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AHG_DTV003K

DIGITAL TELEVISION

Service Considerations

and

Allotment Principles

Prepared by

JTCAB Ad Hoc Group on DTV Planning Parameters

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EXECUTIVE SUMMARY

The primary objective in allotment planning for the introduction of Over the Air (OTA) Digital Television (DTV) is to provide a DTV channel for each existing NTSC TV assignment and allotment and to provide a DTV coverage comparable to the existing TV broadcasting service. Service criteria, planning parameters, and allotment principles are based on implementing the ATSC A/53 standard DTV system using the conventional single transmitter configuration.

The document has four sections covering Planning criteria including spectrum considerations, DTV reception conditions, DTV transmissions conditions and Separation distances to meet protection requirements. Each section considers the work of earlier planning studies, the approach by FCC in their proposed rule making and finally the approach and parameters being recommended for the development of the Canadian DTV allotment plan.

A. Planning Criteria

The overall objective in Canadian allotment planning is to provide, in descending order of priority, a DTV allotment for every existing regular and low power NTSC station and also to provide a DTV allotment for every existing unassigned NTSC allotment. The DTV service should be comparable to the existing NTSC service and should replicate the present coverage area to the extent possible. The service or coverage area for NTSC is defined as the area within the radial distance to the protected (i.e. Grade B) contour. For DTV, the service area is defined as the area within the radial distance to the noise plus interference limited contour, i.e. the contour at which the required performance and service availability for the DTV service is satisfied.

Each DTV channel is allotted/assigned based on service replication of the coverage of the existing NTSC allotment or station using the maximum parameters for the class of the existing allotment or station or the present parameters if less. The DTV channel is paired with the NTSC station or allotment and assumed to be located at the same site as the paired NTSC station or allotment. A flex factor of 8 km is included for the location of the DTV transmitter to allow for cases where the DTV service cannot be accommodated at the existing NTSC site.

Protection from interference to both NTSC and DTV services extends to the coverage contours based on their maximum parameters. The planning approach will attempt to minimize interference into both NTSC and DTV equally.

The **service availability** is based on providing coverage in a service area with an availability of

(90,90) i.e. at 90% of the locations and 90% of the time. This level of availability is considered necessary due to the sharp failure characteristic of DTV. The implication of this abrupt failure characteristic and required service availability may require further consideration after some long term field experience.

With the spectrum management objective of improved spectrum efficiency in mind, a proposed reduction of the current TV broadcast spectrum is factored into the allotment planning. The Canadian studies includes assessment of the core spectrum requirements for a DTV only plan that meet the Canadian requirements with minimum changes from the interim plan. A major part of the planning work will be to meld the Canadian DTV allotment plan with the proposed US plan taking into account the use of common spectrum near the border area.

B. Receiving Considerations

Near the edge of coverage, the receiver noise figure has a direct effect on the required field strength and hence the resulting required transmitter power. For DTV service in Canada, the figure of 5 dB is used (achieved by the use of a low noise preamplifier installed on the antenna mast to minimize down lead loss effect).

For the final allotment planning in Canada, the following receiving system parameters are used.

Parameter	Low VHF	High VHF	UHF
Frequency MHz	69	195	645
Antenna Gain (dipole) dB	6	8	10
Front-to-Back Ratio dB	6	12	16
Downlead Loss dB	1.05	1.81	3.29
Balun 300/75 Loss dB	0.5	0.5	0.5
Receiver Noise Figure dB	5	5	10
Man-made Noise dB (T_a equiv.)	8.2	1	0
LNA Noise Figure (dB)	5	5	5
LNA Gain (dB)	20	20	20

Key factors that impact on allotment planning are the required carrier-to-Noise (C/N) at the TV receiver **ANT IN** terminal and the required co-channel Carrier-to-Interference (C/I). The (C/N) in association with the receive antenna gain, noise figure and desired signal quality establishes the receive field strength requirement and the co-channel (C/I) in association with the receive antenna Front-to-Back ratio determines the required co-channel separation distance. In the Digital TV case, noise and co-channel DTV interference are additive as DTV interference behaves similar to noise. Hence there is a minimum C/(N + I) at the receiver input that needs to be met to achieve a specified threshold picture quality level, normally referred to as Threshold Of Visibility (TOV). Once the TOV value has been established then, for planning purposes, it is necessary to partition the threshold C/(N + I) value between noise (C/N) and co-channel DTV interference (C/I). Based on partitioning equally divided between noise and interference, a **C/N = C/I = 19.5 dB** is proposed at the DTV protected contour.

The minimum required field strength for the three TV bands using the parameters proposed for the final Canadian allotment planning is **35 dBµV/m** for the low VHF band, **33 dBµV/m** for the high VHF band and **39 dBµV/m** for the UHF band compared to 47, 56 and 64 dBµV/m respectively for NTSC.

The protection ratios used in Canadian planning are based upon the values resulting from the measurements and tests of the Grand Alliance DTV system except for the co-channel DTV value which is based on the noise partitioning criteria.

C. Transmitting Considerations

The necessary ERP to produce the required field strength for the noise limited contour at a given distance depends on the ERP (transmitter power, antenna gain, transmission line loss) and antenna height above average terrain. A number of tables present the calculated ERP to produce the required field strength for the different classes of stations assuming replacement channels in the three TV bands; low VHF, high VHF and UHF. The ERP's are given for different time and location availabilities.

The power required for a DTV transmitter is specified as average or RMS power in a linear operating mode whereas NTSC power is given in average power during sync peak in a class C operating mode. This places a limit on the maximum power available at the transmitter; typical transmitters are presently capable of delivering a maximum average power of 50-60 kW in a linear mode. For Canadian planning, an ERP of 1000 kW was used as the maximum limit which is realistic and achievable at economic prices.

D. Separation Tables

Separation distances provide an efficient and effective means for managing interference between NTSC stations and DTV allotments and we believe that such an approach can be used to determine the technical acceptability of DTV channel allotments. The separation tables are based on an equal partitioning between noise and interference in the DTV to DTV case and to keep a degree of balance between interference from NTSC to DTV and from DTV to NTSC. The tables give the separation distances required to protect the TV services of the different classes of stations and form the basis for allotting the frequencies to the DTV service areas.

The appendices and glossary provide supplementary information on the method of deriving the required field strength, the considerations of service availability, Conditions for emission masks and adjacent channel co-location, the effects of short spacings and the terms and acronyms used in the text.

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DIGITAL TELEVISION
Service Considerations and Allotment Principles

Introduction

In Canada, the primary objective in allotment planning for the introduction of Advanced/Digital Television (DTV) is to provide a DTV channel for each existing regular and low power NTSC TV assignment and allotment and to provide a DTV coverage comparable to the existing NTSC TV broadcasting coverage. Under this objective, the DTV allotment planning is based on the following service considerations, allotment principles and planning parameters.

These service criteria, planning parameters, and to a certain extent the allotment principles, are based on a number of assumptions that had to be made in view of the several uncertainties associated with the system approach taken. Because of market size and economical reasons, the reality is that Canada will have to adopt the same system standard for terrestrial DTV broadcasting as the United States.

The allotment planning proposed in this document is therefore based on the following assumptions:

- The DTV system used will be based on the ATSC A/53 standard. The coverage performance of the A/53 system will be similar to the predictions derived from the laboratory tests and the limited field tests in Charlotte, N.C. It is the opinion of JTCAB, however, that the A/53 system has not been sufficiently field tested to derive final technical planning parameters;

- Because the A/53 system does not allow the use of on-channel re-transmitter, the allotment planning is based on the use of a single transmitter/ single frequency transmitter coverage configuration. It is assumed that it will be possible to obtain a suitable service availability in the desired coverage area radius using the DTV A/53 system in the VHF/UHF band in a single transmitter/single frequency transmitter coverage configuration.

The impact of these assumptions are that the technical planning criteria such as the location and time service availability, the required ERP and HAAT to cover a certain area may need to be adjusted to the actual performance and use of the system and the consumer type DTV receivers. Furthermore, if the single transmitter/single frequency transmitter coverage configuration is not sufficiently reliable, additional frequencies will be required to improve the DTV coverage and the service reliability.

This document establishes the service criteria, allotment principles and planning parameters required for the development of a DTV allotment plan that will meet this objective.

Section A establishes the planning criteria including the service objectives and addresses spectrum considerations.

Section B establishes the assumptions for the DTV receiver configuration and characteristics for the specification of a required field strength for minimum reception conditions. Also, the principles for partitioning between noise and co-channel DTV interference are developed.

Section C addresses DTV transmitter considerations and establishes the transmit parameters to provide the desired DTV coverage and availability.

Section D identifies the protection ratio requirements between DTV/DTV and DTV/NTSC and determines the separation distances required to meet the protection criteria.

To the extent applicable each section is divided into three sub-sections. These sub-sections provide:

- the approach and parameters used in earlier DTV planning studies (i.e. studies carried out before the parameters of the Grand Alliance DTV system were known);
- the approach and parameters being recommended by the FCC as specified in the 4th, 5th and 6th Notice of Proposed Rule Making (NPRM) and later adopted in the 4th, 5th, and 6th Reports and Orders. Considering the high degree of coordination required between Canadian and US DTV and NTSC allotments near the border, it was considered to be important to identify the approach being used by the FCC and to clearly indicate where differences exist between the two approaches;
- the approach and parameters being recommended for adoption for the development of the Canadian DTV allotment plan and the identification of spectrum requirements to meet the stated objectives.

A. Planning Criteria

A.1 Overall Objective

A.1.1 Canadian Objective

The overall objective in Canadian allotment planning is to provide, in descending order of priority, a DTV allotment for every existing regular and low power NTSC station and also to provide a DTV allotment for every existing unassigned NTSC allotment. This is to be done without significant interference to NTSC stations. Studies have shown that these objectives can only be met if not all unassigned NTSC allotments are protected.

A.1.2 Current FCC Objective

In the FCC's sixth further Notice of Proposed Rule Making (NPRM) and 6th Report and Order regarding DTV allotments, the objective was to provide a DTV allotment for every existing regular power station and also to provide a DTV allotment for vacant NTSC allotments reserved for educational and public TV. Existing low power NTSC TV stations and existing vacant NTSC allotments are excluded from the planning process. Attempts are made to match the DTV coverage to that of the existing NTSC coverage taking into account existing interference constraints.

A.2 Service Criteria

A.2.1 Initial Canadian Approach

The service criteria used in the initial allotment planning exercises done by the JTCAB Frequency Allotment Planning Group is described below.

The DTV service should be comparable to the existing NTSC service and should replicate the present coverage area. The service area for NTSC is defined as the area within the radial distance to the protected (i.e. Grade B) contour. For DTV, the services area is defined as the area within the radial distance to the noise plus interference limited contour, i.e. the contour at which the required performance and service availability (see Appendix 2 on Service Availability) for the DTV service is satisfied. To establish the replication of coverage area of existing NTSC stations, the DTV coverage area and service is based on providing coverage determined by the radial distance to the location of the protected or Grade B contour of the NTSC station. Where the existing station is operating at maximum parameters for the class of NTSC station its parameters and location of the Grade B contour are established and the DTV coverage area and service is based on these values. Where the existing station is operating at less than maximum parameters for the class of NTSC station, its service was defined by assuming coverage, enclosing or exceeding the existing service area, to a distance equal to the radial distance to the Grade B contour for one of the existing defined classes of station (i.e. 25 km for class A, 70 km for class C, 82 km for class VU, etc.). For NTSC stations operating in the UHF band, maximum parameters are known for the defined (A,B,C) classes of stations. For stations operating in the VHF band, maximum parameters are only defined for one class of stations, VL for channels 2 - 6 and VU for channels 7 - 13 with the result that maximum parameters for other classes of service (A,B,C) had to be developed. By assuming service to the radial distance for each class of station with a given EHAAT, the maximum VHF parameters for NTSC operation required to provide coverage to the Grade B contour were determined and are shown in Table A.2.1. Thus, for stations operating with less than maximum parameters, a station class was assigned which provided coverage that equaled or exceeded the existing coverage of the station. These values are the equivalent NTSC parameters to provide service in the VHF bands to the distances of each class. The DTV coverage area and service is based on replicating the coverage of the NTSC station by assuming coverage to the Grade B of one of the classed of stations in Table A.2.1. The allotment planning and associated interference analysis is based on the maximum parameters for the NTSC station which provide the required service for the different classes of stations (BPR-IV for the UHF band, Table A.2.1 for the VHF band).

