																																									
BROMSGROVE	Strengthening	N/A	Dec-13	Jan-14	Aug-14	Oct-14	Nov-14	0.11	Nov-14	0.11	Nov-14	0.12																																																									
ABERDARE	Strengthening	N/A	Dec-13	Jan-14	Aug-14	Oct-14	Nov-14	0.09	Nov-14	0.09	Nov-14	0.09																																																									
STORETON	Strengthening	N/A	Jan-14	Feb-14	Sep-14	Nov-14	Dec-14	0.08	Dec-14	0.08	Dec-14	0.08																																																									
PONTYPOOL	Strengthening	N/A	Jan-14	Feb-14	Sep-14	Nov-14	Dec-14	0.03	Dec-14	0.03	Dec-14	0.03																																																									
Lower 30 Sites Antenna (& Strengthening) Build Group L30-4, 10 sites																																																																					
WHITEHAWK HILL	Strengthening	Apr-14	May-14	Jun-14	Mar-15	May-15	Jun-15	0.55	Jun-15	0.55	Jun-15	0.65																																																									
BRIERLEY HILL	Strengthening	Apr-14	May-14	Jun-14	Mar-15	May-15	Jun-15	0.26	Jun-15	0.26	Jun-15	0.26																																																									
TUNBRIDGE WELLS	Strengthening	May-14	Jun-14	Jul-14	Apr-15	Jun-15	Jul-15	0.23	Jul-15	0.25	Jul-15	0.27																																																									
PLYMPTON	Strengthening	May-14	Jun-14	Jul-14	Apr-15	Jun-15	Jul-15	0.22	Jul-15	0.20	Jul-15	0.21																																																									
GUILDFORD	Strengthening	Jun-14	Jul-14	Aug-14	May-15	Jul-15	Aug-15	0.21	Aug-15	0.21	Aug-15	0.21																																																									
ROSNETH VP	Strengthening	Jun-14	Jul-14	Aug-14	May-15	Jul-15	Aug-15	0.19	Aug-15	0.19	Aug-15	0.19																																																									
MALVERN	Strengthening	Jul-14	Aug-14	Sep-14	Jun-15	Aug-15	Sep-15	0.21	Sep-15	0.21	Sep-15	0.23																																																									
OLIVERS MOUNT	Strengthening	Jul-14	Aug-14	Sep-14	Jun-15	Aug-15	Sep-15	0.13	Sep-15	0.13	Sep-15	0.13																																																									
SALISBURY	Strengthening	Aug-14	Sep-14	Oct-14	Jul-15	Sep-15	Oct-15	0.12	Oct-15	0.12	Oct-15	0.12																																																									
BRISTOL ILCHESTER CR	Strengthening	Aug-14	Sep-14	Oct-14	Jul-15	Sep-15	Oct-15	0.12	Oct-15	0.12	Oct-15	0.11																																																									
HASTINGS	Strengthening	Sep-14	Oct-14	Nov-14	Aug-15	Oct-15	Nov-15	0.10	Nov-15	0.09																																																											

Appendix C Antenna Selection Process

In respect of new Antennas, Arqiva shall use all reasonable endeavours to ensure that the Antenna patterns are compliant with those as specified by Ofcom in Appendix D. The Antenna System performance (i.e. system gain information) shown in Network Access Schedule 11/Transmission Schedule 6 are indicative and will be subject to variation. Any refined Antenna patterns and associated gain information shall be provided for acceptance by the Customer to allow Arqiva to produce a detailed Antenna Design Specification which the Customer must approve in writing by the Antenna ADS Approval Date. Any refinement of the Antenna patterns may lead to variations in system gain which in turn may lead to changes in Customer Equipment. Any changes from the values shown in Network Access Schedule 11/Transmission Schedule 6 may give rise to variations in the Charges and the Target Station Service Dates which shall be managed in accordance with the Change Control Procedure. Arqiva shall not be responsible for any changes the Customer may require to the Customer Equipment.

In addition to the above, where multiple customers require shared use of a new Antenna, Arqiva shall provide to the Customer and the other customers an Antenna Design Proposal, showing anticipated Antenna performance. It shall be the responsibility of the Customer to act in good faith to agree the Antenna design with Arqiva and the other customers to allow Arqiva to produce a detailed Antenna Design Specification for sign off by the Antenna ADS Approval Date. Failure to agree the ADS by the Antenna ADS Approval Date may lead to a delay in the provision of Network Access facilities and additional Charges.

Since there will be an inter-dependence between coverage and system gain the Customer should be aware that if changes to the proposed Antenna details in Network Access Schedule 11/Transmission Schedule 6 are required, the transmitters required to achieve the nominal ERP may be subject to change. Any consequent implications for other Network Access facilities (as a result of the selection of an Antenna) shall be dealt with by Change Control Procedure.

Appendix D Ofcom Provisional Specification and Restrictions

See attached.

15 September 2011

BY EMAIL

Macquarie UK Broadcast Holdings Limited
Crawley Court
Winchester
Hampshire
England
SO21 2QA

Dr H Nwana
Group Director, Spectrum Policy Group

Direct line: 020 7981 3581

h.nwana@ofcom.org.uk

Attention of: Peter Shore

Arqiva
Crawley Court
Winchester
Hampshire
England
SO21 2QA

Attention of: John Cresswell

Dear Sirs

Notice of Relevant Spectrum Auction and direction to prepare a Reference Offer under Section 10.4.1 and Section 12.4.1 of the Undertakings to the Competition Commission by Macquarie UK Broadcast Holdings Limited et al. of 1 September 2008 (“the Undertakings”)

This letter constitutes written notice of our intention to hold a Relevant Spectrum Auction, as defined and set out in the Undertakings.

In accordance with paragraph 10.4.1 and 12.4.1 of the undertakings, Ofcom hereby directs Arqiva to prepare Reference Offers for digital terrestrial television managed transmission services and network access following the specifications and the timetable set out below.

Background

We have previously discussed Ofcom’s intention to award spectrum in the range 550 MHz to 606 MHz (“the 600 MHz band”). To that effect, Ofcom published a consultation in February 2010¹ asking stakeholders about the potential uses of this spectrum, and an interim

¹http://stakeholders.ofcom.org.uk/binaries/consultations/600mhz_geographic/summary/600condoc.pdf

statement in October 2010 outlining stakeholder responses to the February 2010 consultation and next steps.

The responses we have received to our consultation, subsequent feedback from stakeholders and our own technical assessments suggest that a most likely use for the 600MHz band would be to provide DTT multiplexes. Ofcom commissioned Arqiva spectrum planners to update an illustrative study previously carried out for Ofcom² that illustrates how the band could be used to provide three UK-wide DTT multiplexes, known as “Layers 7, 8 and 9” (layers 1 to 6 are the six DSO multiplexes). We anticipate publishing the updated study on our website, alongside this letter and accompanying Requirements Specification.

Layers 7 and 8 could utilise three channels each in what is principally a multi-frequency network within which some adjacent transmitters operate in a single frequency network configuration. Layer 7 would use channels 31, 32 and 33 and Layer 8 would use channels 34, 35 and 37. It is envisaged that Layer 9 would occupy channel 36 only and operate as a UK-wide single frequency network. Our current thinking, on which we are planning to consult, is that the 600MHz band will be made available as separate lots, i.e. each 8MHz channel will be available individually. Participants in the auction would therefore be able to bid for just one channel, or combinations of channels. International rights vary between the channels and therefore only a few combinations are likely to be suitable if the aim is to provide UK-wide coverage. You should therefore be aware that combinations other than those identified in the Ofcom commissioned report may be possible, as is non-DTT use (subject to that use satisfying the appropriate technical licence conditions. Therefore possible outcomes from the award are that all, some or none of the spectrum may eventually be used to provide DTT services.

Specification

Arqiva should prepare a Reference Offer for Network Access (“NA”) and Transmission Services based upon the attached outline specification. Annex 1 to this letter includes a list of the relevant transmitter sites, together with an outline requirements specification that your Reference Offer team should use as the basis of their calculations. Details of the antenna templates based upon international restrictions will be forwarded under separate cover.

It is likely that the viability of additional DTT multiplexes making use of the 600MHz band will be determined to a large extent by the costs of transmission. We therefore strongly encourage Arqiva to think creatively about the technical arrangement presented within the Reference Offers, with a view to minimising costs. Arqiva is obliged to produce Reference Offers that include only costs that are reasonably and efficiently incurred and we intend to

²<http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-policy-area/projects/ddr/ch21.pdf>

carry out an audit of the Reference Offers to ensure they comply with your cost orientation obligation.

Timetable

Arqiva should provide each Reference Offer to Ofcom by 30 November 2011 in accordance with paragraph 10.6 and 12.6 of the undertakings. We expect to hold regular meetings with Arqiva while the Reference Offers are under preparation with the aim of reviewing progress and addressing any issues that may arise.

Contact

If you would like to discuss any aspect of this notice and direction, please contact Peter Madry at peter.madry@ofcom.org.uk or 020 7783 4325 in the first instance.

Yours sincerely

A handwritten signature in black ink, appearing to be 'H Nwana', written in a cursive style.

H Nwana

cc. Alan Watson, Adjudicator, Broadcast Transmission Services

Kevin Moroney, Arqiva

**Production of Reference Offers in relation to
600MHz spectrum award - Requirements specification**

General

Ofcom is intending making available via auction the spectrum between 550 and 606MHz (channels 31 to 37) also known as “the 600MHz band”. The spectrum is expected to be awarded in 2012 and be available for use from the end of that year. One of the likely uses for this spectrum is to provide additional DTT multiplexes. Initial Ofcom studies have shown that three UK-wide multiplexes are feasible, the “600MHz multiplexes¹”. It is likely that these additional multiplexes will make use of existing transmission sites that are used to broadcast the six UK-wide “DSO multiplexes²”.

The UK’s international negotiations on spectrum rights in channels 31 – 37 have been based upon a notional additional three layers of DTT coverage across the UK. Arqiva spectrum planners have carried out a study to illustrate how the frequencies could be used to enable the UK transmitter network to provide three multiplexes using the 600MHz band. Ofcom is making information from this study available to Arqiva’s Reference Offer team in advance of its publication solely for the purposes of enabling work to commence in preparing reference offers. This information should not be shared with anyone within Arqiva that is, or may potentially be, involved in activities relating to Arqiva’s participation in any award of the 600MHz spectrum.

Format of Reference Offer

Arqiva shall produce Reference Offers for both Network Access and Transmission Services (being Network Access and Managed Transmission Services combined). As a guiding principle, Arqiva can assume that the 600MHz multiplexes would adopt a model similar to that of the three existing commercial DTT multiplexes.

The Reference Offers shall be based upon the most cost-effective solution for customers which may include a combination of the following arrangements:

- Existing infrastructure provided for the DSO multiplexes that could be shared by the 600MHz multiplexes with suitable modification to permit them to develop their maximum permissible powers to enable them to serve as large a proportion of the potential coverage area as possible
- Existing infrastructure provided for the DSO multiplexes that could be shared by the 600MHz multiplexes with suitable modification but with constraints such as a reduction in the maximum power that can be radiated
- Completely new infrastructure designed especially for the 600MHz multiplexes that would be shared by the three multiplexes and permit them to develop their maximum

¹ Carried in UHF channels 31 -37 which covers the frequency range 550-606 MHz.

² Muxes 1 and B (BBC), Mux 2 (Digital 3&4), Mux A (SDN), Muxes C and D (Arqiva)

permissible powers to serve as large a proportion of the potential coverage area as possible

Arqiva shall produce Reference Offers in sufficient detail to meet the requirements of this specification to enable potential participants in the 600MHz awards to assess the indicative costs of transmission. Reference Offers shall be provided that take into account the following situations with appropriate technical arrangements and cost apportionment:

- one 600 MHz multiplex is implemented at 80 transmitter sites as a single continuous programme of works
- three 600 MHz multiplexes are implemented as a single continuous programme of work at 80 transmitter sites

Existing and new infrastructure

The introduction of 600MHz multiplexes will in all cases require some degree of upgrading of the infrastructure at the existing transmission sites. It is our expectation that a combination of new and existing infrastructure will be needed to deliver any new DTT services.

