6.3 Exported interference

While the coverage indicated in Figures 6.4 and 6.5 appears fairly satisfactory, it is based on an assumption that clearance might be obtained to radiate from these sites at the same power as is currently used for the main analogue services.

In the context of the GE-06 plan, this seems unlikely, and predictions have been made of the interference exported by three hypothetical high-power DVB-H networks, and one low power example. In all cases, interference has been modelled using Recommendation P.1546-2 at 1% time, and the results are plotted in Figures 6.7 – 6.10. In these plots the contours are as follows:

- Yellow: 50dBμV/m
- Red: 40dBμV/m
- Blue: 30dBμV/m
- Dark green: 20dBμV/m
- Light green: 10dBμV/m

The two high-power networks includes the following sites:

<table>
<thead>
<tr>
<th>Site</th>
<th>ERP (A)</th>
<th>ERP (B)</th>
<th>ERP (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Croydon</td>
<td>1,000 kW</td>
<td>100 kW</td>
<td>10 kW</td>
</tr>
<tr>
<td>Bluebell Hill</td>
<td>30 kW</td>
<td>3 kW</td>
<td>3 kW</td>
</tr>
<tr>
<td>Dover</td>
<td>100 kW</td>
<td>1 kW</td>
<td>1 kW</td>
</tr>
<tr>
<td>Tunbridge Wells</td>
<td>4 kW</td>
<td>4 kW</td>
<td>4 kW</td>
</tr>
<tr>
<td>Chartham</td>
<td>0.25 kW</td>
<td>0.25 kW</td>
<td>0.25 kW</td>
</tr>
</tbody>
</table>
Figure 6.7: Interference exported from high-power DVB-H network ‘A’ (1% time)

Figure 6.8: Interference exported from high-power DVB-H network ‘B’ (1% time)
Figure 6.9: Interference exported from high-power DVB-H network ‘C’ (1% time)

Figure 6.10: Interference exported from low-power DVB-H network (1%-time)

The simulations for the low-power network exclude the sites located well inland to minimise run-times.
It can be seen by comparing these figures that, as might be expected, the ‘analogue power’ sparse network gives rise to very significant levels of interference power within France and Belgium, while the other options present a much more benign sharing situation.

The plots for the ‘high-power’ cases illustrate the need to ensure that the network is well balanced in terms of both coverage and interference. For instance, the 10dB reduction in power at Croydon, between figures 6.8 and 6.9 has minimal impact on exported interference, as this is dominated by power from Bluebell Hill (where no transmit aerial directivity is assumed).

It is worth noting that a number of continental transmitter sites in this area have current assignments on channel 36, and these are indicated.
7 CONCLUSIONS

The un-coordinated provision of DVB-H services in channel 36 will give rise to significant levels of interference to analogue TV transmissions on Channels 35 and 37. The high probability is fundamentally due to the high field strengths required by a practical DVB-H services, coupled with a protection ratio (DVB-H into PAL system I) of some -5dB.

Such interference may be avoided by ensuring that DVB-H transmitters are co-located with the analogue services. In some areas this will lead to a satisfactory DVB-H service, particularly where the analogue transmitter is located in a dense urban area (as at Croydon). In such areas, however, the DVB-H service area will be much smaller than that for the analogue service; if relay transmitters are installed to rectify this, they will cause interference to the analogue services, which (by definition) will be relatively weak in the areas where such relays might be installed.

In many other cases, however, the analogue transmission site is too far from target DVB-H coverage areas to provide a reliable DVB-H service (while the analogue coverage is satisfactory due to the greater height and gain of the domestic receive aerial).

A final consideration is that the international co-ordination of a network of co-located DVB-H transmitters, of similar power to the analogue services with which they are sited, is likely to be very challenging. If DVB-H services are implemented with lower-power, co-sited transmitters, co-ordination will be significantly eased, but large coverage deficiencies will remain.
A  MEDIAN PATH LOSS MODELS

The following figures illustrate the median path losses obtained from the models used in interference analysis together with those obtained from the free space path loss model.