Protection for the NTSC service will continue to be the area within the protected or Grade B contour. For the DTV service, the area within the noise and interference limited contour will be the protected service area. Allotments will minimize interference to all services and restrictions due to unavoidable interference will be balanced between services i.e. reductions or changes to parameters of affected services will be distributed between services. Protection from interference will extend throughout the coverage area to the protected contour and will be determined by the protection ratio established for the DTV and NTSC systems. Interference will be evaluated on the basis of F(50,10) propagation statistics.

Table A.2.1
Maximum NTSC VHF Parameters for
Service Replication Coverage of UHF, VU and VL Classes

Band	Class	A	B	C	LP	VU	VL
7-13	ERP(dBk) (kW)	-1.5 0.7	7 5	19 80	-4 0.4	25 325	NA
2-6	ERP(dBk) (kW)	-7 0.2	1 1.2	12 17	-10 0.1	17 50	20 100
2-13	EHAAT(m)	100	150	150	30	150	150
2-13	Grade B Dist (km)	25	45	70	12	82	89

For service availability, planning is based on contour locations determined with the F(50,50) curves with an adjustment for 90% of the time resulting in a service area with an (50,90) availability for location and time. In DTV service with its sharp failure characteristic, this level of availability may result in noticeable DTV service unavailability particularly near the edge of the noise and interference limited contour when compared to analog NTSC reception. See Appendix 2 for more details regarding the characteristics of DTV service availability.

A.2.2 FCC Approach

In the adopted FCC allotment plan, service criteria is more restrictive with DTV channels provided only for existing regular power NTSC stations and for vacant allotments reserved for educational or public TV (i.e. non-commercial allotments). Existing low power TV stations and existing vacant NTSC allotments were not considered (i.e. not provided a DTV allotment nor protected from DTV allotments). The DTV service and coverage is based on replicating the existing service area of the NTSC station taking into account both terrain and interference effects. The NTSC service area is defined as the lesser of the area within the protected contour or the Grade B contour or the area within the existing interference limited contour. For DTV, the service area is defined as the area within the radial distance to the noise limited contour, i.e. the contour at which the minimum carrier-to-noise (C/N) ratio for the DTV system is satisfied. It should be noted that partitioning between allowable noise and co-channel DTV interference is not considered in the FCC's approach.

Protection for the NTSC service continues to be the area within the protected or Grade B contour. For the DTV service, the area within the noise and interference limited contour is the protected service area. Allotments minimize interference to all services and unavoidable interference is balanced between services. Protection from interference extends throughout the coverage area to the protected contour and is determined by the protection ratio established for the DTV and NTSC systems. Interference is evaluated on the basis of F(50,10) propagation statistics.

For service availability, planning is based on contour locations determined with the F(50,50) curves with an adjustment for 90% of the time resulting in a service area with an (50,90) availability for location and time. In DTV service with its sharp failure characteristic, this level of availability may result in noticeable DTV service unavailability particularly near the edge of the noise limited contour when compared to analog NTSC reception.

A.2.3 Proposed Canadian Approach

A.2.3.1 Criteria for Canadian Approach

Service criteria for the development of the final Canadian DTV allotment plan is based on the same principles used in the initial planing as described in section A.2.1.

A DTV channel will be provided for all existing NTSC TV services, including regular and low power services and for all existing vacant TV allotments, on a priority basis. Regular power services would be accommodated first, followed by low power services and finally vacant allotments. After DTV requirements have been met, vacant NTSC allotments will be assessed to determine whether they can be retained or replaced without impacting the DTV plan.

Each DTV channel will be allotted/assigned based on service replication of the coverage of the existing NTSC allotment or station using the present parameters and/or the maximum parameters for the class of the existing allotment or station. The DTV channel will be paired with the NTSC station or allotment and assumed to be located at the same site as the paired NTSC station or allotment. A flex factor of 8 km is included for the location of the DTV channel to allow for cases where the DTV service cannot be accommodated at the existing NTSC site. To match NTSC service areas, DTV coverage must extend to the Grade B protected contour of the NTSC station it duplicates, i.e. matching the following radial distances:

NTSC Service	Protected Contour Distance
Low VHF	89 km
High VHF	82 km
UHF Class A	25 km
UHF Class B	45 km
UHF Class C	70 km
Low Power	12 km

Protection from interference to both NTSC and DTV services will extend to the coverage contours based on their maximum parameters. Planning will attempt to minimize interference to all services and restrictions due to unavoidable interference will be apportioned equally between services. Evaluation and analysis of interference will be determined using computer methods based on the F(50,50) and F(50,10) propagation curves with adjustments applied to adjust to F(90,90) and F(10,10) when necessary.

The planning is also based on the use of existing sites and co-locating the DTV facilities at the NTSC sites. Co-location and the use of adjacent channels require the establishment of rules governing siting and the use of an emission mask. A study was done by CRC to determine the effects and requirements of co-location, use of adjacent channels and emission masks. (Included in Appendix 3). The results of the study were used to produce the rules for using the emission mask. These rules are as follows:

NTSC/DTV Adjacent Channel Allocation: if adjacent channels are used, they must be co-located.

Rules of using "relaxed-mask":

- · NTSC/DTV must be co-sited (exact co-location), for adjacent channel assignment;
- · for adjacent channel NTSC/DTV co-siting, DTV MUST be 12 dB (or more) below NTSC.

Rules of using "tight-mask":

- · 5-mile (8-km) flex is allowed for NTSC/DTV adjacent channel assignment;
- · for co-siting case, DTV and NTSC can transmit at the same power level. (Note: it is preferred that NTSC is allocated to the N+1 channel, instead of N-1 channel.)

When NTSC is switched off: adjacent channel assignments should be avoided as much as possible.

If adjacent channel DTV/DTV is un-avoidable:

- · "relaxed-mask" allow co-siting DTV/DTV adjacent channel assignment with a DTV power difference of 14 dB; or
- · "relaxed-mask" allow 5-mile flex for DTV/DTV adjacent channel assignment with a DTV power difference of 2 dB;
- · "tight-mask" allow co-siting DTV/DTV adjacent channel assignment with an (estimated**) DTV power difference of 17-19 dB; or
- · "relaxed-mask" allow 5-mile flux for DTV/DTV adjacent channel assignment

with an (estimated**) DTV power difference of 5-7 dB.

(** Note: when the tight-mask is used, the adjacent channel spill-over is far from white-noise. It is difficult to estimate the DTV receiver performance, since different adaptive equalizers might be used, which act differently to non-white noise. There is no ATSC reference receiver. Based on our experience, a 3-5 dB improvement in comparison to relaxed-mask case is achievable.)

Using computer simulations, a study investigated the possibilities of mixing DTV/DTV and DTV/NTSC transmitter classes and the effect it would have on the permissible distance (flex) between the co-located transmitters. The study developed a set of tables giving permissible flex distances for adjacent channel stations of mixed classes. It recommended that mixed transmitters classes should be avoided as much as possible. When absolutely necessary, the flex distances and mixing of classes given in Tables 1 to 6 must be respected. Practically, adjacent stations, whether DTV-DTV or NTSC-DTV, should be in comparable classes. When mixing classes, it is necessary to ensure that it is a valid combination and that the sites chosen respect the flex distances given in Tables 1-6.

Table A.2.3.1: L-VHF : DTV to DTV Separation Distance Between Different Classes (assuming relaxed emission masks are used).

	L-VHF	L-VHF-HV	L-VHF-C	L-VHF-B	L-VHF-A	LP
L-VHF	18km	11 km	0	X	X	X
L-VHF-HV		19 km	7 km	X	X	X
L-VHF-C			20 km	X	X	X
L-VHF-B				18 km	X	X
L-VHF-A					11 km	X
LP						12 km

Table A.2.3.2: H-VHF : DTV to DTV Separation Distance Between Different Classes (assuming relaxed emission masks are used).

	H-VHF-LV	H-VHF	H-VHF-C	H-VHF-B	H-VHF-A	LP
H-VHF-LV	18 km	11 km	0 km	X	X	X
H-VHF		19 km	7 km	X	X	X
H-VHF-C			20 km	X	X	X
H-VHF-B				18 km	X	X
H-VHF-A					11 km	X
LP						12 km

Table A.2.3.3: UHF: DTV to DTV Separation Distance Between Different Classes (assuming relaxed emission masks are used).

	UHF-LV	UHF-HV	UHF-C	UHF-B	UHF-A	LP
UHF-LV	6 km	0 km	X	X	X	X
UHF-HV		7 km	X	X	X	X
UHF-C			10 km	X	X	X
UHF-B				13 km	X	X
UHF-A					9 km	X
LP						4 km

Table A.2.3.4: L-VHF : DTV to NTSC (assuming tight emission mask is used).

	NTSC L-VHF (dB)	Flex Distance (km)
L-VHF	8.69	11
L-VHF-HV	5.46	14
L-VHF-C	0.07	34
L-VHF-B	-10.77	69
L-VHF-A	-22.99	74
LP	-34.19	> 89

Table A.2.3.5: H-VHF : DTV to NTSC (assuming tight emission mask is used).

	NTSC H-VHF (dB)	Flex Distance (km)
H-VHF-LV	10.52	1
H-VHF	7.65	10
H-VHF-C	-0.15	26
H-VHF-B	-9.19	50
H-VHF-A	-20.99	66
LP	-33.45	> 82

Table A.2.3.6 UHF: DTV to NTSC Separation Distance Between Different Classes (assuming tight emission masks are used).

	NTSC UHF-C (km)	NTSC UHF-B (km)	NTSC UHF-A (km)	NTSC LP (km)
UHF-LV	X	X	X	X
UHF-HV	X	X	X	X
UHF-C	8	X	X	X
UHF-B		12	X	X
UHF-A			8	X
LP				3

The service availability will be based on providing coverage in a service area with a specified availability of (50,90) or (90,90) and consideration of both is given in the planning and development of the criteria. The availability of (50,90) i.e. at 50% of the locations and 90% of the time, as noted in section A.2.1, may need to be improved due to the sharp failure characteristic of DTV. The implication of this will require further consideration. Service availability is discussed in Appendix 2 in more detail.

A.2.3.2 Criteria for Interim Plan

The development of the interim plan uses a specific set of criteria and band assignment priorities. The selection of a DTV channel for each regular power NTSC station uses a service availability of (90,90) for channels 2-59 and (50,90)for channels 60-69. Distance separations between stations or channels were developed using a (10,10) model for DTV to DTV interference and a (50,10) model for DTV to NTSC interference. The separation tables are given in section D.3 and section D.4. Channel requests not initially satisfied use short spacing to fulfill all remaining regular station requirements, still with (90,90) availability. Short spacings between DTV and NTSC are permitted first and between DTV and DTV last. The selection of a DTV channel for NTSC allotments uses the same criteria as for regular power stations. For low power NTSC stations, DTV allotments are made using (90,90) availability to the extent possible. Short spacings are used to meet all requirements on a similar basis as for regular stations and allotments.

Based on the spectrum considerations given in section A.3, the following band assignment priorities are used for the allotment of DTV channels in the interim plan.

BAND	PRIORITY
Ch. 7-13	1^{st}
Ch. 14-59	2^{nd}
Ch. 2-6	3^{rd}
Ch. 60-69	4^{th}

Short spacings are allowed between DTV and NTSC are allowed before putting allotments in the channel band of 60-69. In the channel band from 2 to 59, short spacings between DTV and DTV channels are used only as a last option.

A.3 Spectrum Considerations

A.3.1 Canadian Approach

An objective in spectrum management is to improve the efficiency of spectrum usage. Present NTSC usage of the spectrum for TV Broadcasting involves the channels and spectrum shown in Figure 1. Considerations in the allotment planning includes a proposed reduction of the band, which involves using only Ch 7-13 and Ch 14-51 shown shaded in Figure 2 as the core spectrum for DTV broadcasting. For an interim period during the transition from NTSC to DTV, use of all channels will continue. DTV channels operating outside the core block would move to the core spectrum when NTSC services are discontinued and channels become available. The strategy for planning will be to develop a Canadian plan with consideration of all Canadian requirements and to meld this plan with the adopted US plan as presented in the FCC's sixth Report and Order.

Canadian planning studies will include an assessment of how many channels are required for a DTV-only plan[1]:

a) if channel changes from the interim DTV/NTSC plan are minimized;

b) with no channel constraints from the DTV/NTSC plan.