Although it is understood that spare capacity has not been incorporated into antenna and feeder systems for the DSO multiplexes by design, some spare capacity may nevertheless exist. There may be occasions where it is possible from a technical perspective and is advantageous in terms of cost and time for implementation for the new 600MHz multiplexes to share infrastructure with the DSO multiplexes. It is also desirable that work aloft be avoided where possible to reduce the impact on viewers and on other users of the structure as well as reducing dependence upon seasonal build cycles.

In some cases, completely new antenna and combiner equipment will need to be installed to enable the broadcasting of the 600MHz multiplexes. This new equipment would generally be separate from that carrying the six UK-wide DSO multiplexes due to power, frequency and pattern constraints.

In producing the Reference Offers, Arqiva shall assess the capability of existing infrastructure to accommodate the 600MHz multiplexes. Below is some guidance on the methodology to be adopted to allow viable solutions to be presented in the Reference Offers to potential bidders.

Guideline 1: Where existing antennas at a particular transmitter site can be used to support the required 600MHz without compromise to the existing services then these shall be offered as the default solution provided that:

- the 600MHz service(s) can be accommodated within the existing antenna system and can operate at an ERP that is no more than 10dB less than set out in the schedule of powers in the Outline Network Requirements Specification.
- normal voltage and power safety factors are not exceeded
- antenna pattern ripple does not exceed 10dB

- antenna system return loss meets usual specification

Guideline 2: Where existing antennas cannot be used to support additional 600MHz services in accordance with Guideline 1, provision of an additional '600MHz Antenna' shall be proposed in which the antenna shall support 600MHz multiplexes at their full rated power. Such antennas shall be configured in two halves to all half antenna operation at -3dB relative to nominal ERP.

Below is an Outline Network specification for the 600MHz multiplexes.

Outline Network Requirements Specification

Network Access

Transmitter locations: Eighty principal sites as set out in Appendix A. There is flexibility to make use of alternative sites in some areas should it be disproportionately expensive or difficult to build at the principal site, perhaps due to congestion or loading of the structure. The alternative sites are set out in Table 1.

Table 1	
Principal site	Alternative
Black Hill	Kirk O'Shotts
Caldbeck	Sandale
CrystalPalace	Croydon
Divis	BlackMountain
Pontop Pike	Burnhope
Rowridge	Chillerton Down
Sutton Coldfield	Lichfield
Wenvoe	St Hilary

Number of multiplexes

Arqiva shall produce Reference Offers based upon one and three UK-wide multiplexes as set out in Table 2 at the eighty principal sites. Arqiva may also indicate the technical feasibility of providing five multiplexes at the top 20 locations.

Table 2		
Name	Type	Channel(s)
Layer 7	Multi-frequency network with regional synchronisation of some transmitters	31, 32, 33
Layer 8	Multi-frequency network with regional synchronisation of some transmitters	34, 35, 37
Layer 9	Single frequency network	36

Channel and ERP: Specified by transmitter site in Appendix B. These have been derived under work initiated by Ofcom by the Arqiva spectrum planners' 600MHz study which

assumes each transmitter operates at 4dB below the level at which it would just meet international obligations. This is to ensure that the power sum of all UK emissions does not breach internationally agreed limits.

Antenna templates: Templates have been developed under work initiated by Ofcom by Arqiva spectrum planners based upon best understanding of international rights as of Dec 2010. The patterns will be made available by Ofcom separately to this document. For Reference Offers, the Antenna pattern ripple should be consistent with the Antenna Templates specification for DSO multiplexes (except as set out in Guideline 1 above). Reference offers do not need to include for helicopter testing of antenna patterns.

Antenna system configuration

If a new antenna is required at a site, the new antenna should be mounted as high as reasonably possible on the structure within available aperture. The new antenna should be split into two halves, both of which are normally in use. Under fault conditions, reconfiguration should permit full transmitter power to be fed into one half of the antenna which should be suitably rated to maintain ERP no less than 3dB below normal.

Combiner configuration

Dual combiners are required at the 50 main transmitter sites. At the 30 smaller sites either dual or single combiners with a split output are acceptable.

Power system

Dual power feeds are required to the 50 main transmitters where this is achievable at reasonable cost. Single feeds are acceptable elsewhere. Back-up generators should be included to meet the stated availability. Assumptions for transmitter efficiency should be consistent with that allowed for the DSO multiplexes or where applicable manufacturer's latest available information at the time the Reference Offers are drafted.

Managed Transmission Service

Transmitter system

The transmitter system should be designed to accept two separate input feeds from diverse sources. Encoding of programme services, multiplexing SI Management and distribution from multiplexing centre(s) to transmitter sites may be carried out by others and lie outside the scope of the Transmission Reference Offer.

Equipment architecture shall employ duplication or be configured such that failure of a single component or module does not lead to a complete loss of service. Temporary reductions in output power under fault conditions are permissible. For guidance, we would expect that power reductions should be no more than 6dB for faults that can be rectified within 12 hours or 3 dB for faults that are likely to take longer to resolve.

Arqiva should set out in the offer what the maximum reduction in power is likely to be under fault conditions.

Transmitter power

Transmitter systems shall be rated to permit the maximum ERP set out in the schedule of powers in Appendix B to be achieved (except as noted in Guideline1 above).

Single frequency operation

Arqiva shall make allowance in the Reference Offers for the necessary infrastructure to permit the Layer 9 multiplex to operate as a UK-wide single frequency network. Whilst Layers 7 and 8 are nominally multi-frequency networks, Arqiva shall make allowance for a number of stations within those networks to operate as single frequency networks, these are detailed in Table 3.

Table 3	Transmitters in SFN	Channels
1	Tacolneston, Sudbury	31, 37
2	Carmel, Preseli	32, 35
3	Crystal Palace, Reigate, Guildford	33, 35
4	Sutton Coldfield, Bromsgrove, The Wrekin	33, 35
5	Winter Hill, Saddleworth, Storeton	31, 37
6	Emley Moor, Chesterfield	32, 34
7	Wenvoe, Kilvey Hill, Pontypool	31, 37
8	Waltham, Nottingham	31, 37
9	Mendip, Bristol Ilchester Crescent, Bristol Kings Weston	33, 35
10	Rowridge, Salisbury, Midhurst	31, 37
11	Llanddona, Moel-y-Parc	32
12	Heathfield, Hastings	32, 34

Availability

The system specified in the reference offer shall be designed to achieve a minimum in-service availability of 99.9% averaged over a rolling twelve month period.

Monitoring

All transmitter sites shall incorporate facilities to monitor the status of the transmission equipment and confirm normal operation. It is desirable for a degree of remote control to be incorporated (for example resetting of trips and changeover systems where this can be safely carried out remotely).

Timetable

Delivery of reference offer	30 Nov 2011
Award of spectrum	2012
Service launch - to include nations capital cities where feasible	early 2014
Expansion of network	2015-16
Completion of rollout	2017

Appendix A – List of principal transmitters

Site name	Main transmitter	Site Name	Main transmitter
ABERDARE		LANCASTER	
ANGUS	Y	LARK STOKE	
BEACON HILL	Y	LIMAVADY	Y
BELMONT	Y	LLANDDONA	Y
BILSDALE	Y	MALVERN	
BLACK HILL	Y	MENDIP	Y
BLAENPLWYF	Y	MIDHURST	Y
BLUEBELL HILL	Y	MOEL Y PARC	Y
BRESSAY	Y	NOTTINGHAM	
BRIERLEY HILL		OLIVERS MOUNT	
BRISTOL ILCHESTER CR		OXFORD	Y
BRISTOL KINGS WESTON		PENDLEFOREST	
BROMSGROVE		PLYMPTON	
BROUGHMOUNTAIN	Y	PONTOP PIKE	Y
CALDBECK	Y	PONTYPOOL	
CARADON HILL	Y	PRESELI	Y
CARMEL	Y	REDRUTH	Y
CHATTON	Y	REIGATE	
CHESTERFIELD		RIDGE HILL	Y
CRAIGKELLY	Y	ROSEMARKIE	Y
CRYSTALPALACE	Y	ROSNEATH VP	
DARVEL	Y	ROWRIDGE	Y
DIVIS	Y	RUMSTERFOREST	Y
DOVER	Y	SADDLEWORTH	
DURRIS	Y	SALISBURY	
EITSHAL	Y	SANDY HEATH	Y
EMLEY MOOR	Y	SELKIRK	Y
FENHAM		SHEFFIELD	
FENTON		STOCKLAND HILL	Y
GUILDFORD		STORETON	
HANNINGTON	Y	SUDBURY	Y
HASTINGS		SUTTON COLDFIELD	Y
HEATHFIELD	Y	TACOLNESTON	Y
HEMEL HEMPSTEAD		THE WREKIN	Y
HUNTSWAW CROSS	Y	TOROSAY	Y
IDLE		TUNBRIDGE WELLS	
KEELYLANG HILL	Y	WALTHAM	Y
KEIGHLEY		WENVOE	Y
KILVEY HILL		WHITEHAWK HILL	
KNOCKMORE	Y	WINTER HILL	Y

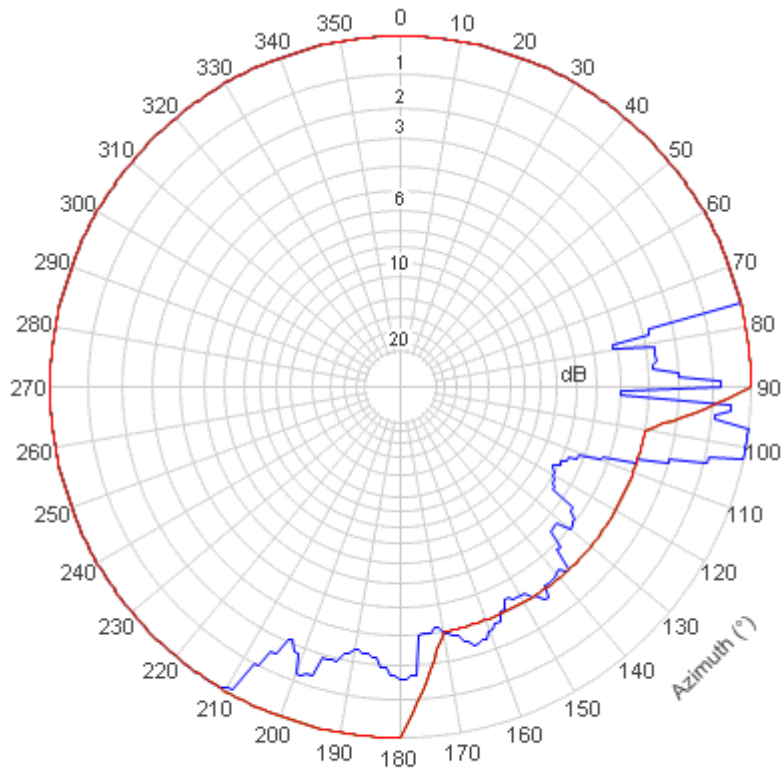
Appendix B – Schedule of transmitter channels and powers

Site ID	Site Name	TLA	Channels	Maximum ERP (kW)
10100	CrystalPalace	CP	33,35,36	200
10101	Guildford	GI	33,35,36	2
10103	Reigate	REI	33,35,36	2
10104	Tunbridge Wells	TW	31,37,36	4
10105	Hemel Hempstead	HH	31,37,36	2
10200	Sutton Coldfield	SC	33,35,36	200
10203	Brierley Hill	BOF	31,37,36	2
10206	Bromsgrove	BGE	33,35,36	0.4
10207	Malvern	MVR	31,37,36	0.4
10208	Lark Stoke	LKK	32,34,36	1.26
10211	Fenton	FNT	32,34,36	2
10300	Winter Hill	WRH	31,37,36	100
10302	PendleForest	PLF	33,35,36	0.1
10306	Saddleworth	SWH	31,37,36	0.4
10307	Storeton	SEN	31,37,36	0.56
10335	Lancaster	LCR	33,34,36	2
10400	Emley Moor	MLM	32,34,36	200
10403	Sheffield	SF	31,37,36	1
10405	Chesterfield	CD	32,34,36	0.4
10407	Keighley	KJ	31,37,36	2
10413	Idle	IDL	33,35,36	0.05
10500	Black Hill	BKH	32,35,36	100
10510	Torosay	TOY	31,37,36	4
10600	Wenvoe	WV	31,37,36	100
10601	Kilvey Hill	KVH	31,37,36	2
10606	Aberdare	ABR	32,34,36	0.1
10615	Pontypool	PPL	31,37,36	0.05
10700	Divis	DIV	33,34,36	100
10800	Rowridge	ROW	31,37,36	200
10801	Salisbury	SA	31,37,36	2
10805	Whitehawk Hill	WL	33,35,36	4
10860	Rowridge VP	ROW	31,37,36	200
10900	Pontop Pike	PP	33,34,36	100
10903	Fenham	FNH	31,37,36	0.4
11000	Mendip	MEN	33,35,36	100
11007	Bristol Kings Weston	BSK	33,35,36	0.2
11008	Bristol Ilchester Crescent	BSL	33,35,36	0.2
11100	Waltham	WBF	31,37,36	50
11101	Nottingham	NOU	31,37,36	0.4
11200	Durriss	DUS	32,35,36	100
11300	Dover	DOV	33,35,36	100