Figure A.1: Median Path Losses (TX h = 100 m, RX h = 10 m, d <1000 m)

The Rec.1546 and COST 231 Hata path loss models are defined for path lengths greater than 1 km. Within Seamcat the COST 231 Hata model has been extrapolated downwards to address path lengths less than 1 km. We have used this extrapolated model and similarly extrapolated the Rec.1546 model downwards. In order to ensure that the Rec.1546 path loss curve is continuous at 1 km, losses for path lengths less than 1 km are reduced by an amount equal to the difference between the loss obtained from the COST 231 urban Hata model and the loss obtained from the Rec.1546 model at 1 km. For both models, median path losses less than those obtained from the free space path loss model are replaced by the corresponding free space path losses.

Throughout the modelling we have used Rec.1546 for analogue TV and DVB-T coverage, and the urban Hata model for DVB-H coverage, the latter on the assumption that DVB-H systems are most likely to be deployed in or around urban centres. The urban Hata model has also been applied to interfering paths.
Figure A.2: Median Path Loss Models (TX h = 30 m, RX h = 10 m, d <1000 m)

Figure A.3: Median Path Loss Models (TX h = 30 m, RX h = 1.5 m, d <1000 m)
B SENSITIVITY ANALYSIS FOR INTERFERENCE FROM DVB-H INTO ANALOGUE TV

The sensitivity of the failure rates to a number of parameters is examined.

B.1 Correlation

The baseline modelling assumes that the wanted and interference path loss variations are uncorrelated. A simple correlation model based on the ratio of the wanted and interference path lengths and the angle between the two paths at the receiver point has been implemented for the sensitivity analysis (Reference: Antennas and Propagation for Wireless Communication Systems, Simon R Saunders, Wiley, 1999).

The correlation model assumes that when the angle between the wanted and interference paths at the receiver point is less than a given threshold angle the correlation coefficient is equal to the square root of the ratio of the path lengths. For greater angles, an angle dependent term is introduced to the equation, as shown below.

\[
\rho := \begin{cases} 
\sqrt{\frac{d_1}{d_2}} & \text{if } 0 \leq \phi \leq \phi_T \\
\left(\frac{\phi_T}{\phi}\right)^\gamma \sqrt{\frac{d_1}{d_2}} & \text{if } \phi > \phi_T 
\end{cases}
\]

where \(\rho\) is the correlation coefficient,

\(d_1\) is the shorter of the wanted and interference path lengths,

\(d_2\) is the longer of the wanted and interference path lengths,

\(\phi_T\) is the threshold angle,

\(\phi\) is the angle between the wanted and interference paths,

\(\gamma\) is the factor representing the correlation between the shadowing elements of the wanted and interference paths (\(\gamma\) is assumed to be 0.3).

The following plots compare the failure rates within the DVB-H coverage area for a number of threshold angles.
DVB-H into Analogue TV Failure Rates Within DVB-H Coverage Area from Deterministic Model
(Correlation Sensitivity)

For the assumed analogue TV TX and DVB-H TX separation distances and
threshold angles, the variation in the failure rates remains within approximately 4%.

DVB-H into Analogue TV Failure Rates Within DVB-H Coverage Area from Probabilistic Model
(Correlation Sensitivity)

In the case of the probabilistic model, the maximum variation in the failure rates is
approximately 1%.

B.2 Antenna Height

The baseline modelling assumes that the analogue TV TX height is 100m and the
DVB-H TX height is 30 m. As a part of the sensitivity analysis, simulations have
been carried out for the analogue TV TX heights of 50 and 100m and the DVB-H TX height of 50 m. Results are compared in the following figures.

Figure B.3: Failure Rates (Analogue TV TX Antenna Sensitivity)

Figure B.4: Failure Rates (DVB-H TX Antenna Sensitivity)

**B.3 Interfering TX Power**

The impact of an increased DVB-H TX power has been investigated by assuming that the DVB-H TX power is increased from 1 kW to 20 kW. This, in turn, implies a DVB-H coverage radius increase from 1243 m to 2908 m. In the deterministic model, the number of pixels has been increased from 5025 to 27,729 in order to make sure that the pixel size is the same for both radius. The probabilistic
modelling is based on a total sample points of 20,000 for both radius. Results are compared in the following figure.