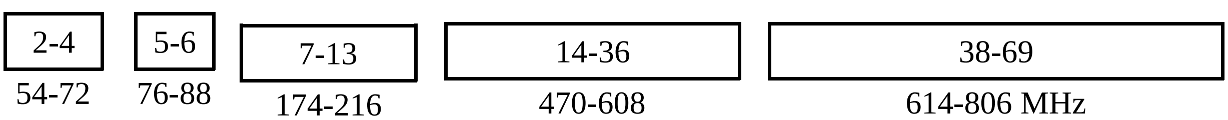

Figure 1 Current TV Broadcast Spectrum

Figure 2 Proposed TV Broadcast Spectrum

Canadian studies to date have looked at several variations of the above, where the final DTV only plan would use:

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[1]Further studies will be required in sharing with the land mobile systems adjacent to TV channels 14 and 69.

- all currently available channels
- the current UHF channels only
- the shaded channels in Figure 2
- VHF channels 7-13 and UHF channels 14-36 and 38-55
- VHF channels 7-13 and UHF channels 14-36 and 38-59

Following completion and adoption of this paper, a draft Canadian allotment plan will be developed, giving priority to the shaded channels in Figure 2 for DTV allotments and protecting the draft US plan to the extent possible. Shortened separations between DTV allotments on the shaded channels will be avoided. Next a straw man final plan for DTV only will be developed. In the DTV only plan, it will be assumed that all DTV allotments on the shaded channels will be maintained and that all stations whose DTV allotment is outside those channels, but whose NTSC channel is within, will use the latter for DTV. If all remaining DTV requirements cannot be met on these channels, different options will have to be explored, such as expanding the band or reallotting some channels.

A.3.2 FCC Approach

As described in section A.1.2 on the service criteria, the FCC have only considered regular power stations and only those allotments which are designated non-commercial. They are considering a spectrum option, the one shown in Figure 2, where all future digital TV service would be located in a core spectrum region of the existing VHF and UHF TV broadcast spectrum, namely the spectrum at TV channels 7 to 51 from 174-216 MHz and from 470-698 MHz. Under this plan, they have attempted to accommodate all existing broadcasters and designated non-commercial allotments with a DTV channel inside the core spectrum. Because of spectrum availability, existing NTSC services and interference considerations, some DTV channels are assigned outside the core area during the transitional phase. These DTV channels outside the core area would move into the core spectrum as channels become available from the closing of NTSC operations and release of channels.

This option, if successful, would permit the eventual recovery of 138 MHz of spectrum. Their plan, which minimizes the number of digital TV allotments in channels 60-69, calls for possible early recovery of 60 MHz of spectrum, i.e. channels 60-69, because of the limited use of these channels by full service analog and digital broadcasters. They propose to make channels 60-69 available to other services on a non-interference basis shortly after reaching a decision, and later open access to channels 52-59. However, at this time it is not clear when and how much of this spectrum will become available for other services.

In the 6th Report and Order, the adopted plan includes the above core spectrum approach but also includes another possible core spectrum option which uses Ch. 2-46 in place of Ch. 7-51.

B. Receiving Considerations

B.1 Receiving System Model

B.1.1 General Receiver Configuration

A model of a typical receiving installation located near the edge of the service area is shown in Figure 3 consisting of an externally mounted antenna, a interconnecting downlead cable and an ATV receiver. The amplifier symbol shown in the ATV receiver represents the input

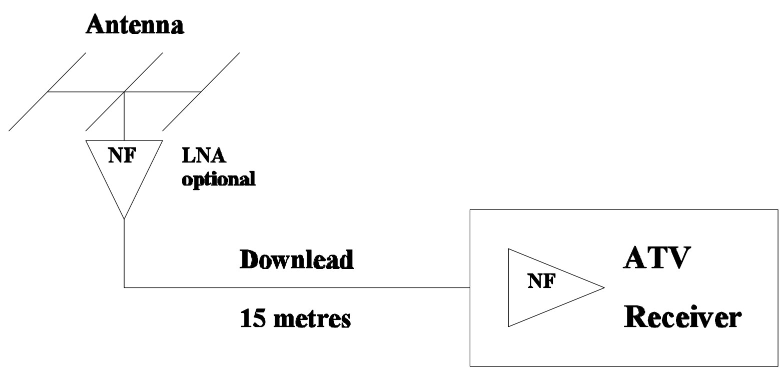

Figure 3. Receiving System Model

amplification circuitry which also determines the receiver noise figure. In the UHF TV band, it may be necessary to add an additional LNA mounted at the antenna to achieve a low noise figure equal to the noise figure for the VHF TV bands. The receiver configuration model described applies to locations near the edge of the coverage area (i.e. weak signal conditions).

B.1.2 Preliminary Receiving Parameters (Canadian)

The table below gives the parameters of the receiving system that were assumed during the preliminary allotment planning investigations carried out within JTCAB.

The choice of antenna gain was based on a reasonable assumption for gain for the VHF band representative of a three element Yagi type antenna. For the UHF band, the figure of 10 dB was chosen as representative of a standard UHF antenna without a high degree of complexity. The receiving antenna front-to-back ratio is based on values given in ITU-R Recommendation 419-2 which are representative of performance readily available with current antennas.

Parameter	Low VHF	High VHF	UHF
Frequency MHz	69	195	645
Antenna Gain (dipole) dB	6	8	10
Front-to-Back Ratio dB	6	12	16
Downlead Loss dB	2.5	3.3	4.9
Receiver Noise Figure dB	6	6	6
Man-made Noise dB (T_a equiv.)	8.2[2]	1	0

B.1.3 FCC Receiving Parameters (US)

The table below gives the parameters of the receiving system proposed for use in the US. The values were obtained from the FCC's sixth notice and are based on the numbers from the ATV test data.

Parameter	Low VHF	High VHF	UHF
Frequency MHz	69	194	615
Antenna Gain (dipole) dB	4	6	10
Front-to-Back Ratio dB	10	12	14
Downlead Loss dB	1	2	4
Receiver Noise Figure dB*	5	5	10
Man-made Noise dB*	4	1	0

* These values were changed in FCC's sixth Report and Order, see B.3.2.

B.1.4 Proposed Receiving Parameters (Canadian)

The receiver noise figure has a direct effect on the required field strength to provide coverage and the resulting required transmitter power. In the UHF band for service in Canada, an appropriate figure may be 5 dB (achieved by the use of a low noise preamplifier installed at the antenna output on the mast).

For the final allotment planning in Canada, the following receiving system parameters are proposed.

---

[2]Assumed noise for a rural environment using information from ITU-R Report 258-5.

Parameter	Low VHF	High VHF	UHF
Frequency MHz	69	195	645
Antenna Gain (dipole) dB	6	8	10
Front-to-Back Ratio dB	6	12	16
Downlead Loss dB	1.05	1.81	3.29
Balun 300/75 Loss dB	0.5	0.5	0.5
Receiver Noise Figure dB	5	5	10
Man-made Noise dB (T_a equiv.)	8.2	1	0
LNA Noise Figure (dB)	5	5	5
LNA Gain (dB)	20	20	20

B.2 Receiving System Parameters

In the analog TV case, the two parameters that are key factors that impact on allotment planning are the required carrier-to-Noise (C/N) at the TV receiver **ANT IN** terminal and the required co-channel Carrier-to-Interference (C/I). The (C/N) in association with the receive antenna gain, noise figure and desired signal quality establishes the receive field strength requirement and the co-channel (C/I) in association with the receive antenna Front-to-Back ratio determines the required co-channel separation distance.

In the Digital TV case, noise and co-channel DTV interference are additive as DTV interference behaves similar to noise. Hence there is a minimum C/(N + I) at the receiver input that needs to be met to achieve a specified threshold picture quality level, normally referred to as Threshold Of Visibility (TOV). Once the TOV value has been established then, for planning purposes, it is necessary to partition the threshold C/(N + I) value between noise (C/N) and co-channel DTV interference (C/I).

B.2.1 Minimum C/(N + I)

The minimum value of C/(N + I) for the 8 VSB Grand Alliance system has been measured in laboratory and field tests. Laboratory test results on the GA system report a value of 15.28 dB corresponding to TOV[3]. However this value represents the minimum C/N for TOV without additional impairments resulting from multipath and interference that would be expected to be present in the field. Based on the review of lab tests reported in the document referenced in the

[3]Document 11-3/CAN 2, 21 October 1996 "***DTV C/N Requirement for the 8-VSB Transmission System in a Noise Dominated Channel (MHz)*** " Submitted by CRC to TG 11-3 Meetings, Sydney Australia, November 1996

footnote, an additional headroom of 1.2 to 3.6 dB is required for typical multipath distortion. Assuming the minimum recommended headroom of 1.2 dB results in a minimum C/(N + I) of 16.5 dB at TOV.

B.2.2 Partitioning Between Noise & DTV Interference

Based on the above discussion and considering that the impact of DTV interference is noise like then it remains to establish an optimum partitioning between noise and co-channel interference at the DTV protected contour. Aspects to consider in this partitioning are:

- a higher threshold C/N, for a given receiver figure-of-merit (G/T) and coverage distance, translates into higher DTV transmit parameter values (HAAT and/or EIRP). Hence the value adopted for C/N must be within feasible limits for DTV transmit parameters corresponding to the most demanding case (i.e. DTV UHF-LV).

- On the other hand, a higher value of threshold C/N results in improving the balance in the spacings required for DTV interfering into NTSC (DTV/NTSC) and NTSC interfering into DTV (NTSC/DTV);

Based on these considerations and on further consideration of NTSC interfering into DTV as discussed in the next section, it is proposed that the partitioning be equally divided between noise and interference. **This results in a C/N = C/I = 19.5 dB at the DTV protected contour.**

B.2.3 NTSC Interference into DTV

The required C/I for NTSC interfering into DTV depends on whether a comb filter is used in the DTV receiver. Based on lab tests summarized in the document referenced in the footnote, with the comb filter in a C/I of 7.2 dB (NTSC/DTV) is required corresponding to a C/N of 19.4 dB. Without the comb filter the C/I required is 19.9 dB corresponding to a C/N of 16 dB which implies that the comb filter degrades the C/N by approximately 3.9 dB compared to the theoretical degradation of 3 dB. The comb filter will only be required during the transition phase when both DTV and NTSC are in operation. After the phase out of NTSC service, there will be a 3.9 dB improvement in the DTV carrier-to-noise ratio which means either an improvement in service availability or a reduction in transmitter power is possible.

Thus, assuming that the co-channel interference will either be DTV or NTSC and not both in the same instance, and that the comb filter will be used in areas where performance is constrained by NTSC interference and switched out in those areas where performance is constrained by noise and/or DTV interference then a value of co-channel **C/I of 7.2 dB for NTSC into DTV will be**

appropriate. Note also that this arrangement fits nicely with the assumption on Interference and Noise partitioning made in B.2.2 (i.e. threshold C/N = 19.5 dB).

B.3 Required Minimum Field Strength

The field strength required to provide ATV service for a given C/N ratio can be determined by:

$$C/N(dB) = \Phi(dBW/m^2) - G_i(1m^2) + G_A/T_e - K - B_{rf}$$

$$E_{RX}(dB\mu V/m) = \Phi(dBW/m^2) + 145.8(dB)$$
$$= 145.8 + C/N + 10logk + 10logB + G_i(1m^2) - G_A + T_e$$

E_{RX}	required field strength at the receive system antenna
Φ	power flux density at the receive system antenna
C/N	carrier to noise ratio
k	Boltzmann's constant
B	system bandwidth
$G_i(1m^2)$	gain of 1 metre squared
G_A/T_e	G/T of the receive system
G_A	gain of the receive system (isotropic) (see Appendix 1 for derivation)
Te	effective noise temperature (see Appendix 1 for derivation)

This method for deriving the field strength is given in detail in Appendix 1.

B.3.1 Preliminary Planning Parameters (Cdn)

The minimum required field strength for the three TV bands using the parameters assumed for the preliminary Canadian planning is given in Table B.3.1 below.

Table B.3.1

Preliminary Canadian Planning Parameters

Planning Parameter	Low VHF	High VHF	UHF
Frequency (MHz)	69	195	645
C/N (dB)	16.1	16.1	16.1
k (dB)	-228.6	-228.6	-228.6
B (dB) (6 MHz)	67.78	67.78	67.78
$G_i(1m^2)$ (dB)	-1.77	7.25	17.64
$G_{dipole\ (dB)}$	6	8	10
$G_{isotropic\ (dB)}$	8.15	10.15	12.15
Line Loss (dB) α (numeric)	2.5 0.56	3.3 0.47	4.9 0.32
Receiver Noise Figure (dB)	6	6	6
T_{rx}	864.5	864.5	864.5
T_{line}	126.9	154.4	196.2
αTa	5584.4	262.4	0
T_e	6575.8	1281.3	1060.7
$10\log(T_e)$	38.18	31.08	30.26
$G_{A\ (dB)}$	5.65	6.85	7.25
E_{reqd}	32	33	42

B.3.2 FCC Planning Parameters (US)

In the US, the method to determine required field strength is based on thermal noise at the reference temperature of 290° K and the receiver noise figure with a factor added for external noise. The formula is:

$$E_{RX}(dB\mu V/m) = \Phi(dBW/m^2) + 145.8(dB)$$
$$= 145.8 + C/N + G_i(1m^2) - G_A + 10\log k + 10\log B$$

$+ 10\log T_0 + F + N_{ext}$

The minimum required field strength for the three TV bands using the parameters adopted for use in the US and given in FCC's sixth Report and Order is shown in Table B.3.2 below.