Site ID	Site Name	TLA	Channels	Maximum ERP (kW)
11400	Tacolneston	TAC	31,37,36	100
11500	Sudbury	SUY	31,37,36	100
11600	Bilsdale	BIL	31,37,36	100
11700	Oxford	OF	31,37,36	100
11800	Llanddona	LLA	32,35,36	20
11900	Carmel	CRL	32,35,36	20
12000	Belmont	BMN	33,35,36	200
12002	Olivers Mount	OMT	32,34,36	2
12100	The Wrekin	WRK	33,35,36	20
12300	Angus	AGU	31,37,36	20
12400	Sandy Heath	SDT	32,34,36	200
12500	Midhurst	MH	31,37,36	20
12600	Hannington	HAN	32,34,36	50
12900	Presely	PRS	32,35,36	20
13000	Limavady	LTS	32,35	20
13100	Caradon Hill	CNH	31,37,36	100
13105	Plympton	PTN	32,35,36	0.4
13200	Stockland Hill	SDL	32,37,36	50
13400	Keelylang Hill	KEE	33,34,36	20
13402	Bressay	BRQ	31,37,36	2
13500	Blaenplwyf	BY	31,37,36	40
13600	Beacon Hill	BNL	33,34,36	20
13700	Caldbeck	CDK	32,35,36	100
13800	Huntshaw Cross	HC	33,34,36	20
13900	Heathfield	HJV	32,34,36	20
13902	Hastings	HS	32,34,36	1
14100	Redruth	RR	33,34,36	20
14500	Moel Y Parc	MYP	32,34,36	20
14700	Craigkelly	CGK	33,34,36	20
14800	RumsterForest	RMF	32,35,36	20
14900	Ridge Hill	RHA	32,34,36	20
15100	BrougheMountain	BRM	31,37	20
15200	Darvel	DVL	31,37,36	20
15211	Rosneath VP	ROS	33,34,36	2
15300	Knockmore	KMR	33,34,36	20
15400	Eitshal	ETL	33,34,36	20
15500	Chatton	CHN	32,35,36	20
15600	Rosemarkie	RK	31,37,36	20
15800	Bluebell Hill	BBL	32,34,36	20
16100	Selkirk	SXJ	31,37,36	10

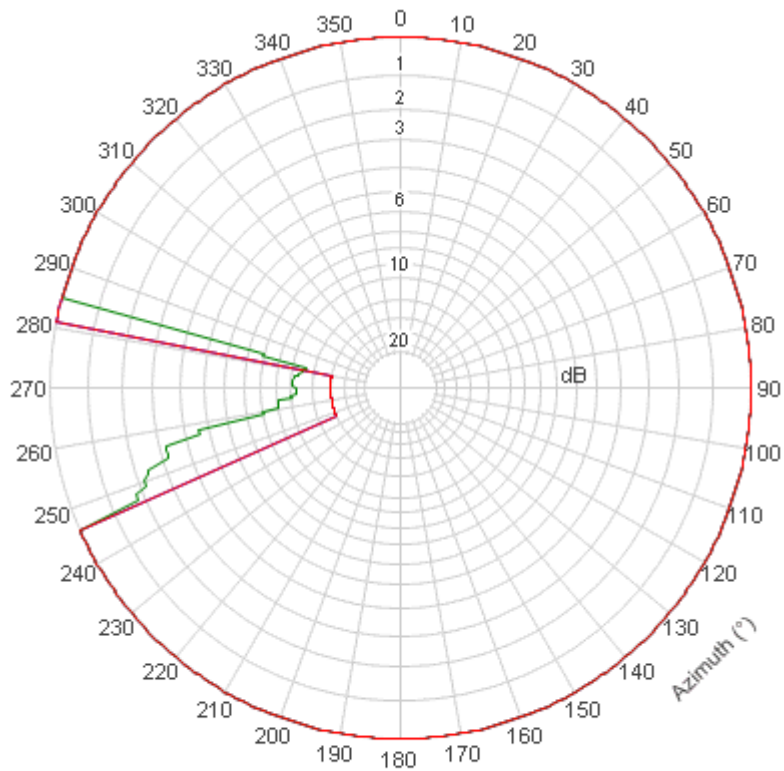
600 MHz Reference Offer
Summary of Pattern Restrictions

Station	Main/ Relay	Pattern Restricted?	Maximum restriction dB		
			Layer 7	Layer 8	Layer 9
Angus	M	No			
Beacon Hill	M		7	13	22
Belmont	M		0	0	1
Bilsdale	M	No			
Black Hill	M	No			
Blaenplwyf	M		18	18	28
Bluebell Hill	M		8	5	4
Bressay	M	No			
Brougher Mountain	M		5	5	*
Caldbeck	M		0	0	12
Caradon Hill	M		7	20	20
Carmel	M	No			
Chatton	M		8	8	0
Craigkelly	M	No			
Crystal Palace	M		3	3	6
Darvel	M		0	0	1
Divis	M		0	0	26
Dover	M		22	26	30
Durris	M	No			
Eitshal	M	No			
Emley Moor	M	No			
Hannington	M		2	5	1
Heathfield	M		20	13	14
Huntshaw Cross	M		11	11	12
Keelylang Hill	M	No			
Knockmore	M	No			*
Limavady	M	No			
Llandona	M		0	0	12
Mendip	M		2	10	7
Midhurst	M		4	8	9
Moel y parc	M		0	0	11
Oxford	M		0	4	0
Pontop Pike	M	No			
Presely	M		0	0	18
Redruth	M		3	10	13
Ridge Hill	M	No			
Rosemarkie	M	No			
Rowridge	M		31	33	34
Rumster Forest	M	No			
Sandy Heath	M		1	3	0
Selkirk	M	No			
Stockland Hill	M		0	26	20
Sudbury	M		13	8	18
Sutton Coldfield	M	No			
Tacolneston	M		3	5	6
The Wrekin	M	No			
Torosay	M	No			
Waltham	M	No			
Wenvoe	M		1	3	1
Winter Hill	M		14	14	11
Aberdare	R	No			
Brierley Hill	R	No			
Bristol Ilchester Crescent	R	No			
Bristol Kings Weston	R	No			
Bromsgrove	R	No			
Chesterfield	R	No			
Fenham	R	No			
Fenton	R	No			
Guildford	R		3	0	0
Hastings	R		14	14	20
Hemel Hempstead	R	No			
Idle	R	No			
Keighley	R	No			
Kilvey Hill	R	No			
Lancaster	R		0	0	5
Larkstoke	R	No			
Malvern	R	No			
Nottingham	R	No			
Olivers Mount	R	No			
Pendle Forest	R	No			
Plympton	R		7	7	0
Pontypool	R	No			
Reigate	R		3	0	0
Rosneath	R	No			
Saddleworth	R	No			
Salisbury	R	No			
Sheffield	R	No			
Storeton	R	No			
Tunbridge Wells	R	No			
Whitehawk Hill	R		9	13	20



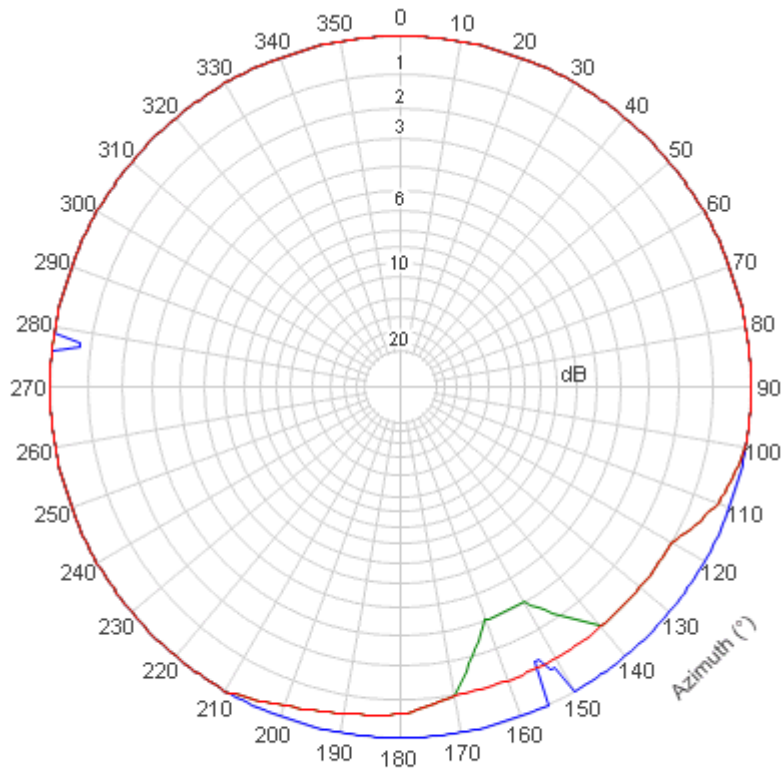
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Crystal Palace



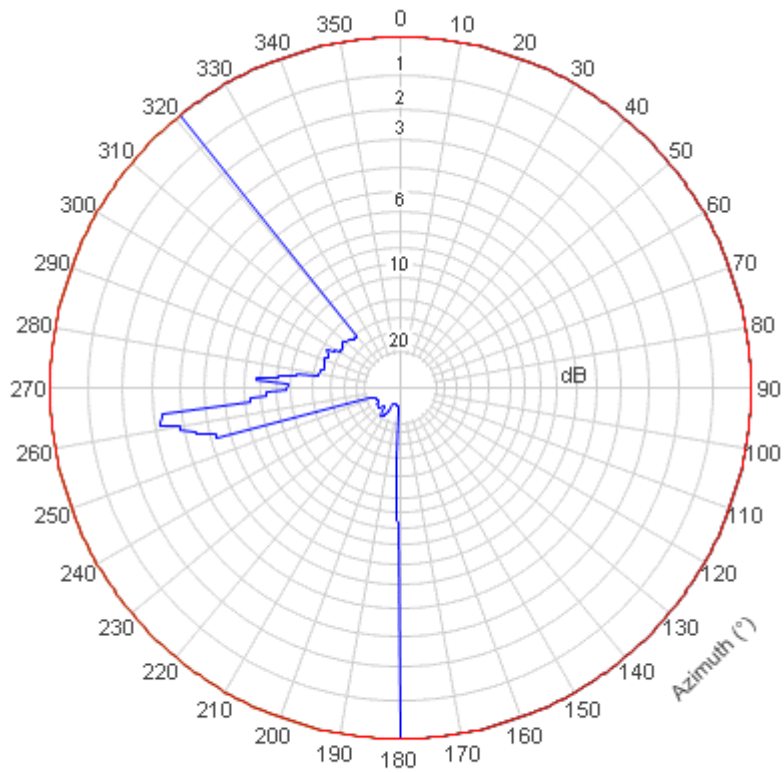
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Winter Hill