![DVB-H into Analogue TV Failure Rates Within DVB-H Coverage Area](image)

**Figure B.5: Failure Rates (DVB-H TX Power Sensitivity)**

In the deterministic model, the failure rate increase due to an increased DVB-H TX power remains below approximately 5% for the distances considered. The failure rate increase is limited to approximately 2% in the results obtained from the probabilistic model.

The results indicate that the failure percentage does not vary significantly when the DVB-H transmit power is increased. This is due to the fact that the increase in the DVB-H coverage area and the increase in the failed points in DVB-H coverage area are proportional when the DVB-H transmit power is increased.

### B.4 Analogue TV Median Path Loss Propagation Model

In the baseline model, the wanted path propagation loss is modelled by Rec.1546. The implications of the use of COST 231 urban Hata model for the median wanted path loss has been examined. The following plots show the path losses obtained from both models up to a distance of 22 km.
The failure rates within the DVB-H coverage area are compared in the following figure.

**Figure B.6: Median Path Loss Models**
(TX h = 100 m, RX h = 10 m, d <10,000 m)

The plots indicate that, in the deterministic model, the use of COST 231 urban Hata model results in approximately 9% decrease in the failure rate within the DVB-H coverage area when the analogue TV and DVB-H TXs are separated by approximately 20 km. This is illustrated below.
The baseline model results are based on the assumption that the DVB-H wanted median signal level is 90 dB\textmu V/m which, in turn, implies a coverage area radius of 1243 m. The deterministic and probabilistic baseline models have been re-simulated with a lower median signal level of 70 dB\textmu V/m for which the DVB-H coverage radius is 4531 m. The following diagrams compare the failure rates corresponding to both median signal levels when the analogue TV and DVB-H TXs are separated by 7458 m. It should be noted that, while the ‘failed’ areas appear slightly different, this is an artefact of the plotting in terms of pixel resolution (deterministic presentation) and sample density allied to colours printing on top of one another (probabilistic presentation) – furthermore the large and small circular areas are not exactly to scale with respect to one another.

B.5 **DVB-H Median Wanted Field Strength**

The baseline model results are based on the assumption that the DVB-H wanted median signal level is 90 dB\textmu V/m which, in turn, implies a coverage area radius of 1243 m. The deterministic and probabilistic baseline models have been re-simulated with a lower median signal level of 70 dB\textmu V/m for which the DVB-H coverage radius is 4531 m. The following diagrams compare the failure rates corresponding to both median signal levels when the analogue TV and DVB-H TXs are separated by 7458 m. It should be noted that, while the ‘failed’ areas appear slightly different, this is an artefact of the plotting in terms of pixel resolution (deterministic presentation) and sample density allied to colours printing on top of one another (probabilistic presentation) – furthermore the large and small circular areas are not exactly to scale with respect to one another.
Figure B.9: Successful and Failed Points for 70 dBμV/m and 90 dBμV/m DVB-H Wanted Median Signal Level (Deterministic Model)

Figure B.10: Successful and Failed Points for 70 dBμV/m and 90 dBμV/m DVB-H Wanted Median Signal Level (Probabilistic Model)
C ANALOGUE TV COVERAGE AREAS

C.1 Croydon

C.1: Croydon Analogue TV TX ‘Real World Coverage Area’ (60 & 72 dBµV/m)
C.2 Mendip

C.2: Mendip Analogue TV TX ‘Real World Coverage Area’ (60 & 72 dBµV/m)
C.3 Blackhill

C.3: Blackhill Analogue TV TX ‘Real World Coverage Area’ (60 & 72 dB\mu V/m)
C.4 Lichfield

C.4: Lichfield Analogue TV TX ‘Real World Coverage Area’ (60 & 72 dBµV/m)