Table B.3.2

FCC Planning Parameters

Planning Parameter	**Low VHF**	**High VHF**	**UHF**
Geometric Mean Frequency (MHz)	69	194	615
C/N (dB)	15.19	15.19	15.19
k (dB)	-228.6	-228.6	-228.6
B (dB)	67.78	67.78	67.78
$G_i(1m^2)$ (dB)	-1.77	7.21	17.23
G_{dipole} (dB)	4	6	10
$G_{isotropic}$ (dB)	6.15	8.15	12.15
Line Loss (dB)	1	2	4
Receiver Noise Figure F (dB)	10	10	7
$10\log(T_0)$ (dB)	24.62	24.62	24.62
N_{ext} (dB)	included in noise figure	included in noise figure	0
$G_{A\ (dB)}$	5.15	6.15	8.15
E_{reqd}	27.8	35.8	40.8

B.3.3 Proposed Planning Parameters (Cdn)

The minimum required field strength for the three TV bands using the parameters proposed for the final Canadian allotment planning is given in Table B.3.3 below.

Table B.3.3

Proposed Canadian Planning Parameters

Planning Parameter	Low VHF	High VHF	UHF_{LNA}
Frequency (MHz)	69	194	615
C/N (dB)	19.5	19.5	19.5
k (dB)	-228.6	-228.6	-228.6
B (dB) (6 MHz)	67.78	67.78	67.78
$G_i(1m^2)$ (dB)	-1.77	7.25	17.23
$G_{dipole\ (dB)}$	6	8	10
$G_{isotropic\ (dB)}$	8.15	10.15	12.15
Line Loss (dB) α (numeric)	1.05 0.786	1.81 0.659	3.29 0.468
Balun 300/75 Loss (dB) α_{balun} (numeric)	0.5 0.891	0.5 0.891	0.5 0.891
Receiver Noise Figure (dB)	5	5	10
T_{rx}	627.1	627.1	2610
T_{line}	62.1	98.9	154.3
LNA Noise Figure (dB)	5	5	5
LNA Gain (dB)	20	20	20
T_{LNA}	627.1	627.1	627.1
T_{balun}	31.6	31.6	31.6
T_a	9972.1	569.1	neg

Planning Parameter	Low VHF	High VHF	UHF_{LNA}
$\alpha_{balun}T_a$	8885.1	507.1	neg
$T_{line}/\alpha G$	0.79	1.5	3.3
$T_{rx}/\alpha G$	7.98	9.52	55.8
T_e	9552.6	1176.8	717.8
$10\log(T_e)$	39.8	30.71	28.56
$G_{A\ (dB)}$	7.65	9.65	11.65
E_{reqd}	35	33	39

B.4 Protection Ratios

The protection ratios are based upon the values resulting from the measurements and tests of the Grand Alliance DTV system, except those marked with an asterisk. Values marked with an asterisk * are estimates based on measurements made on earlier DTV systems which preceded the Grand Alliance system.

DTV System Protection Ratios[4]

Parameter	FCC or Measured Value (dB)	Previous	Proposed
Carrier-to-Noise Ratio	+15.19	16	[19.5]
Co-channel D/U Ratio			
DTV into NTSC	+34.44 (+33.81)**	34	[33.81]
NTSC into DTV	+1.81	7	[7.2]
DTV into DTV	+15.27	15	[19.5]

[4] FINAL TECHNICAL REPORT, Federal Communications Commission, Advisory Committee on Advanced Television Service, draft October 30, 1995.

** Values recorded in original lab tests on the GA system.

Values in [ ] indicate planning values adopted for Canadian allotment planning purposes where different from FCC values. See section B.2.2 and B.2.3 for explanation.

Adjacent Channel D/U Ratio				
Lower DTV into NTSC		-17.43 (-15.96)**	-17	[-15.96]
Upper DTV into NTSC		-11.95	-12	
Lower NTSC into DTV		-47.73	-48	
Upper NTSC into DTV		-48.71	-49	
Lower DTV into DTV		-41.98	-42	
Upper DTV into DTV		-43.17	-43	
Taboo D/U Ratio, DTV into NTSC				
N-2		-23.73	-24	
N+2		-27.93	-28	
N-3		-29.73	-30	
N+3		-34.13	-34	
N-4		-34.00*	-34	
N+4		-24.96	-25	
N-7		-35.00*	-35	
N+7		-34.00*	-34	
N-8		-31.62	-32	
N+8		-43.22	-43	
N+14		-33.38	-33	
N+15		-30.58	-31	
Taboo D/U Ratio, NTSC into DTV				
N-2		-62.45	-62	
N+2		-59.86	-60	
N-3	<	-61.79	-62	
N+3	<	-62.49	-62	
N-4		-58.00*	-58	
N+4		-58.00*	-57	
N-7		-58.00*	-58	
N+7		-58.00*	-60	
N-8		-58.00*	-58	
N+8		-58.00*	-58	
N+14		-58.00*	-58	

N+15		-58.00*	-58

Taboo D/U Ratio, DTV into DTV

N-2		-60.52	)not used
N+2		-59.13	)
N-3	<	-60.61	)
N+3	<	-61.53	)
N-4		-58.00*	)
N+4		-62.00*	)
N-7		-63.00*	)
N+7		-63.00*	)
N-8		-63.00*	)
N+8		-63.00*	)
N+14		-63.00*	)
N+15		-63.00*	)

C. Transmitting Considerations

C.1 Transmitting System Requirements

The necessary ERP to produce the required field strength for the noise limited contour at a given distance depends on the ERP (transmitter power, antenna gain, transmission line loss) and antenna height above average terrain. The location availability factor, which is the ratio in dB of the field strength for a given percentage of the receiving locations to the field strength for 50% of the receiving locations, is obtained from ITU-R Recommendation P370-7 Figures 5 and 12 for an Δh of 50 metres. The time availability factor is determined from the FCC's F(50,50) and F(50,10) curves. The ERP required was determined from the F(50,50) curves and adjusted for the location and time availability factors.

C.1.1 Transmitted Power Parameter (FCC)

Table C.1.1 below gives the ERP required for an UHF channel providing service for the classes of stations used in Canadian planning. The required field strength for the UHF channel assumed is 40.8 dBμV/m as calculated for the FCC example in their sixth Report and Order. The table allows comparison of the FCC example and power requirements with proposed Canadian values.

Table C.1.1 ERP Required (FCC Case)

UHF Channel Replacement

Class of Station	Low VHF	High VHF	UHF C	UHF B	UHF A	Low Power
Grade B Distance (km)	89	82	70	45	25	12
EHAAT (m)	300	300	300	150	100	30
T(90) dB	9.5	8.7	6.4	3.1	1.0	0
L(70) dB	2.6	2.6	2.6	2.6	2.6	2.6
L(90) dB	7.1	7.1	7.1	7.1	7.1	7.1
E_{reqd} 40.8 dBμV/m						
ERP (50,50) kW dBkW	43.15 16.35	21.83 13.39	5.12 7.09	0.583 -2.34	0.046 -13.37	0.025 -16.02
ERP (50,90) kW dBkW	384.6 25.85	161.8 22.09	22.34 13.49	1.191 0.76	0.056 -12.37	0.025 -16.02
ERP (70,90) kW dBkW	699.8 28.45	294.4 24.69	40.64 16.09	2.168 3.36	0.105 -9.77	0.0455 -13.42
ERP (90,90) kW dBkW	1972 32.95	829.9 29.19	114.6 20.59	6.109 7.86	0.297 -5.27	0.128 -8.92

C.1.2 Proposed Transmitted Power Parameter (Cdn)

C.1.2.1 DTV Power assuming UHF Band replacement channel

In the Canadian planning case, the required field strength calculated for the UHF channel is 39 dBμV/m assuming UHF band replacement and is the value determined for use in the proposed final allotment planning. The location availability factor and time availability factor are determined as specified in section C.1. The ERP required was determined from the F(50,50) curves and adjusted for the location and time availability factors.

Table C.1.2.1 ERP Required
UHF channel Replacement

Class of Station	Low VHF	High VHF	UHF C	UHF B	UHF A	Low Power
Grade B Distance (km)	89	82	70	45	25	12
EHAAT (m)	300	300	300	150	100	30
T(90) dB	9.5	8.7	6.4	3.1	1.0	0
L(70) dB	2.6	2.6	2.6	2.6	2.6	2.6
L(90) dB	7.1	7.1	7.1	7.1	7.1	7.1
E_{reqd} 39 dBμV/m						
ERP (50,50) kW dBkW	28.51 14.55	14.41 11.59	3.38 5.29	0.385 -4.15	0.031 -15.09	0.016 -17.96
ERP (50,90) kW dBkW	254.1 24.05	106.8 20.29	14.75 11.69	0.786 -1.05	0.039 -14.09	0.016 -17.96
ERP (70,90) kW dBkW	462.4 26.65	194.5 22.89	26.85 14.29	1.43 1.55	0.071 -11.49	0.029 -15.36
ERP (90,90) kW dBkW	1303 31.15	548.3 27.39	75.68 18.79	4.03 6.05	0.200 -6.99	0.082 -10.86

C.1.2.2 DTV Power assuming High VHF Band replacement channel

The required field strength calculated for the high VHF channel is 33 dBμV/m assuming high VHF band replacement and is the value determined for use in the proposed final allotment planning. The location availability factor and time availability factor are determined as specified in section C.1. The ERP required was determined from the F(50,50) curves and adjusted for the location and time availability factors.

Table C.1.2.2 ERP Required
High VHF Channel Replacement

Class of Station	Low VHF	High VHF	UHF C	UHF B	UHF A	Low Power
Grade B Distance (km)	89	82	70	45	25	12
EHAAT (m)	300	300	300	150	100	30
T(90) dB	6.0	5.2	4.4	2.2	0.9	0
L(70) dB	2.0	2.0	2.0	2.0	2.0	2.0
L(90) dB	6.1	6.1	6.1	6.1	6.1	6.1
E_{reqd} 33 dBμV/m						
ERP (50,50) kW dBkW	0.837 -0.77	0.391 -4.08	0.103 -9.87	0.023 -16.38	0.0035 -24.56	0.002 -26.99
ERP (50,90) kW dBkW	3.33 5.23	1.29 1.12	0.283 -5.47	0.038 -14.18	0.0043 -23.66	0.002 -26.99
ERP (70,90) kW dBkW	5.28 7.23	2.05 3.12	0.450 -3.47	0.068 -11.68	0.007 -21.66	0.003 -24.99
ERP (90,90) kW dBkW	13.58 11.33	5.27 7.22	1.156 0.63	0.156 -8.08	0.018 -17.56	0.008 -20.89

C.1.2.3 DTV Power assuming Low VHF Band replacement channel

The required field strength calculated for the low VHF channel is 35 dBμV/m assuming low VHF band replacement and is the value determined for use in the proposed final allotment planning. The location availability factor and time availability factor are determined as specified in section C.1. The ERP required was determined from the F(50,50) curves and adjusted for the location and time availability factors.

Table C.1.2.3 ERP Required
Low VHF Channel Replacement

Class of Station	Low VHF	High VHF	UHF C	UHF B	UHF A	Low Power
Grade B Distance (km)	89	82	70	45	25	12
EHAAT (m)	300	300	300	150	100	30
T(90) dB	6.2	5.4	4.4	2.5	1.1	0
L(70) dB	2.0	2.0	2.0	2.0	2.0	2.0
L(90) dB	6.1	6.1	6.1	6.1	6.1	6.1
E_{reqd} 35 dBμV/m						
ERP (50,50) kW dBkW	1.671 2.23	0.831 -0.804	0.260 -5.85	0.075 -11.25	0.012 -19.21	0.0064 -21.94
ERP (50,90) kW dBkW	6.966 8.43	2.884 4.60	0.716 -1.45	0.133 -8.75	0.015 -18.11	0.0064 -21.94
ERP (70,90) kW dBkW	11.04 10.43	5.75 7.60	1.135 0.55	0.211 -6.75	0.024 -16.11	0.010 -19.94
ERP (90,90) kW dBkW	28.38 14.53	11.75 10.70	2.92 4.65	0.543 -2.65	0.063 -12.01	0.026 -15.84

C.1.3 Transmitted Power for US Planning

C.1.3.1 Transmitted Power for Replacement Stations (US)

In the US draft Table of Allotments for existing broadcasters, the DTV service is based on NTSC service replication which determines the required ERP and EHAAT for each DTV station. The ERP for each allotment is calculated to provide service area replication up to a maximum ERP of 5 megawatts.