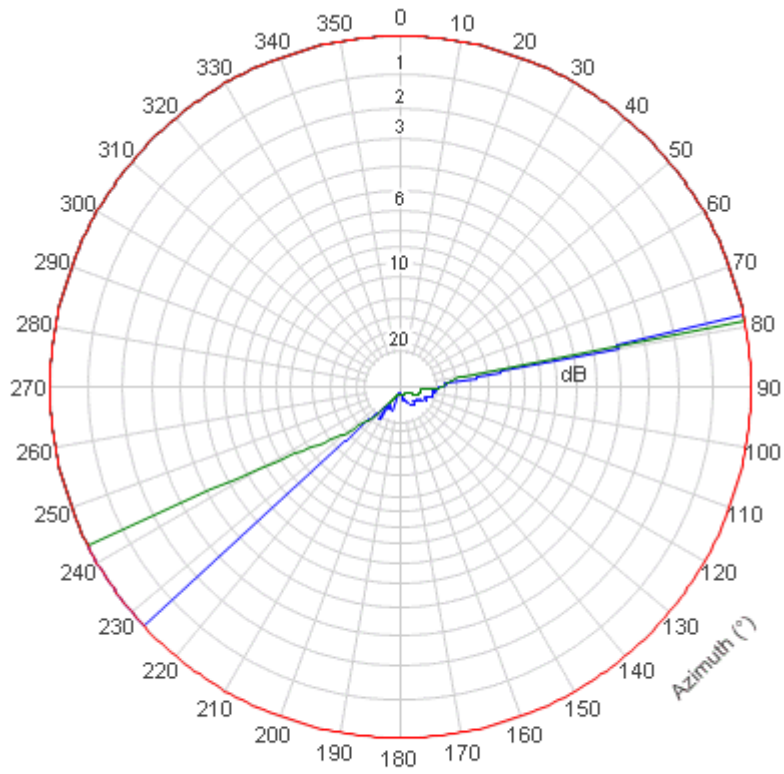
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Wenvoe



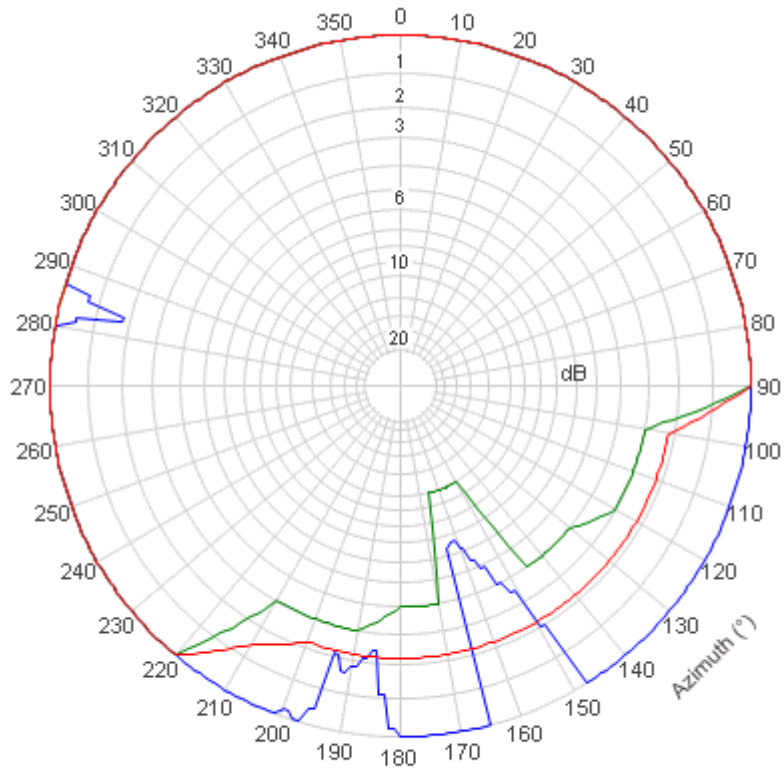
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Divis



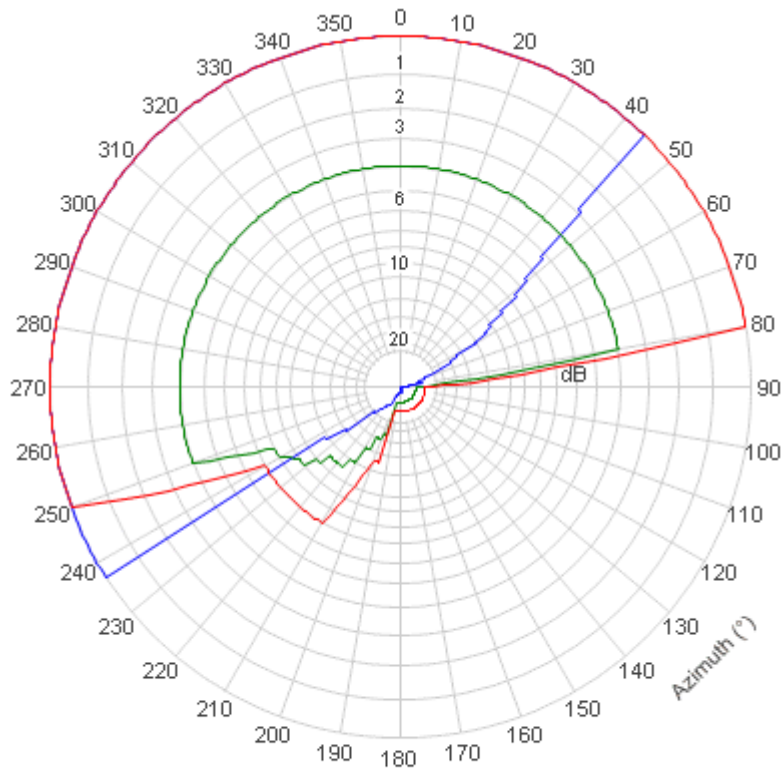
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Rowridge



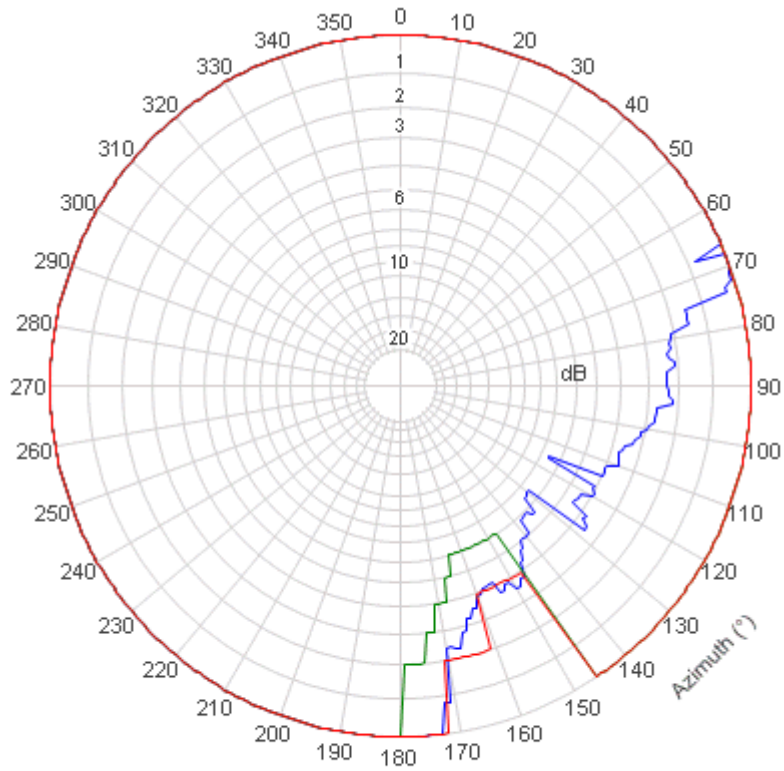
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Mendip



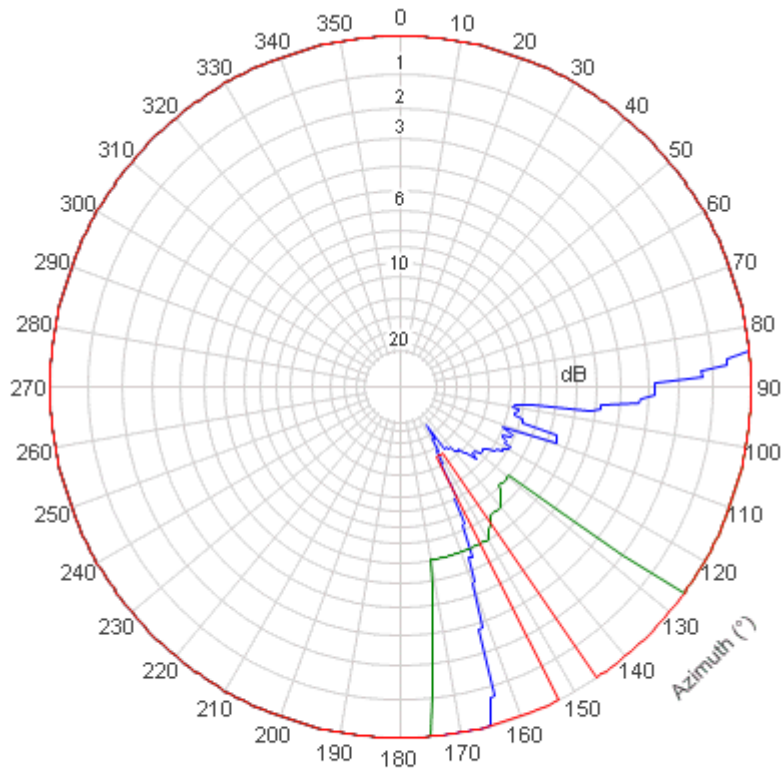
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Dover



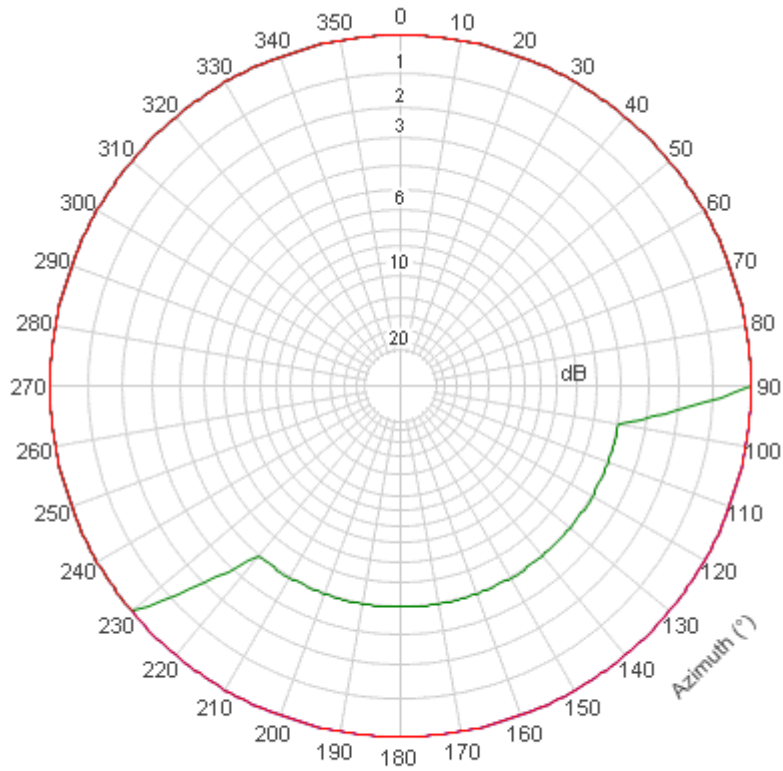
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Tacolneston