C.1.3.2 Transmitted Power for Future Stations (US)

For new stations or allotments, maximum permissible ERP and EHAAT specifications were adopted by FCC'S 6th Report and Order. These specifications would allow an UHF station to serve a geographic area with a radius of 107 km. The maximum parameters for an UHF DTV station are given in Table C.1.3.2.

Table C.1.3.2
US Maximum Allowable ERP and Antenna Height for Future UHF DTV Stations

Antenna Height EHAAT (metres)	Effective Radiated Power ERP (kW)
610	316
580	350
550	400
520	460
490	540
460	630
425	750
395	900
365	1000

C.2 Realistic DTV Powers and Antenna Gains

The power required for a DTV transmitter is specified as average or RMS power in a linear operating mode whereas NTSC power are given in peak power in a class C operating mode.

This places a limit on the maximum power available at the transmitter, typical transmitters are presently capable of delivering a maximum average power of 50-60 kW in a linear mode. The maximum ERP adopted by the FCC for UHF stations is 1000 kW. For Canadian planning, a maximum ERP of 1000 kW is proposed as the maximum limit which gives a margin of 6 dB over the maximum of 254 kW ERP needed to achieve the required field strength. A survey of the industry is required to determine if these figures are realistic and achievable at economic prices.

C.3 Summary of DTV Powers and Classes for Planning

The specification for classes of station/service for DTV is based on the existing types of classes used in the NTSC service. Rather than specify maximum parameters for ERP and EHAAT as presently used, maximum values of the distance to the protected contour and of the EHAAT are used. The classes selected are given in Table C.3 below along with the transmitting ERP required to provide service at a (50,90) availability.

Table C.3
ERP for Classes of DTV Stations

TV Band	Class of Station	Protected Contour Distance km	EHAAT metres	DTV ERP (50,90)
	E_{reqd} 35 dBμV/m			
Low VHF	Low VHF	89	300	8.43 dBkW 6.97 kW
	Low VHF-HV	82	300	4.60 dBkW 2.88 kW
	Low VHF-C	70	300	-1.45 dBkW 716 W
	Low VHF-B	45	150	-8.75 dBkW 133 W
	Low VHF-A	25	100	-18.11 dBkW 15 W
	LP	12	30	-21.74 dBkW 6.7 W
	E_{reqd} 33 dBμV/m			

TV Band	Class of Station	Protected Contour Distance km	EHAAT metres	DTV ERP (50,90)
High VHF	High VHF-LV	89	300	5.23 dBkW 3.33 kW
	High VHF	82	300	1.12 dBkW 1.29 kW
	High VHF-C	70	300	-5.47 dBkW 283 W
	High VHF-B	45	150	-14.18 dBkW 38 W
	High VHF-A	25	100	-23.66 dBkW 4.3 W
	LP	12	30	-27.0 dBkW 2.0 W
	E_{reqd} 39 dBμV/m			
UHF	UHF-LV	89	300	24.05 dBkW 254.1 kW
	UHF-HV	82	300	20.29 dBkW 106.8 kW
	UHF Class C	70	300	11.69 dBkW 14.75 kW
	UHF Class B	45	150	-1.05 dBkW 0.786 kW
	UHF Class A	25	100	-14.09 dBkW 39 W
	UHF Class LP	12	30	-17.96 dBkW 16 W

D. Separation Tables

Separation distances provide an efficient and effective means for managing interference between NTSC stations and DTV allotments and we believe that such an approach can be used to determine the technical acceptability of DTV channel allotments. The separation tables are developed using the appropriate protection ratios, antenna discrimination and distances to protected and interfering contours for a specified service availability. They are based on an equal partitioning between noise and interference in the DTV to DTV case and to keep a degree of balance between interference from NTSC to DTV and the inverse. The tables give the separation distances required to protect the TV services of the different classes of stations and form the basis for allotting the frequencies to the DTV service areas.

Also, in developing the allotment plans, short spacings were used in order to satisfy all requirements. A study on the effect of short spacings on coverage was done to evaluate different percentages of possible reduction of spacings between stations. The study showed that the coverage was reduced with co-channel operation of different classes of stations at the presently used separations. As a result, a new set of taboos and separation distances was developed and the short spacing study was updated to reflect the new separations and incorporated into this document as Appendix 4. These new values will be used in future development of the Canadian allotment plan and are the values in the separation tables given in section D.3 for a service availability of (50.90) and in section D.4 for a service availability of (90.90).

D.1 Canadian Separation Distances used for Initial Planning

The following tables are based on an equal partitioning between noise and interference to keep a degree of balance between interference from NTSC to DTV and the inverse.

TABLE D.1.1

UHF BAND TABOOS - DTV -> DTV   Separation distances in km

CLASS Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-25	-45	-70	-25	82	89	-45	-45	-70	-45	-82	-89	-70	-70	-71	-70	-83	-90
0	60	91	164	47	212	234	91	111	184	78	232	254	164	184	209	151	257	279
1	-25	-45	-70	-25	82	89	-45	-45	-70	-45	-82	-89	-70	-70	-71	-70	-83	-90

CLASS Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL

Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-25	-45	-70	-12	82	89	-82	-82	-83	82	-88	-98	89	-89	-90	89	-96	-105
0	47	78	151	27	189	211	212	232	257	189	269	293	234	254	279	221	291	298
1	-25	-45	-70	-12	82	89	-82	-82	-83	82	-88	-98	89	-89	-90	89	-96	-105

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.1.2

UPPER VHF BAND TABOOS - DTV -> DTV   Separation distances in km

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-25	-45	-70	-12	-82	-89	-45	-46	-71	-13	-83	-90	-70	-71	-72	-14	-84	-91
0	68	93	125	52	145	160	93	113	145	80	165	180	125	145	170	112	190	205
1	-25	-45	-70	-12	-82	-89	-45	-46	-71	-13	-83	-90	-70	-71	-72	-14	-84	-91

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-12	-13	-14	0	-15	-16	-82	-83	-84	-15	-85	-92	-89	-90	-91	-16	-92	-93
0	52	80	112	31	132	147	145	160	190	132	202	217	160	180	256	147	217	224
1	-12	-13	-14	0	-15	-16	-82	-83	-84	-15	-85	-92	-89	-90	-91	-16	-92	-93

TABLE D.1.3

LOWER VHF BAND TABOOS - DTV -> DTV   Separation distances in km

To be revised

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C

CHAN.																		
-1	-27	-47	-72	-26	-84	-91	-47	-48	-73	-46	-85	-92	-72	-73	-80	-71	-91	-98
0	81	125	177	68	207	230	125	145	197	112	227	250	177	197	222	164	252	275
1	-27	-47	-72	-26	-84	-91	-47	-48	-73	-46	-85	-92	-72	-73	-80	-71	-92	-99

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-26	-46	-71	-13	-83	-90	-84	-85	-92	-83	-97	-104	-91	-92	-99	-90	-104	-106
0	68	112	164	37	194	217	194	227	252	194	264	287	230	250	275	217	287	294
1	-26	-46	-71	-13	-83	-90	-84	-85	-91	-83	-97	-104	-91	-92	-98	-90	-104	-106

TABLE D.1.4

<u>UHF BAND TABOOS - DTV -> NTSC</u> Separation distances in km

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-15	0	0	0	0	0	0	0	0	0	0	0	0	25	-45	-70	12	-82	-89
-14	0	0	0	0	0	0	0	0	0	0	0	0	25	-45	-70	12	-82	-89
-8	0	0	0	0	-25	25	0	0	-45	0	-45	-45	25	-45	-70	12	-82	-89
-7	0	0	-25	0	-26	26	0	0	-45	0	-45	-46	25	-45	-70	12	-82	-89
-4	0	0	-25	0	-26	26	0	0	-45	0	-46	-46	25	-45	-70	12	-82	-89
-3	0	0	-25	0	-25	26	0	0	-45	0	-45	-46	25	-45	-70	12	-82	-89
-2	0	0	-25	0	-26	28	0	0	-45	0	-46	-48	25	-45	-70	12	-82	-89
-1	-27	-47	-72	14	-84	-91	-46	-49	-74	16	-86	-93	71	-73	-80	22	-92	-99
0	71	91	136	58	181	202	103	123	156	90	201	222	169	189	214	156	226	247
1	-27	-47	-72	14	-84	-91	-46	-49	-74	16	-86	-93	71	-73	-80	22	-92	-99
2	0	0	-25	0	-25	26	0	0	-45	0	-45	-46	25	-45	-70	12	-82	-89
3	0	0	0	0	-25	25	0	0	0	0	-45	-45	25	-45	-70	12	-82	-89
4	0	0	-25	0	-26	28	0	0	-45	0	-46	-48	25	-45	-70	12	-82	-89
7	0	0	-25	0	-26	26	0	0	-45	0	-46	-46	25	-45	-70	12	-82	-89
8	0	0	0	0	-25	25	0	0	-45	0	-45	-45	25	-45	-70	12	-82	-89
14	0	0	-25	0	-26	27	0	0	-45	0	-46	-47	0	0	-70	0	-71	-72
15	0	0	-25	0	-26	28	0	0	-45	0	-46	-48	0	0	-70	0	-71	-73

CLASS						
Int.	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP

CHAN.

-15	0	0	0	0	0	0
-14	0	0	0	0	0	0
-8	0	0	0	0	12	12
-7	0	0	-12	0	12	13
-4	0	0	-12	0	13	13
-3	0	0	-12	0	12	13
-2	0	0	-12	0	13	15
-1	-26	-46	-71	-13	-83	-90
0	50	70	123	37	168	189
1	-26	-46	-71	-13	-83	-90
2	0	0	-12	0	12	13
3	0	0	0	0	12	12
4	0	0	-12	0	13	15
7	0	0	-12	0	13	13
8	0	0	0	0	12	12
14	0	0	-12	0	13	14
15	0	0	-12	0	13	15

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
A separation of zero means that interference is unlikely at any separation.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.1.5

UPPER VHF BAND TABOOS - DTV -> NTSC   Separation distances in km

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-27	-47	-72	-25	-84	-91	46	-50	-75	45	-87	-94	71	72	-85	70	-91	-104
0	86	106	131	73	145	150	113	143	168	110	180	187	200	220	245	187	257	264
1	-27	-47	-72	-25	-84	-91	46	-50	-75	45	-87	-94	71	72	-85	70	-91	-104

CLASS												
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU
CHAN.												
-1	-26	-46	-71	-13	-83	-90	83	87	-94	82	-104	-111
0	51	71	96	38	110	132	230	250	275	217	287	294

1	-26	-46	-71	-13	-83	-90	83	85	-97	82	-109	-116

TABLE D.1.6

LOWER VHF BAND TABOOS - DTV -> NTSC   Separation distances in km

To be revised

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-27	-47	-72	-25	-84	-91	-46	-51	-76	-45	-88	-95	-71	-73	-80	-70	-92	-99
0	79	99	124	66	142	160	120	140	165	107	177	184	150	170	195	137	207	214
1	-28	-48	-73	-25	-85	-92	-46	-51	-76	-45	-88	-95	-71	-73	-81	-70	-93	-100

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-26	-46	-71	-13	-83	-90	83	-85	-89	82	-103	-110	90	92	-96	89	-106	-113
0	50	70	109	37	129	147	207	227	252	194	264	271	225	245	270	190	282	289
1	-26	-46	-71	-13	-83	-90	83	-85	-88	82	-105	-112	90	92	-95	89	-108	-115

TABLE D.1.7

UHF BAND TABOOS - NTSC -> DTV

CLASS												
Int.	A	B	C	LP	A	B	C	LP	A	B	C	LP
Prot.	A	A	A	A	B	B	B	B	C	C	C	C
CHAN.												
-15	0	0	0	0	0	0	0	0	-25	-45	-70	-12
-14	0	0	0	0	0	0	0	0	-25	-45	-70	-12
-8	0	0	25	0	0	0	-45	0	0	-70	-70	0
-7	0	0	25	0	0	0	-45	0	-25	-70	-70	-12
-4	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
-3	0	0	25	0	0	0	-45	0	0	0	-70	0
-2	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
-1	-27	-46	71	-26	-47	-49	-73	-46	-72	-74	-80	-71
0	71	103	169	50	91	123	189	70	136	156	214	123
1	-27	-46	71	-26	-47	-49	-73	-46	-72	-74	-80	-71
2	0	0	25	0	0	0	-45	0	-25	-45	-70	-12

3	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
4	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
7	0	0	25	0	0	0	-45	0	-25	-45	-70	-12
8	0	0	25	0	0	0	-45	0	0	-45	-70	0
14	0	0	25	0	0	0	-45	0	0	-45	-70	0
15	0	0	25	0	0	0	-45	0	0	-45	-70	0

CLASS												
Int.	A	B	C	LP	A	B	C	LP	A	B	C	LP
Prot.	LP	LP	LP	LP	VU	VU	VU	VU	VL	VL	VL	VL
CHAN.												
-15	0	0	0	0	-26	-46	-71	13	28	-48	-73	15
-14	0	0	0	0	-26	-46	-71	13	27	-47	-72	14
-8	0	0	12	0	-25	-45	-82	12	25	-45	-89	12
-7	0	0	12	0	-26	-46	-82	13	26	-46	-89	13
-4	0	0	12	0	-26	-46	-82	13	28	-48	-89	15
-3	0	0	12	0	-25	-45	-82	12	25	-45	-89	12
-2	0	0	12	0	-25	-45	-82	12	26	-46	-89	13
-1	14	16	22	-13	-84	-86	-92	-83	-91	-93	-99	-90
0	58	90	156	37	181	201	226	168	202	222	247	189
1	14	16	22	-13	-84	-86	-92	-83	-91	-93	-99	-90
2	0	0	12	0	-26	-46	-82	13	28	-48	-89	15
3	0	0	12	0	-25	-45	-82	12	26	-46	-89	13
4	0	0	12	0	-26	-46	-82	13	26	-46	-89	13
7	0	0	12	0	-26	-46	-82	13	26	-46	-89	13
8	0	0	12	0	-25	-45	-82	12	25	-45	-89	12
14	0	0	12	0	0	0	-82	0	0	0	-89	0
15	0	0	12	0	0	0	-82	0	0	0	-89	0

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
A separation of zero means that interference is unlikely at any separation.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.1.8

UPPER VHF BAND TABOOS - NTSC -> DTV

CLASS															
Int.	A	B	C	LP	VU	A	B	C	LP	VU	A	B	C	LP	VU
Prot.	A	A	A	A	A	B	B	B	B	B	C	C	C	C	C
CHAN.															

-1	-27	46	71	-26	83	-47	-50	72	-46	87	-72	-75	-85	-71	-92
0	86	113	200	51	230	106	143	220	71	250	131	168	245	96	275
1	-27	46	71	-26	83	-47	-50	72	-46	87	-72	-75	-85	-71	-92

CLASS															
Int.	A	B	C	LP	VU	A	B	C	LP	VU	A	B	C	LP	VU
Prot.	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL
CHAN.															
-1	-25	45	70	-13	82	-85	-88	-101	-83	-109	-92	-95	-108	-90	-116
0	73	110	187	38	217	145	180	257	110	287	150	187	264	132	294
1	-25	45	70	-13	82	-84	-87	-97	-83	-104	-91	-94	-104	-90	-111

TABLE D.1.9

<u>LOWER VHF BAND TABOOS - NTSC -> DTV</u>

To be revised

CLASS																	
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-28	-46	-71	-26	83	90	-48	-51	-73	-46	-85	92	-73	-76	-81	-71	-88	-95
0	79	120	150	50	207	225	99	140	170	70	227	245	124	165	195	109	252	270
1	-27	-46	-71	-26	83	90	-47	-51	-73	-46	-85	92	-72	-76	-80	-71	-89	-96

CLASS																		
Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-25	-45	-70	-13	82	89	-85	-88	-93	-83	-105	-108	-92	-95	-100	-90	-112	-115
0	66	107	137	37	194	212	142	177	207	129	264	282	160	184	214	147	271	289
1	-25	-45	-70	-13	82	89	-84	-88	-92	-83	-103	-106	-91	-95	-99	-90	-110	-113

D.2 US Tables

The following is an excerpt from FCC 96-317.

a. <u>Geographic Spacing Approach</u>. Spacing standards have proven to be an efficient and effective means for managing interference between NTSC stations and we believe that such an approach could be used to determine the technical acceptability of DTV channel allotments. We note that geographic spacing approach provides considerable flexibility in the specification of station operating parameters such as power and antenna height. Based on the engineering performance characteristics used in developing the initial DTV Table proposed herein, we have developed the following DTV spacing standards. If we adopt a geographical spacing approach, we would propose to permit the addition or modification of DTV allotments provided such allotments meet the following spacing standards.[5]

Channel Relationship		Separation Requirement
VHF Channels 7-13		
Co-channel, DTV to DTV		
	Zone I	152 miles (244.6 km)
	Zones II & III	170 miles (273.6 km)
Co-channel, DTV to NTSC		
	Zone I	152 miles (244.6 km)
	Zone II & III	170 miles (273.6 km)
Adjacent Channel		
DTV to DTV		No allotments permitted between:
	Zone I	25 miles (40.2 km) and 60 miles (96.6 km)
	Zones II & III	30 miles (48.3 km) and 60 miles (96.6 km)
DTV to NTSC		No allotments permitted between:
	Zone I	7 miles (11.3 km) and 71 miles (114.3 km)
	Zone II & III	11 miles (17.7 km) and 91 miles (146.4 km)
UHF Channels		
Co-channel, DTV to DTV		
	Zone I	122 miles (196.3 km)
	Zone II & III	139 miles (223.7 km)

[5] Proposals for new DTV allotments would also be subject to other requirements and standards for new allotments set forth in Sections 73.610 and 73.611 of our rules, see 47 CFR §§73.610 and 73.611. The DTV to NTSC minimum spacing requirements would apply only during the transition period.

Co-channel, DTV to NTSC

	Zone I	135 miles (217.3 km)
	Zone II & III	152 miles (244.6 km)

Adjacent Channel

DTV to DTV		No allotments permitted between:
	All Zones	20 miles (32.2 km) and 55 miles (88.5 km)
DTV to NTSC		No allotments permitted between:
	All Zones	6 miles (9.7 km) and 55 miles (88.5 km)
Taboo Channels, DTV to NTSC only (+/- 2, +/- 3, +/- 4, +/- 5, +/- 7, +/- 8, +/- 14 and +/- 15 channels)		No allotments permitted between:
	Zone I	15 miles (24.1 km) and 50 miles (80.5 km)
	Zone II & III	15 miles (24.1 km) and 60 miles (96.6 km)

D.3 Proposed Canadian Tables (50,90 Service Availability)

TABLE D.3.1

UHF BAND TABOOS - DTV -> DTV   Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-26	-45	70	-12	82	89	-46	-47	-72	14	84	91	71	-72	-77	18	-88	-95
0	58	114	204	56	258	283	114	111	185	126	239	264	204	185	207	216	254	276
1	-26	-46	71	-13	83	90	-45	-47	-72	14	84	91	70	-72	-77	19	-89	-96

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-13	14	19	0	24	27	83	84	-89	17	-94	-101	90	91	-96	21	-101	-104
0	56	126	216	30	270	296	258	239	254	270	266	288	283	264	276	296	288	295

1	-12	14	18	0	24	26	82	84	-88	24	-94	-101	89	91	-95	27	-101	-104

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.3.2

UPPER VHF BAND TABOOS - DTV -> DTV   Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-26	-46	71	-25	83	90	-46	-47	-72	-45	84	91	71	-72	-74	70	-86	-93
0	68	100	154	63	191	215	100	120	162	103	193	215	154	162	187	166	218	240
1	-26	-46	71	-25	83	90	-46	-47	-72	-45	84	91	71	-72	-74	70	-86	-93

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-25	-45	70	-12	82	89	83	84	-86	82	-88	-94	90	91	-93	89	-95	-98
0	63	103	166	33	203	227	191	193	218	203	230	252	215	215	240	227	252	259
1	-25	-45	70	-12	82	89	83	84	-86	82	-88	-95	90	91	-93	89	-94	-98

TABLE D.3.3

LOWER VHF BAND TABOOS - DTV -> DTV   Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-26	-46	71	-25	83	90	-46	-48	-73	-45	-85	92	71	-73	-78	70	-89	-96
0	86	127	180	74	214	236	127	147	201	124	234	256	180	200	225	181	259	281
1	-26	-46	71	-25	83	90	-46	-48	-73	-45	-85	92	71	-74	-78	70	-90	-97

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL

CHAN.

-1	-25	-45	70	-12	82	89	83	-85	-90	82	-93	-100	90	92	-97	89	-100	-103
0	74	124	181	40	216	239	214	234	259	216	271	293	236	256	281	239	293	300
1	-25	-45	70	-12	82	89	83	-85	-89	82	-93	-100	90	92	-96	89	-99	-103

TABLE D.3.4

UHF BAND TABOOS - DTV -> NTSC   Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-15	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-53	-78	-20	-90	-97
-14	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-53	-78	-20	-90	-97
-8	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-70	-78	-20	-90	-97
-7	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-70	-78	-20	-90	-97
-4	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-70	-78	-20	-90	-97
-3	-26	-46	-71	-13	-83	-90	-27	-47	-72	-14	-84	-91	-31	-71	-76	-18	-88	-96
-2	-26	-46	-71	-13	-83	-90	-45	-48	-73	-15	-85	-92	-70	-71	-77	-19	-89	-95
-1	-28	-48	73	-15	85	92	-46	-51	76	-18	88	95	-71	-72	-85	-27	97	104
0	99	100	143	111	192	215	162	144	169	174	181	197	241	223	240	254	252	259
1	-28	-48	73	-25	85	92	-46	-51	76	-45	88	95	-71	-73	-86	-70	98	105
2	-26	-46	-71	-13	-83	-90	-27	-47	-72	-14	-84	-91	-31	-71	-76	-18	-88	-95
3	-26	-46	-71	-13	-83	-90	-27	-47	-72	-14	-84	-91	-31	-70	-76	-18	-88	-95
4	-26	-46	-71	-13	-83	-90	-45	-48	-73	-15	-85	-92	-70	-71	-78	-20	-90	-97
7	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-70	-78	-20	-90	-97
8	-26	-46	-71	-13	-83	-90	-28	-48	-73	-15	-85	-92	-33	-53	-78	-20	-90	-97
14	0	-25	-27	0	-29	-30	0	-45	-47	0	-49	-50	0	-70	-72	0	-74	-75
15	0	-26	-27	0	-30	-31	0	-46	-47	0	-50	-51	0	-71	-72	0	-75	-76

Int.	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP
CHAN.						
-15	-25	-45	-70	-12	-82	-89
-14	-25	-45	-70	-12	-82	-89
-8	-25	-45	-70	-12	-82	-89
-7	-25	-45	-70	-12	-82	-89
-4	-25	-45	-70	-12	-82	-89
-3	-25	-45	-70	-12	-82	-89
-2	-25	-45	-70	-12	-82	-89
-1	-26	46	71	-13	83	90
0	68	79	155	80	204	227
1	-26	46	71	-13	83	90
2	-25	-45	-70	-12	-82	-89
3	-25	-45	-70	-12	-82	-89
4	-25	-45	-70	-12	-82	-89
7	-25	-45	-70	-12	-82	-89
8	-25	-45	-70	-12	-82	-89
14	0	-12	-14	0	-16	-17
15	0	-13	-14	0	-17	-18

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
A separation of zero means that interference is unlikely at any separation.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.3.5

UPPER VHF BAND TABOOS - DTV -> NTSC   Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-27	-47	72	-25	84	91	-46	-50	-75	-45	87	94	-71	-72	-81	-70	-93	-100
0	93	113	138	97	150	167	139	147	171	150	183	190	206	206	231	218	243	250
1	-28	-48	73	-25	85	92	-46	-51	-76	-45	88	95	-71	-73	-82	-70	-94	-101

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU
CHAN.												
-1	-27	47	72	-14	84	91	-83	-84	-87	-82	-99	-106
0	64	84	121	70	155	178	243	239	264	254	276	283
1	-27	47	72	-14	84	91	-83	-85	-89	-82	-100	-107

TABLE D.3.6

LOWER VHF BAND TABOOS - DTV -> NTSC   Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-29	47	72	-27	84	91	-49	-53	74	-47	86	93	-74	-78	-88	-72	96	102
0	93	137	193	70	227	249	116	157	213	109	247	269	171	191	238	172	272	294
1	-30	47	72	-27	84	91	-50	-53	74	-47	86	93	-75	-80	-93	-72	104	111