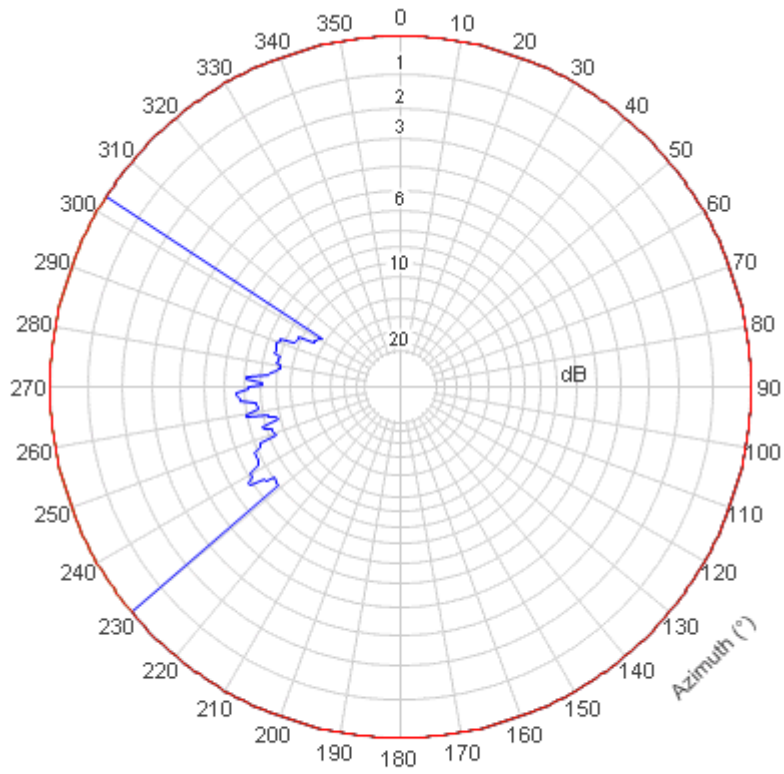
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Sudbury



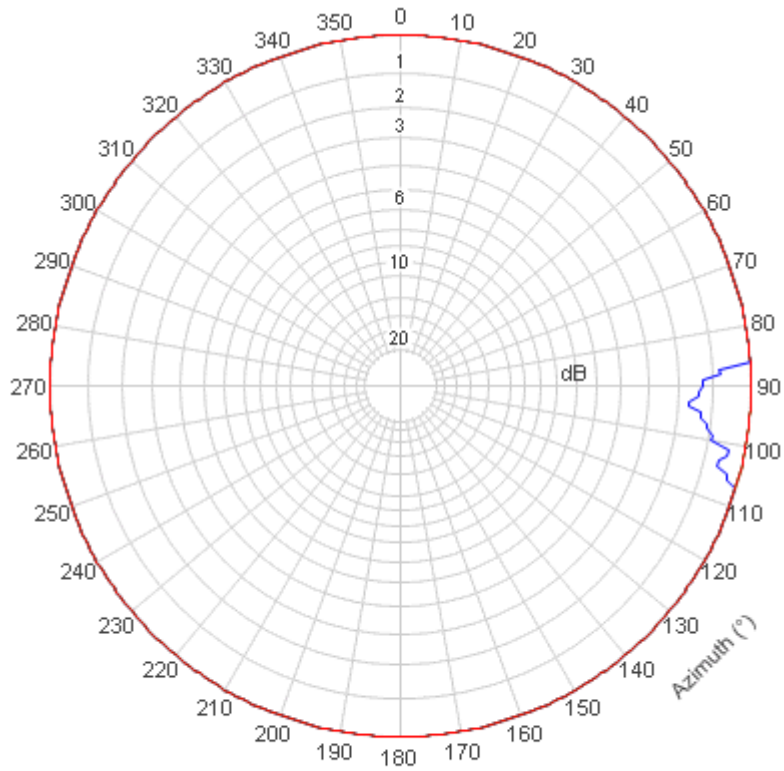
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Oxford



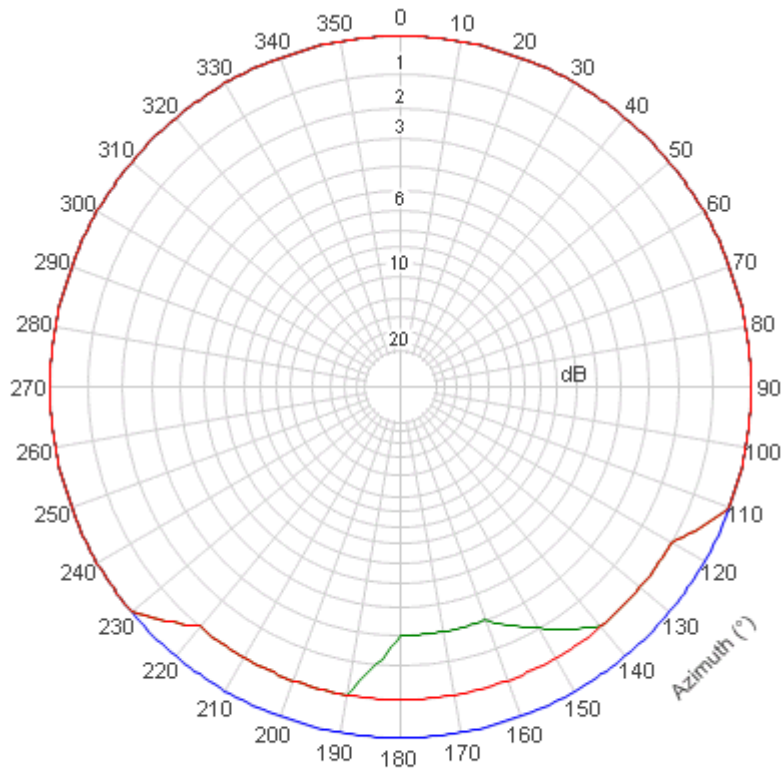
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Llanddona



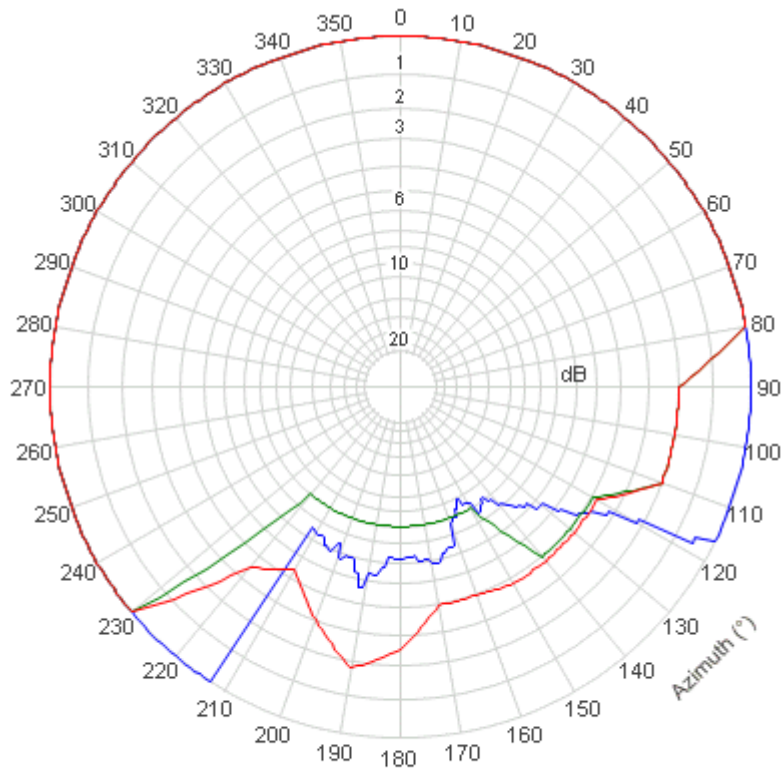
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Belmont



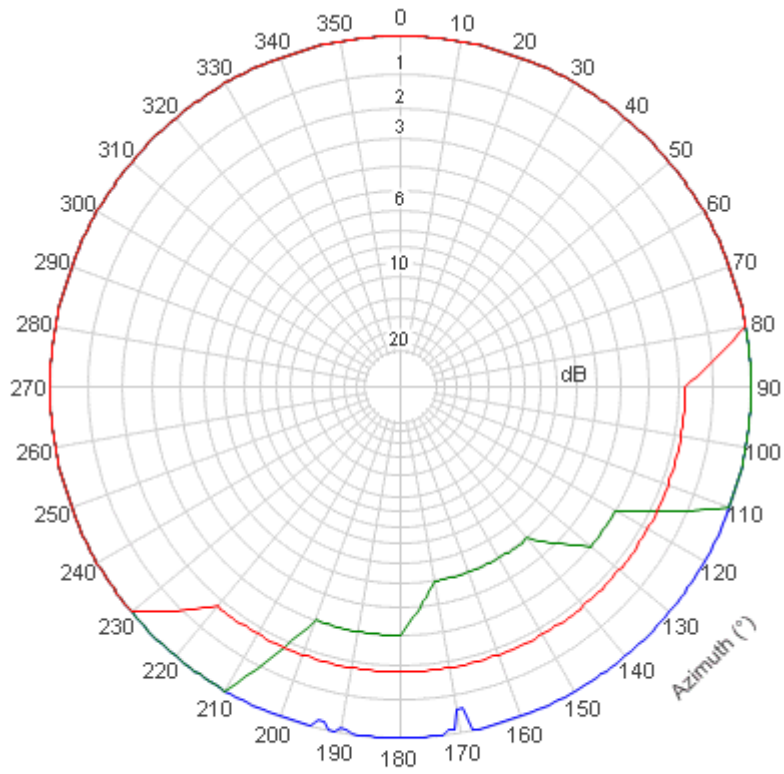
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Sandy



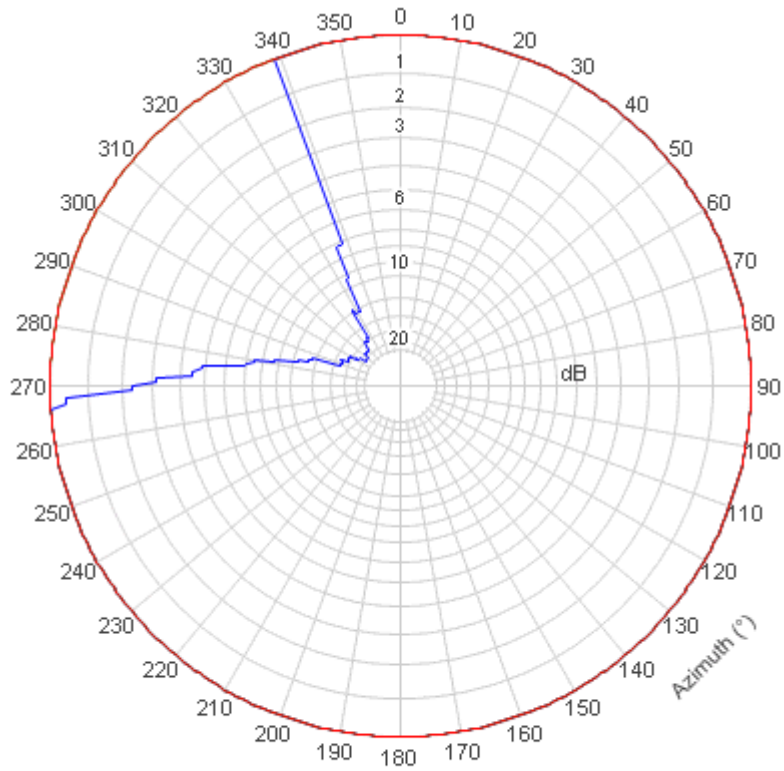
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Midhurst



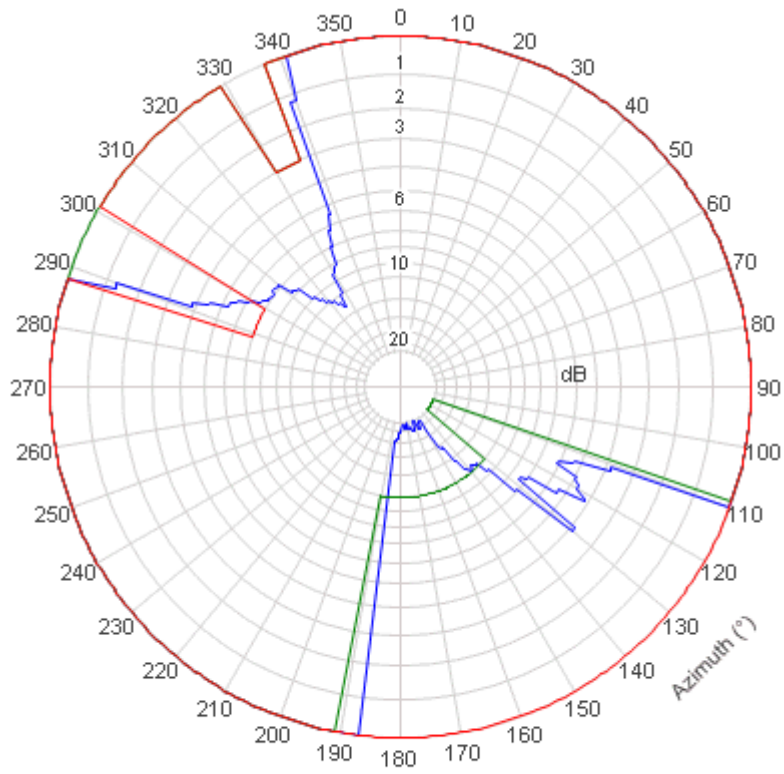
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Hannington