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	26	46	71	-14	83	90	-86	-90	-100	-84	-108	-114	-93	-97	-107	-91	-115	-121
0	82	136	194	47	230	253	198	218	250	199	284	306	214	234	259	216	291	313

1 26 46 71 -14 83 90 -87 -92-105 -84-116-123 -94 -99-112 -91-123-130

TABLE D.3.7

UHF BAND TABOOS - NTSC -> DTV

Int.	A	B	C	LP	A	B	C	LP	A	B	C	LP
Prot.	A	A	A	A	B	B	B	B	C	C	C	C
CHAN.												
-15	0	0	0	0	-26	-46	-71	-13	-27	-47	-72	-14
-14	0	0	0	0	-25	-45	-70	-12	-27	-47	-72	-14
-8	-26	-28	-33	-25	-46	-48	-53	-45	-71	-73	-78	-70
-7	-26	-28	-33	-25	-46	-48	-70	-45	-71	-73	-78	-70
-4	-26	-45	-70	-25	-46	-48	-71	-45	-71	-73	-78	-70
-3	-26	-27	-31	-25	-46	-47	-70	-45	-71	-72	-76	-70
-2	-26	-27	-31	-25	-46	-47	-71	-45	-71	-72	-76	-70
-1	-28	-46	-71	-26	-48	-51	-73	46	73	76	-86	71
0	99	162	241	68	100	144	223	79	143	169	240	155
1	-28	-46	-70	-26	-48	-51	-72	46	73	76	-85	71
2	-26	-45	-70	-25	-46	-48	-71	-45	-71	-73	-77	-70
3	-26	-27	-31	-25	-46	-47	-71	-45	-71	-73	-76	-70
4	-26	-28	-33	-25	-46	-48	-70	-45	-71	-73	-78	-70
7	-26	-28	-33	-25	-46	-48	-70	-45	-71	-73	-78	-70
8	-26	-28	-33	-25	-46	-48	-70	-45	-71	-73	-78	-70
14	-26	-28	-33	-25	-46	-48	-53	-45	-71	-73	-78	-70
15	-26	-28	-33	-25	-46	-48	-53	-45	-71	-73	-78	-70

Int.	A	B	C	LP	A	B	C	LP	A	B	C	LP
Prot.	LP	LP	LP	LP	VU	VU	VU	VU	VL	VL	VL	VL
CHAN.												
-15	0	0	0	0	-30	-50	-75	-17	-31	-51	-76	-18
-14	0	0	0	0	-29	-49	-74	-16	-30	-50	-75	-17
-8	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
-7	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
-4	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
-3	-13	-14	-18	-12	-83	-84	-88	-82	-90	-91	-95	-89
-2	-13	-14	-18	-12	-83	-84	-88	-82	-90	-91	-95	-89
-1	-25	-45	-70	-13	85	88	98	83	92	95	105	90
0	111	174	254	80	192	181	252	204	215	197	259	227
1	-15	-18	-27	-13	85	88	97	83	92	95	104	90
2	-13	-15	-19	-12	-83	-85	-89	-82	-90	-92	-96	-89
3	-13	-14	-18	-12	-83	-84	-88	-82	-90	-91	-95	-89
4	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
7	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
8	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89
14	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89

15	-13	-15	-20	-12	-83	-85	-90	-82	-90	-92	-97	-89

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
A separation of zero means that interference is unlikely at any separation.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.3.8

UPPER VHF BAND TABOOS - NTSC -> DTV

Int.	A	B	C	LP	VU	A	B	C	LP	VU	A	B	C	LP	VU
Prot.	A	A	A	A	A	B	B	B	B	B	C	C	C	C	C
CHAN.															
-1	-28	-46	-71	-27	-83	-48	-51	-73	47	-85	73	-76	-82	72	-89
0	93	138	206	64	243	113	146	206	84	240	138	171	231	121	264
1	-27	-46	-71	-27	-83	-47	-50	-72	47	-84	72	-75	-81	72	-87

Int.	A	B	C	LP	VU	A	B	C	LP	VU	A	B	C	LP	VU
Prot.	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL
CHAN.															
-1	-25	-45	-70	-14	-82	84	88	-94	84	-100	92	95	-101	91	-107
0	97	150	218	70	254	150	183	243	155	276	166	190	250	178	283
1	-25	-45	-70	-14	-82	84	87	-93	84	-99	91	94	-100	91	-106

TABLE D.3.9

LOWER VHF BAND TABOOS - NTSC -> DTV

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-30	-50	-75	26	-87	-94	47	-55	-80	46	-92	-99	72	74	-93	71	-105	-112
0	93	116	171	82	198	214	137	157	191	136	218	234	193	213	238	194	250	259
1	-29	-49	-74	26	-86	-93	47	-53	-78	46	-90	-97	72	74	-88	71	-100	-107

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-27	-47	-72	-14	-84	-91	84	86	-103	83	-116	-123	91	93	111	90	123	-130

0	70	109	172	47	199	216	227	247	272	230	284	291	249	269	294	253	306	313
1	-27	-47	-72	-14	-84	-91	84	86	-96	83	-108	-115	91	93	102	90	114	-121

D.4 Proposed Canadian Tables (90,90 Service Availability)

TABLE D.4.1

UHF BAND TABOOS - DTV -> DTV (90,90/10,10) Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-27	-47	72	-26	84	91	-47	-51	-75	46	87	94	72	-76	-87	71	-98	-105
0	112	194	296	124	363	386	194	175	277	207	344	367	296	277	287	309	340	359
1	-27	-47	72	-26	84	91	-47	-51	-76	46	88	95	72	-75	-87	71	-99	-106

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-26	46	71	-13	83	90	84	88	-99	83	-110	-115	91	95	-106	90	-117	-122
0	124	207	309	88	375	398	363	344	340	375	352	371	386	367	359	398	371	378
1	-26	46	71	-13	83	90	84	87	-98	83	-110	-117	91	94	-105	90	-115	-122

A minus sign means that either co-siting or the indicated separation is OK.
Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.
Channel -1 means lower first adjacent.
Protection was assessed in both directions and the greater separation distance was used.

TABLE D.4.2

UPPER VHF BAND TABOOS DTV->DTV (90,90/10,10) Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-27	-47	72	-26	84	91	-47	-49	-74	-46	86	93	72	-74	-81	71	-92	-99
0	100	156	224	109	265	291	156	160	223	168	260	284	224	223	248	236	285	309
1	-27	-47	72	-26	84	91	-47	-49	-74	-46	86	93	72	-74	-81	71	-93	-100

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		

-1	-26	-46	71	-13	83	90	84	86	-93	83	-100	-105	91	93	-100	90	-107	-111
0	109	168	236	76	277	303	265	260	285	277	297	321	291	284	309	303	321	328
1	-26	-46	71	-13	83	90	84	86	-92	83	-100	-107	91	93	-99	90	-105	-111

TABLE D.4.3

<u>LOWER VHF BAND TABOOS DTV->DTV (90,90/10,10)</u> Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-28	-48	73	-27	85	92	-48	-52	-77	-47	-89	96	73	-77	-86	72	-97	-104
0	132	191	249	130	286	309	191	211	269	191	306	329	249	269	294	252	331	354
1	-28	-48	73	-26	85	92	-48	-52	-77	-46	-89	96	73	-77	-86	71	-98	-105

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-26	-46	71	-14	83	90	85	-89	-98	84	-105	-111	92	96	-105	91	-112	-118
0	130	191	252	95	290	315	286	306	331	290	343	366	309	329	354	315	366	373
1	-27	-47	72	-14	84	91	85	-89	-97	83	-105	-112	92	96	-104	90	-111	-118

TABLE D.4.4

<u>UHF BAND TABOOS DTV->DTV (90,90/50,10&50,90/10,10)</u> Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-26	-46	71	-25	83	90	-46	-48	-73	45	85	92	71	-73	-81	70	-92	-99
0	75	153	249	86	307	386	153	136	231	165	289	368	249	231	246	261	296	359
1	-26	-46	71	-25	83	90	-46	-48	-73	45	85	92	71	-73	-81	70	-93	-100

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-25	45	70	-12	82	89	83	85	-93	82	-101	-106	90	92	-100	89	-108	-112
0	86	165	261	53	319	398	307	289	261	320	308	371	330	312	315	342	327	378
1	-25	45	70	-12	82	89	83	85	-92	82	-101	-108	90	92	-99	89	-106	-112

TABLE D.4.5

UPPER VHF BAND TABOOS DTV->DTV (90,90/50,10 & 50,90/10,10) Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-26	-46	71	-25	83	90	-46	-48	-72	-45	84	91	71	-73	-77	70	-88	-95
0	83	123	189	85	227	292	123	137	190	135	226	284	189	190	215	200	251	309
1	-26	-46	71	-25	83	90	-46	-48	-73	-45	85	92	71	-72	-77	70	-89	-96

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-25	-45	70	-12	82	89	83	85	-89	82	-93	-99	90	92	-96	89	-100	-105
0	82	134	200	52	239	303	227	226	251	239	263	321	252	249	274	264	286	328
1	-25	-45	70	-12	82	89	83	84	-88	82	-93	-100	90	91	-95	89	-99	-105

TABLE D.4.6

LOWER VHF BAND TABOOS DTV->DTV (90,90/50,10 & 50,90/10,10) Separation distances in km

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-27	-47	72	-26	84	91	-47	-50	-75	-46	-87	94	72	-75	-81	71	-92	-99
0	107	157	214	99	249	272	157	177	234	158	269	292	214	234	259	216	294	317
1	-27	-47	72	-26	84	91	-47	-50	-75	-46	-87	94	72	-75	-81	71	-93	-100

Int.	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
Prot.	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-26	-46	71	-13	83	90	84	-87	-93	83	-98	-104	91	94	-100	90	-105	-109
0	99	158	216	66	253	276	249	269	294	253	306	329	272	292	317	276	329	336
1	-26	-46	71	-13	83	90	84	-87	-92	83	-98	-105	91	94	-99	90	-104	-109

Appendix 1

Figure of Merit Derivation Method

$$E_{RX}(dBV/m) = \Phi(dBW/m^2) + 10\log(120\pi)\ (dB)$$
$$C/N(dB) = \Phi(dBW/m^2) - G_i(1m^2) + G_A/T_e - K - B_{rf}$$

$$E_{RX}(dB\mu V/m) = \Phi(dBW/m^2) + 145.8(dB)$$
$$= 145.8 + C/N + 10\log k + 10\log B + G_i(1m^2) - G_A + T_e$$

E_{RX}	required field strength at the receive system antenna
Φ	power flux density at the receive system antenna
C/N	carrier to noise ratio
k	Boltzmann's constant
B	system bandwidth
$G_i(1m^2)$	gain of 1 metre squared
G_A/T_e	G/T of the receive system
G_A	gain of the receive system (isotropic)
Te	effective noise temperature

Receive System Figure of Merit

$$G_A / T_e = (G - A_L) / (\alpha T_a + (1 - \alpha)T_0 + (n - 1)T_0)$$
$$(G - A_L) / (\alpha T_a + T_L + T_{rx})$$

Receiver Noise Temperature

$$T_{rx} = (10^{nf/10} - 1)*290^\circ K$$

Transmission Line Loss

$$A_L = -10\mathrm{Log}(\alpha)$$

α Numeric ratio of transmission line attenuation

Transmission Line Noise Temperature

$$T_L = (1 - 1/10^{A_L/10})*290^\circ K$$

Antenna Noise Temperature

$$T_a = 10^{(6.63-2.77(F))} * 290°K$$

reference ITU-R Report 258-5

Antenna Noise Temperature (referred to receive input)

$$\alpha T_a = T_a(10^{-A_L/10})$$

System Noise Temperature

$$T_e = \alpha T_a + T_L + T_{rx}$$

Gain of 1 metre squared

$$G_{1m^2} = 10\log(4\pi/\lambda^2)$$

Time Availability Factor

$$\Delta T(90) = ((F(50,10) - F(50,50))/1.282)*(-1.282)$$

This method is described in chapter 6 of the Television Engineering Handbook.

Location Availability Factor

$$\Delta L(90) = -7.1 \text{ dB}$$

This value is from Figure 12 of ITU-R Recommendation P370-7 for digital systems and applies over a range of frequencies which include the UHF TV band.

Appendix 2

SERVICE AVAILABILITY

Introduction

A characteristic of Digital TV systems which impacts on the planning factors is the sharp degradation between the point when picture impairment is first visible and the point when the picture is unusable. With this degradation factor in the order of 1 dB, a critical review of planning criteria in terms of service availability and quality of service may be necessary in light of the objective to duplicate existing NTSC coverage to the extent possible.