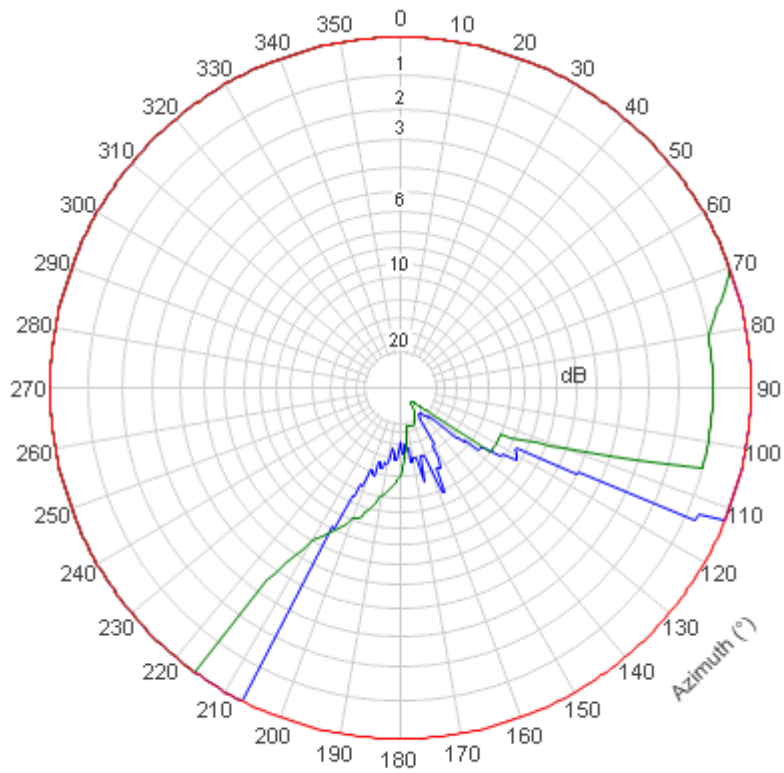
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Presely



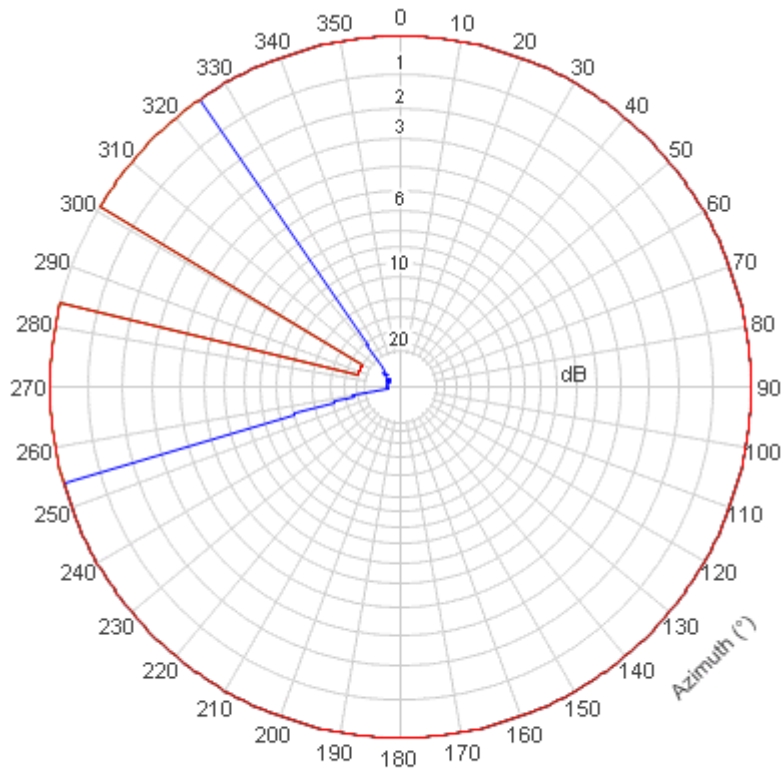
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Caradon Hill



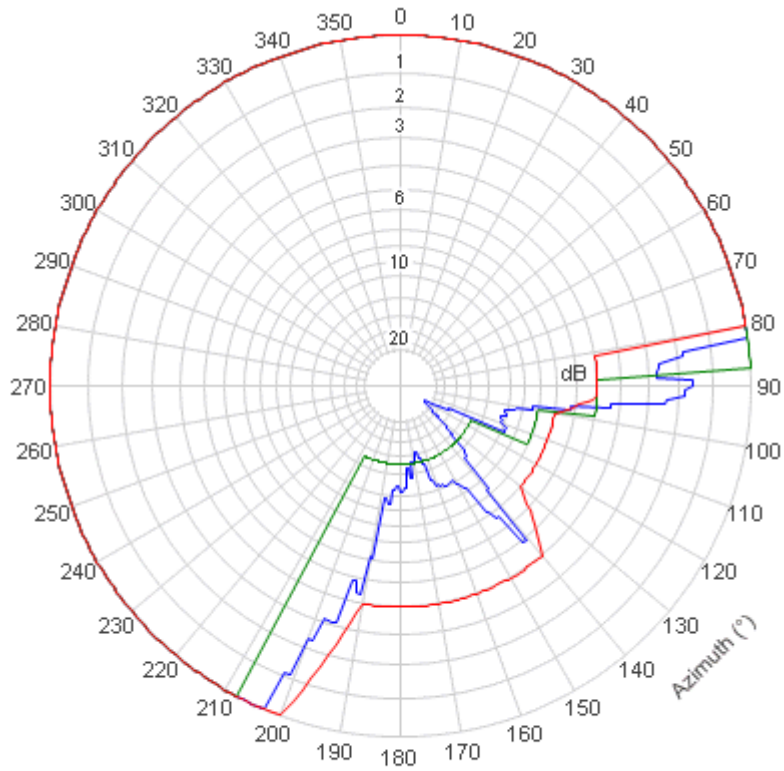
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Stockland Hill



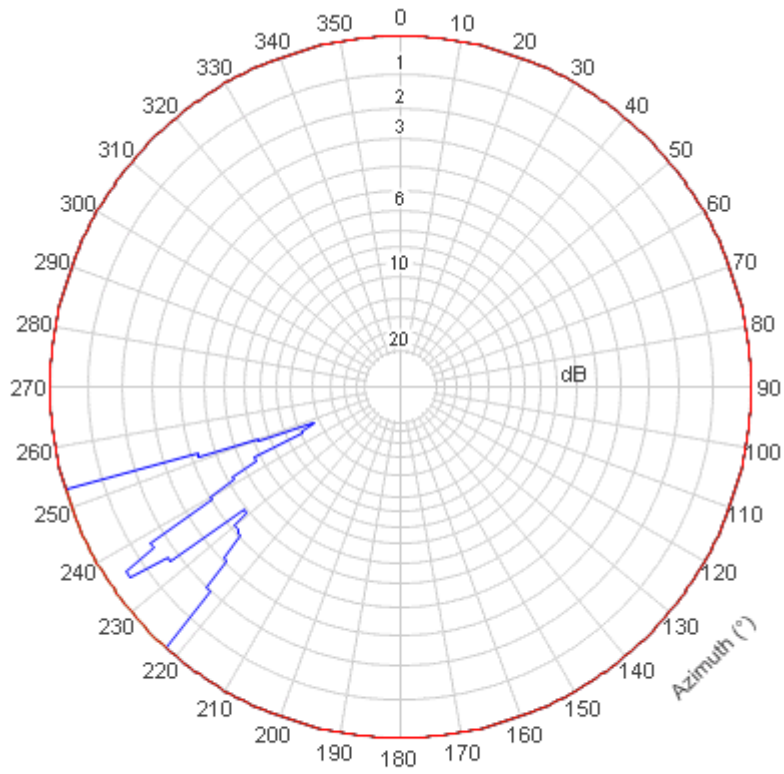
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Blaenplwyf



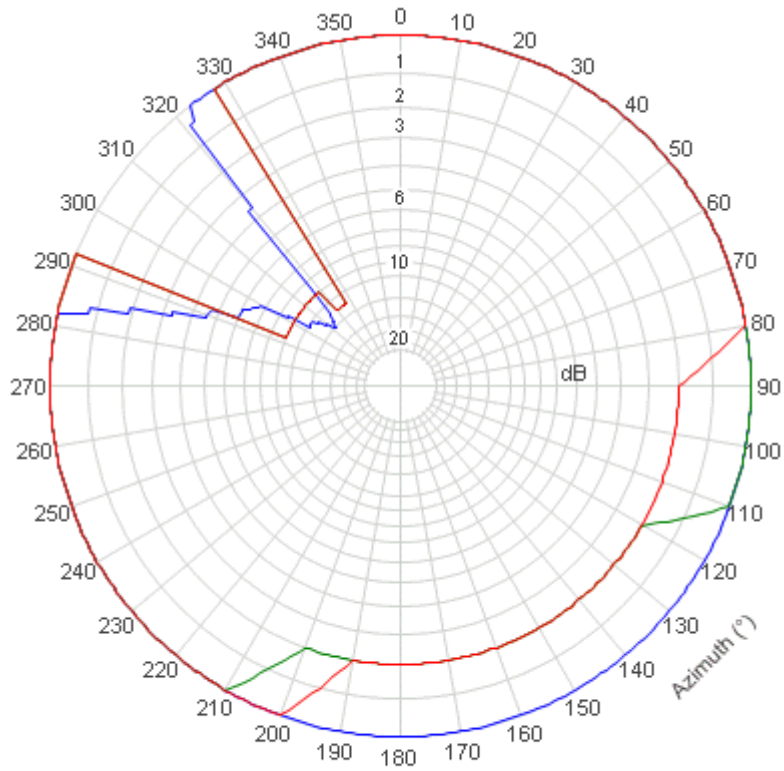
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Beacon Hill



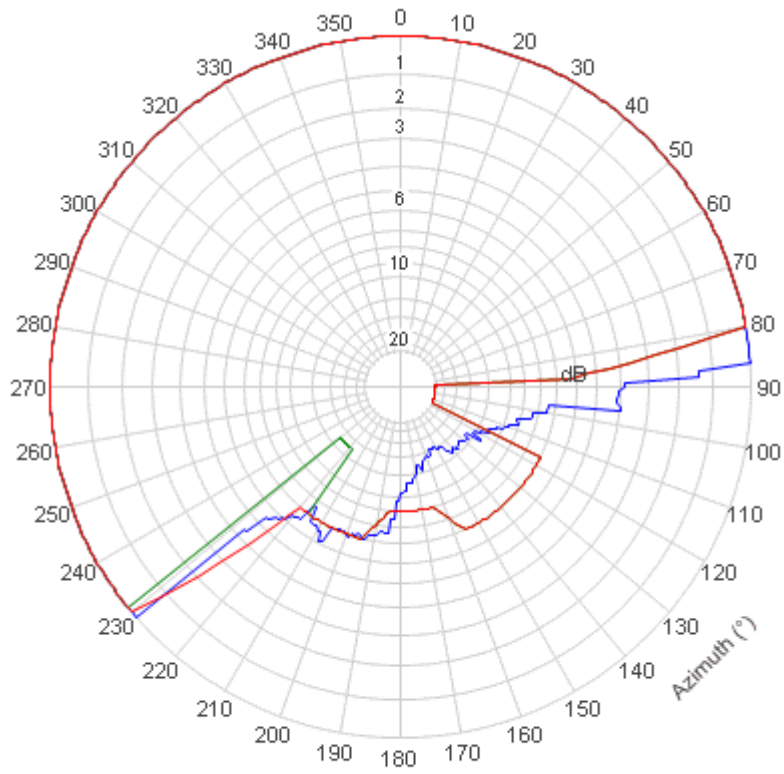
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Caldbeck



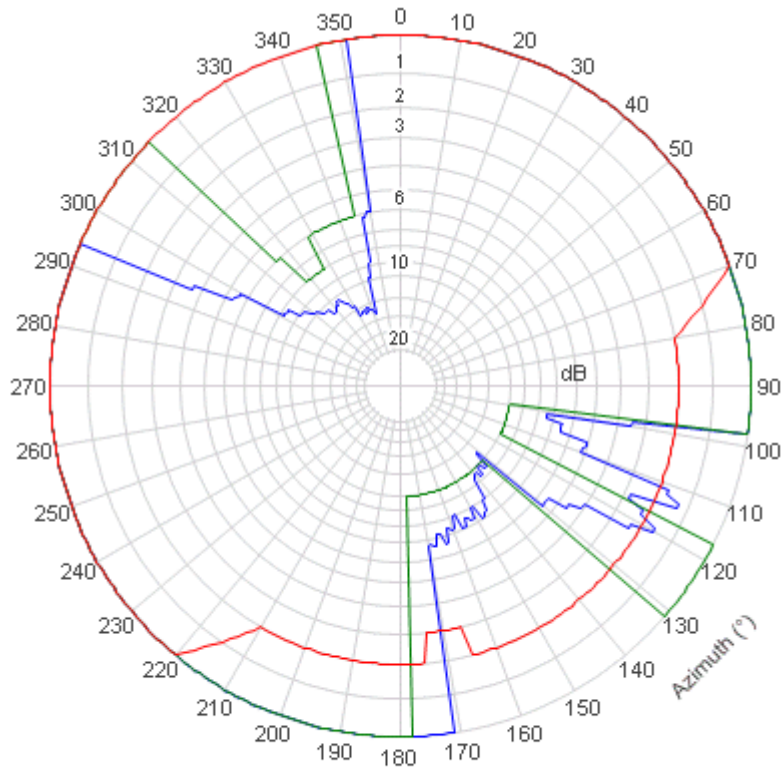
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Huntshaw Cross



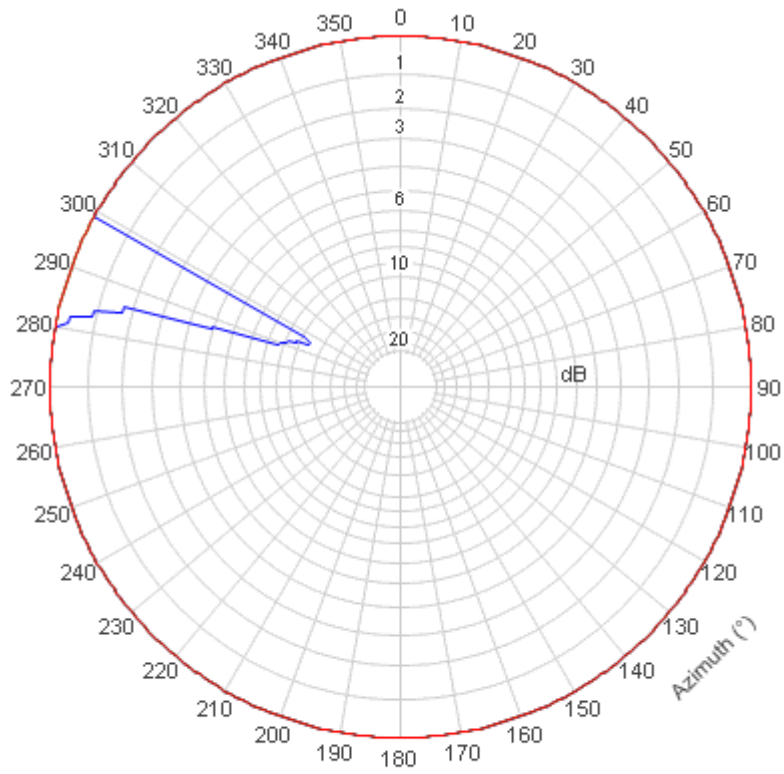
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Heathfield



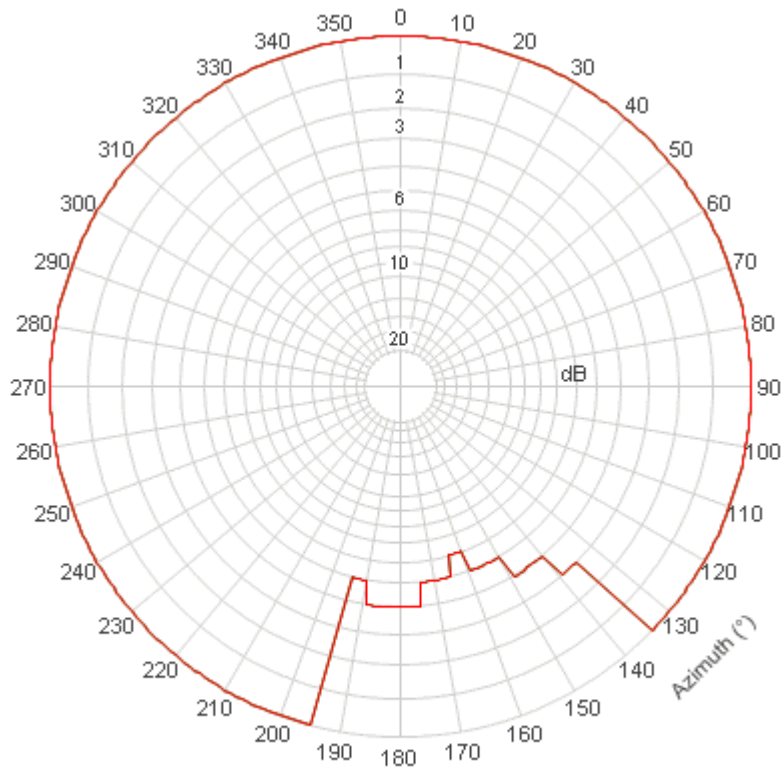
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Redruth



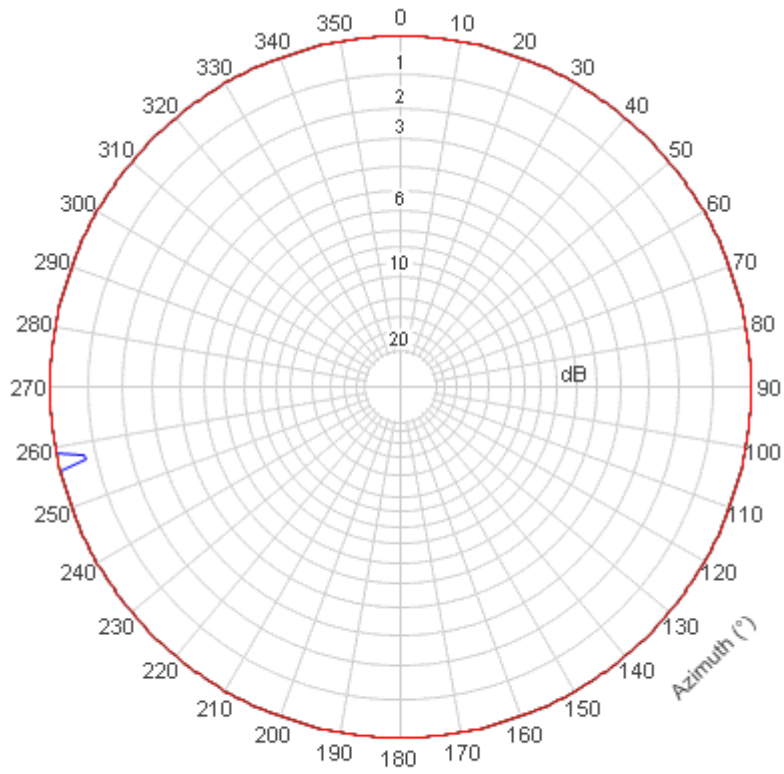
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Moel Y Parc



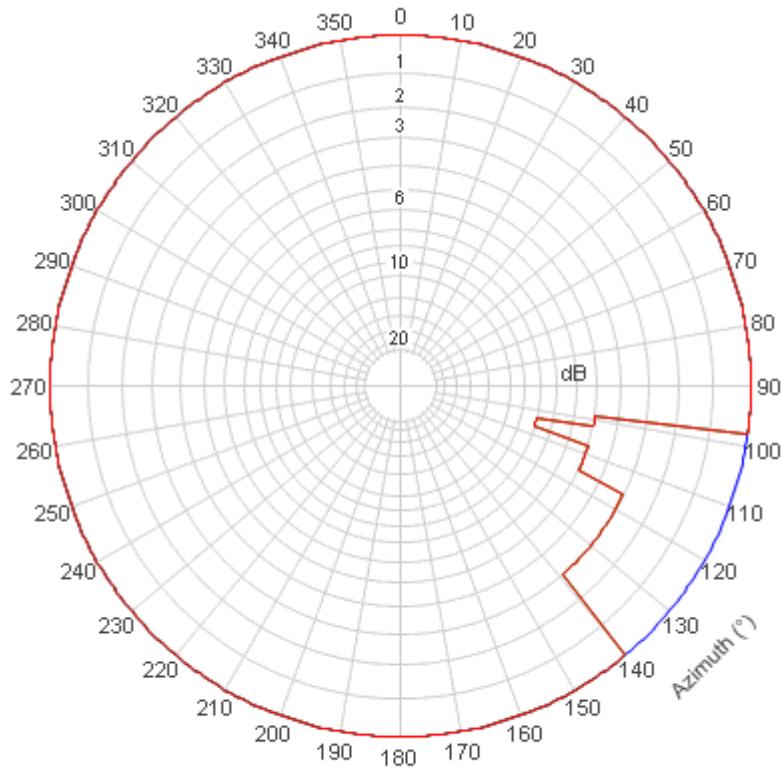
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[GT15100_37C20110106.plt](#)

Brougher Mountain



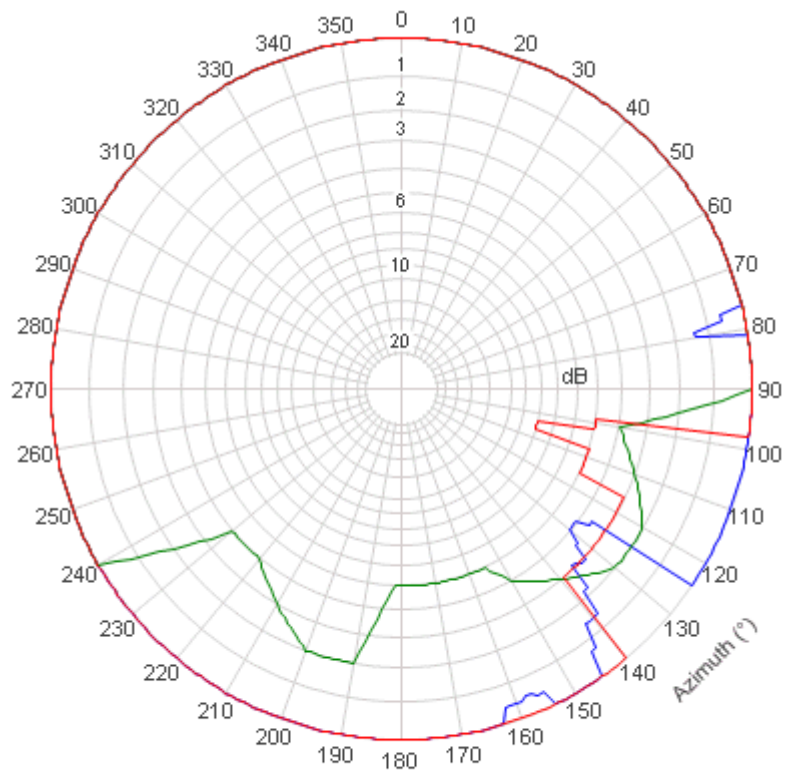
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[GT15200_37C20110106.plt](#)
[GT15200_36C20110106.PLT](#)

Darvel



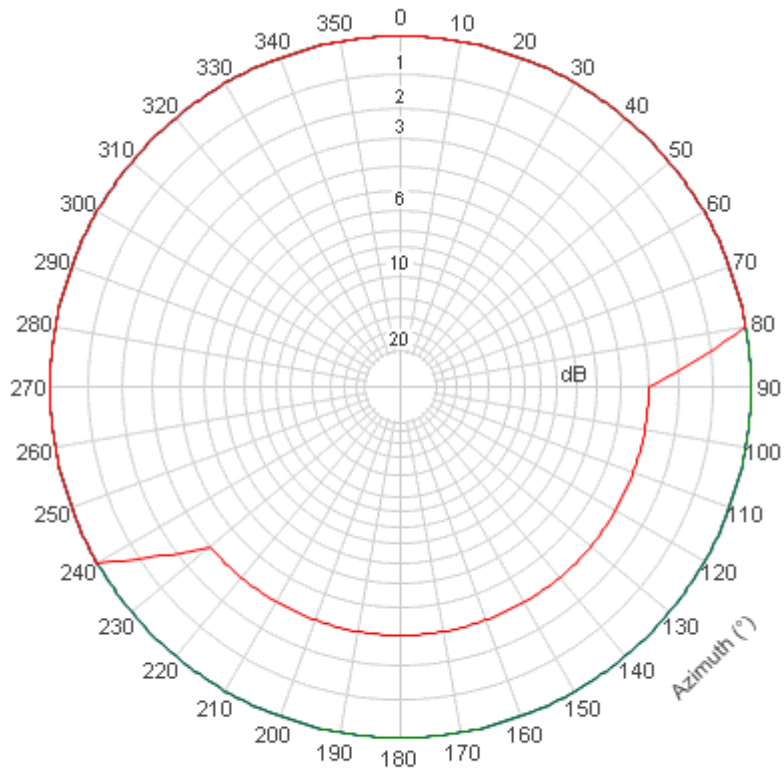
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[GT15500_35C20110106.plt](#)
[GT15500_36C20110106.PLT](#)

Chatton



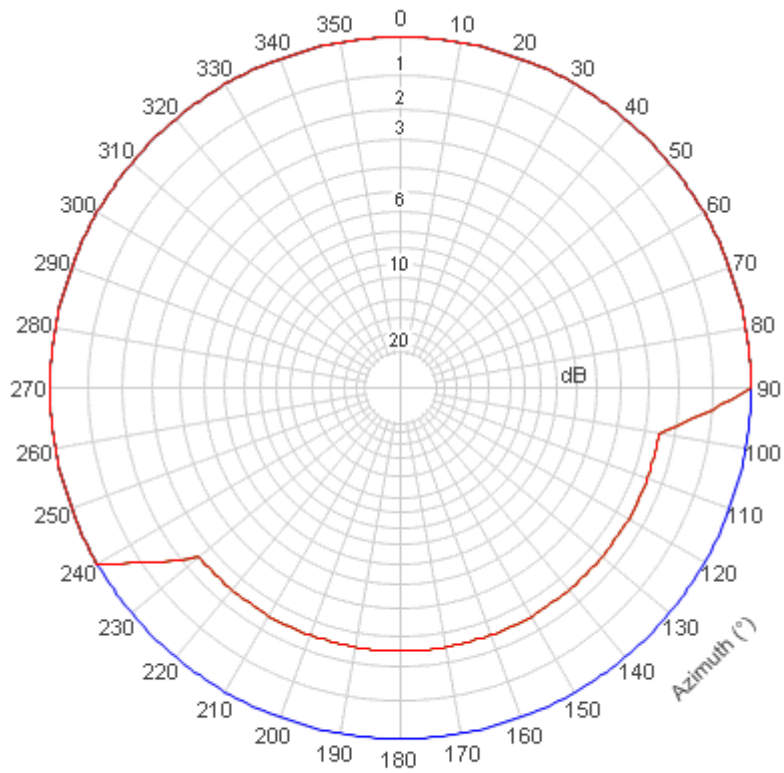
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Bluebell Hill



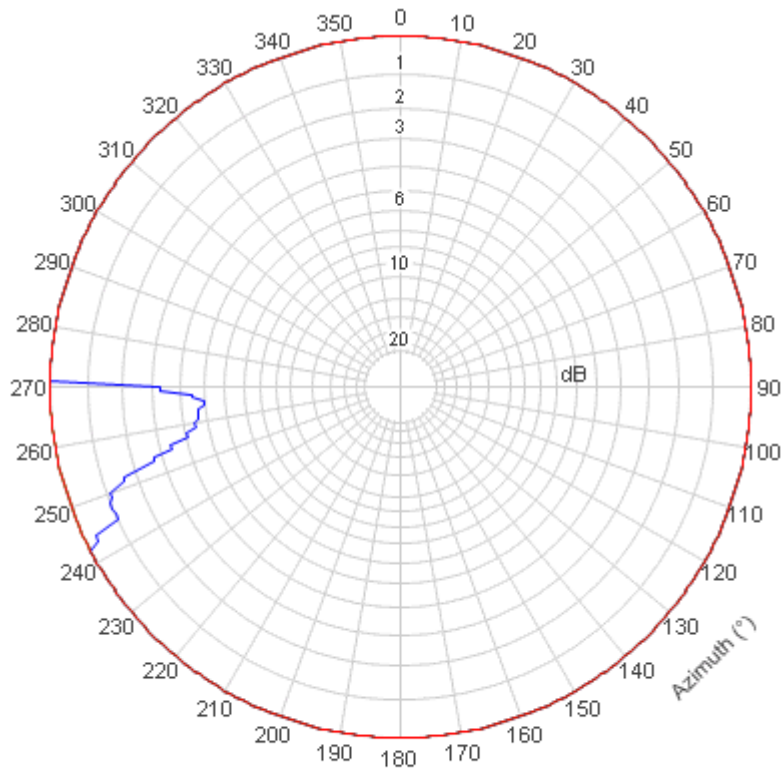
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Guildford



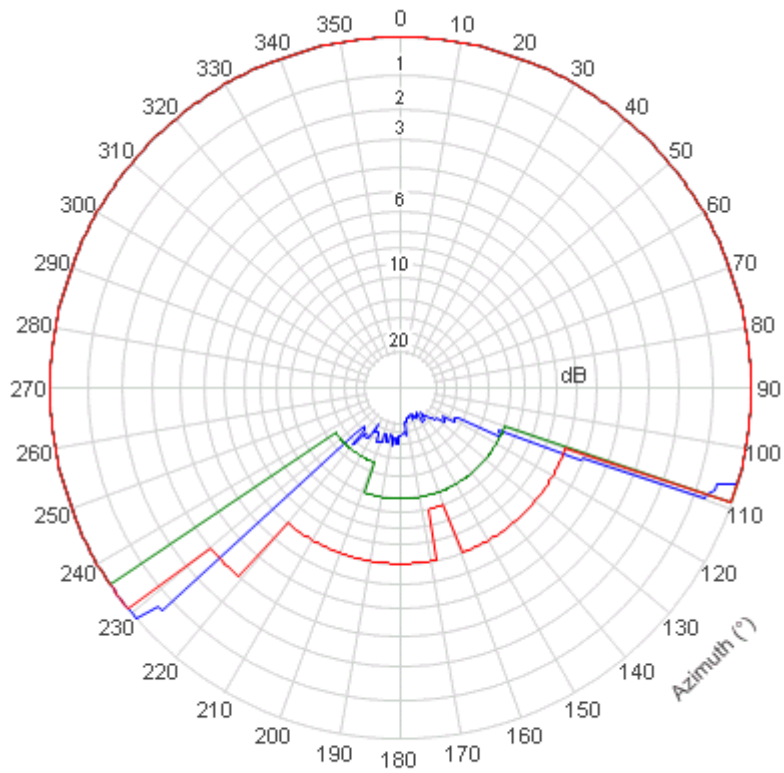
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[GT10103_35C20110106.plt](#)
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Reigate



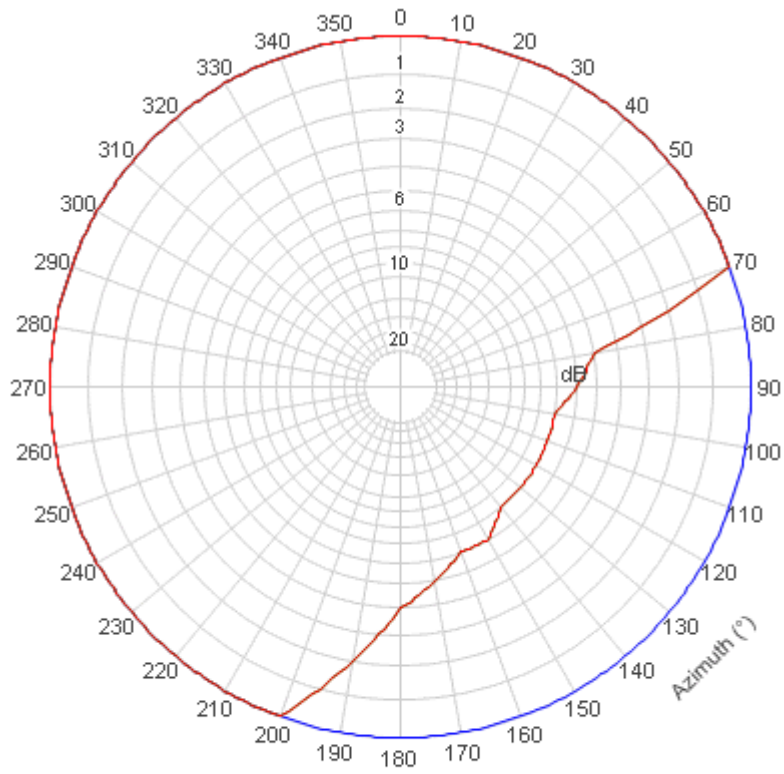
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[GT10335_34C20110106.plt](#)
[GT10335_36C20110106.PLT](#)

Lancaster



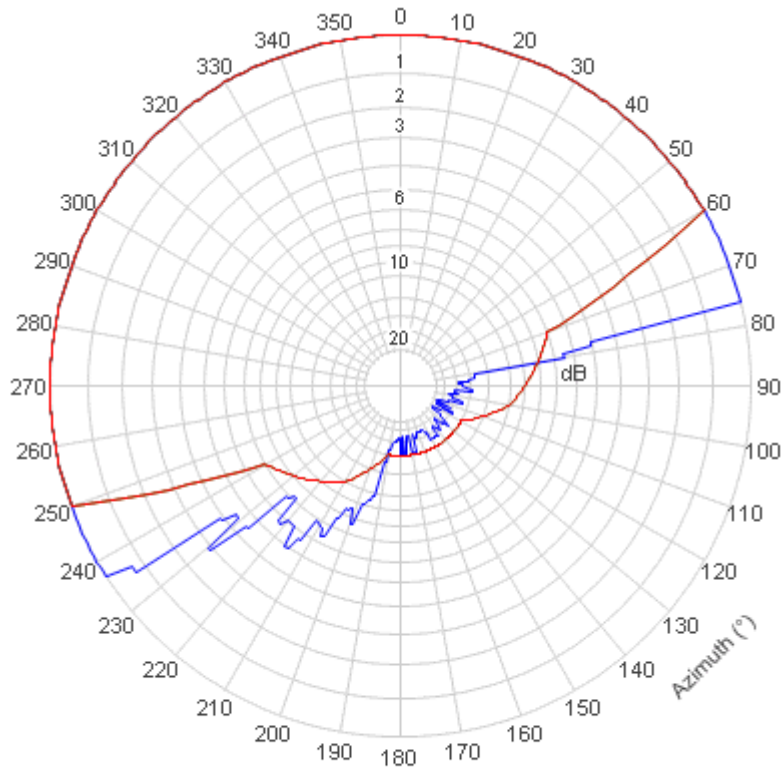
[GT10805_33C20110106.plt](#)
[GT10805_35C20110106.plt](#)
[GT10805_36C20110106.PLT](#)

Whitehawk Hill



[GT13105_32C20110106.plt](#)
[GT13105_35C20110106.plt](#)
[GT13105_36C20110106.PLT](#)

Plympton



[GT13902_32C20110106.plt](#)
[GT13902_34C20110106.plt](#)
[GT13902_36C20110106.PLT](#)

Hastings