Service availability in location and time are factors which must be chosen to provide the required DTV service in an efficient and viable manner. The transmission and reception characteristics of a digital TV system differ from an analog system and it is believed that better location and time availability than that used for analog service planning will be required to provide an acceptable DTV service.

Discussion

The coverage requirement for DTV was identified as that matching the Grade B contour of existing NTSC services in the VHF/UHF TV bands. The Grade B service is defined as the signal level providing an acceptable picture at 50% of the locations for 90% of the time. This implies that reliable service be provided to all locations presently served and that the quality of service be maintained throughout the coverage area.

Quality objectives for DTV service with the sharp degradation nature of digital system have little or no range available. In comparison, based on figures from 1974 FCC tests, NTSC picture quality can change gradually from Fine to Passable (Acceptable) and from Passable to Poor (Outage) over ranges of 10 and 13 dB respectively. DTV with a differential in the order of only 1 dB between just noticeable impairment and unusable picture virtually eliminates any range of picture quality. The only choices may be excellent quality service or no service at all.

A question that needs to be resolved in the coverage planning of Digital TV is what Service Availability objectives should be at or near the edge of the protected coverage area (i.e. Grade B contour) that would correspond to an “equivalent” availability as provided by NTSC service. Whereas NTSC is planned on the basis of a specified performance for at least 50% of locations and 90% of the time, the gradual degradation characteristic of the analog service results in a considerably higher service availability statistic at or near the edge of the Grade B contour. If it is the goal to duplicate the coverage with an DTV station, then a higher propagation margin would need to be considered due to the abrupt nature of the threshold to service outage exhibited by Digital TV compared to NTSC.

The NTSC Grade B coverage is based on passable or acceptable picture quality service to fixed receivers with an external directional antenna at 10 metres above ground. Location and time availability are 50 and 90 percent respectively. The location variability of 50% was considered adequate because of the gradual degradation nature of NTSC picture quality and the assumption that the viewer had some degree of latitude to choose a good receiving location. The 90% time availability was achieved by including a factor to convert from the F(50,50) signal value. Using the F(50,50) and F(50,10) propagation curves for the UHF TV band and the standard Grade B contour distance of 70 km, the 90% time availability factor is 6.2 dB. Under these conditions with the gradual degradation to outage, the overall availability will be greater than that given by the (50,90) criteria. If a margin of 12 dB between passable and outage and the location availability curve Figure 12 of ITU-R Rec. P370-7 for analog systems is used, the NTSC service availability, i.e. service to outage, becomes 90% for location and 90% for time.

In DTV service with its sharp degradation characteristic, service will change from available to unavailable within 1 dB. Human nature being what it is, viewers may tolerate poorer quality for short periods (the NTSC case) but will not tolerate loss of service for the same periods. Thus to match NTSC service with a comparable DTV service, the abrupt failure characteristic of DTV may necessitate a minimum availability of (90, 90) for location and time.

Service Availability can affect the level of the transmitter power required to establish the desired availability at the required coverage distance. Using location availability values for digital systems given ITU-R Rec. P370-7, Table A shows the change in ERP required for digital TV systems for some different values of availability when a VHF channel is used as a replacement.

Table A

Transmitted ERP Increase

vs

Service Availability

(High VHF Channel Replacement)

Grade B Distance (km)		89	82	70	45	25	12
Service Availability (%)		Transmitted ERP Increase dB					
Location	Time						
50	50	0	0	0	0	0	0
50	90	6	5.2	4.4	2.2	0.9	0
70	50	2	2	2	2	2	2
70	90	8	7.2	6.4	4.2	2.9	2
90	50	6.1	6.1	6.1	6.1	6.1	6.1
90	90	12.1	11.3	10.5	8.3	7	6.1

Table B shows the change in ERP for some different values of availability when a UHF channel is used as a replacement.

Table B

Transmitted ERP Increase

vs

Service Availability

(UHF DTV Channel Replacement)

Grade B Distance (km)		89	82	70	45	25	12
Service Availability (%)		Transmitted ERP Increase dB					
Location	Time						
50	50	0	0	0	0	0	0
50	90	9.5	8.7	6.4	3.1	1	0
70	50	2.6	2.6	2.6	2.6	2.6	2.6
70	90	12.1	11.3	9	5.7	3.6	2.6
90	50	7.1	7.1	7.1	7.1	7.1	7.1
90	90	16.6	15.8	13.5	10.2	8.1	7.1

A parameter to note, particularly for its economic impact, is the transmitter power required to establish the ERP for a specified level of service availability. The transmitter power increases directly with the ERP of a service when the availability parameter is increased.

Conclusions

The service availability of the DTV service influences the transmitted ERP and the separation distances between DTV and NTSC services. As the service availability is increased in either Location or Time, the required transmitted ERP increases and the separation distances required for interference protection between DTV and NTSC services increase. The development of availability planning factors to optimize the provision and implementation of DTV service needs careful consideration.

Appendix 3

DTV Emission Mask Study
Communications Research Centre

1. Background

An emission mask is used to limit the spectral out-off-band spill-over to control the interference into the adjacent channels. An interfering first adjacent DTV signal will degrade the picture quality of the desired NTSC signal more than any other types of interference. Therefore, interference from the first adjacent DTV into NTSC is the limiting factor in the design of the DTV emission mask. This is because the NTSC threshold of visibility (TOV) is around C/N = 50 dB, while the DTV TOV is about C/N = 16 dB. This document analyzes the first adjacent channel DTV to NTSC interference, assuming exact co-location as well as 5-mile (8 km) antenna separation. A NTSC spectrum weighting function is used in the interference calculation. Two emission masks are proposed: a "loose-mask" for exact co-location and a "tight-mask" for 5-mile separation

2. Exact co-location case and loose-mask

A typical transmitter high power amplifier (HPA) output spectrum (unfiltered) is shown in Figure 1 [1] (RES BW 500 kHz). The output back off (OPBO) of the amplifier is about 6-7 dB and there is no attempt to linearize the amplifier. At the band edge, the spectrum is about 35 dB down relative to the flat portion of the DTV spectrum. Generally, the band edge spectrum never exceed a 39 dB drop relative to the in-band spectrum, except when a large value of OPBO is used [1]. An NTSC signal RF subjective weighting curve, Figure 2 [1], is used in the interference calculation. Figure 2 shows that the NTSC visual signal between 1.5 and 2.5 MHZ is the part most sensitive to the interference

.

In Figure 1, it is assumed that the NTSC peak sync. power is 0 dB and the DTV signal average power is -12 dB (D/N = -12 dB). Since a measurement bandwidth of 500 kHz is used, the DTV spectrum in-band flat portion should be $10\log_{10}(0.5/6)$ @ -11 dB below the DTV power level, or -12 - 11 = -23 dB below the NTSC peak sync level. The DTV band edge spectrum is -23 - 35 = -58 dB. This value is used in the spectrum mask calculation, see Equation 1.

It is assumed that the NTSC signal TOV is 50 dB (for random noise uniformly distributed across the 6 MHZ channel). This value, when expressed as a noise density in twelve 500 kHz bands, is $-50 + 10\log_{10}(0.5/6)$ @ -61 dB. In Figure 1, when placing the NTSC RF weighting curve's top portion at the -61 dB level in the upper adjacent channel, it coincidentally crosses the spectrum plot. This means the unfiltered spectrum plot, shown in Figure 1, meets the lower adjacent channel DTV to NTSC interference requirement with 0 dB implementation margin. This result is confirmed in the laboratory test [3], where the measured lower adjacent channel DTV to NTSC interference margin is less than 1 dB.

It should be pointed out that the TOV for NTSC is very "soft". Even if the DTV to NTSC interference temporally exceeds the threshold, the viewer can only see "just noticeable" disturbance on the NTSC receiver. This is because a NTSC TOV of C/N = 50 dB is assumed. It is equivalent to CCIR Grade 4.5. Most of the existing analog TV transmission systems (Cable, terrestrial and analog satellite DTH) can not provide this service quality.

From Figure 1, the calculated upper adjacent channel DTV (unfiltered) to NTSC interference has a margin of -68 - (-61) = 7 dB. It is much relaxed than that of the lower adjacent channel case.

Also marked in Figure 1, at a power level of -44 dB, is the NTSC Threshold of Audibility (TOA) for the upper and lower adjacent channel, where a TOA with S/N = 68 dB is assumed. From Figure 1, the N-1 TOA margin is 14 dB and the N+1 margin is 34 dB. In both cases, no additional spectrum attenuation is required.

Although the above calculation demonstrated that, for the exact co-location case, unfiltered spectrum (see Figure 1) meets the adjacent channel DTV to NTSC interference requirement, there should be a limit for the spurious emission in the second adjacent channel. ITU-R SG-1 recommends an attenuation of 60 dB for spurious emission limit for broadcast television service. Since the DTV spectrum band edge has an attenuation of 35 dB, an additional 25 dB attenuation should be achieved at the edge of the first adjacent channel. Based on this assumption an emission mask is defined (This is the same emission mask adopted by the FCC Sixth Report and Order [2]).

For a DTV spectrum mask, the out-of-band emission measured in a 500 kHz resolution bandwidth centered Df MHZ from the edge of the assigned channel shall be attenuated below the average DTV transmitted power according to the following schedule:

For 0.25 MHZ Δf 6 MHZ:

$$\textbf{Attenuation in dB} = 58 + (D/N) + [(\Delta f)^2 / 1.44] \qquad (1)$$

The effects of the 500kHz measurement bandwidth and the "smearing" effect of the measurement bandwidth at the channel edge are considered. In Equation 1, Δf is the deviation in MHZ of the center of the 500 kHz measurement bandwidth from the edge of the assigned 6 MHZ DTV channel, and

(D/N) dB = 10 $\log_{10}$ (Average power of the DTV signal / Peak sync power of the adjacent channel NTSC signal)

The emission mask, Equation 1, is plotted in Figure 1.

For Δf 6 MHZ:

Attenuation in dB = 83 + (D/N) (2)

3. Tight-masks for 5-mile separation

Table 1 shows the differences, in dB, between the F(50,10) and F(50,90) curves at the end of the Grade B coverage for different class of stations and frequency bands. ITU-R P370 model was used. The assumed transmitter antenna separations are 5-mile and 10-mile, respectively. It should be pointed out that the differences listed in Table 1 could be an over-kill when used for adjacent channels, since the adjacent channels signal strengths might have high correlation.

From Table 1, for 5-mile separation, an UHF Class C station require a protection ratio of 12.67 dB and an UHF Low Power (LP) station requires 27.39 dB. The LP case might not be relevant, since its coverage radius is only 12 km and it is, therefore, unlikely to require 5-mile (8 km) separation.

From the field strength differences listed in Table 1, the attenuation factor α (dB/MHZ), can be calculated. From Figure 1, the DTV band edge spectrum is -58 dB, while the NTSC weighting curve flat top is centered at 2 MHZ from the edge, where the DTV unfiltered spectrum level is -61 dB. Thus, the α factor can be calculated as:

[Field Strength Difference + (-58+61)] × 0.5 (dB/MHZ) .

The calculated α factors are listed in Table 2.

VHF Class of Station	Low VHF	High VHF
Grade B Distance (km)	89	82
5-mile Separation (dB)	10.78	9.92
10-mile Separation (dB)	12.32	12.66

UHF Class of Station	C	B	A	LP
Grade B Distance (km)	70	45	25	12
5-mile Separation (dB)	12.67	10.61	12.55	27.39
10-mile Separation (dB)	16.66	16.27	26.47	-

Table: 1: Field strength differences between F(50,90) and F(50,10) curve with 5-mile and 10-mile transmitter separation.

VHF Attenuation factor α	Low VHF		High VHF	
5-mile Separation (dB)	6.89		7.46	
10-mile Separation (dB)	7.66		7.83	
UHF Attenuation factor α	Class C	Class B	Class A	LP
5-mile Separation (dB)	7.84	6.81	7.78	-
10-mile Separation (dB)	9.83	9.64	14.74	-

Table 2: Required attenuation factor α.

VHF Attenuation factor α	Low VHF		High VHF	
5-mile Separation (dB)	7.5			
10-mile Separation (dB)	7.8			
UHF Attenuation factor α	Class C	Class B	Class A	LP
5-mile Separation (dB)	7.5			
10-mile Separation (dB)	9.8			

Table 3: Suggested attenuation factor α.

For 5-mile separation, the low and high VHF α factors are 6.89 dB and 7.46 dB. An α factor of 7.5 is recommend. For UHF Class A, B and C, α = 7.8 dB meets the requirement. Considering the UHF adjacent channels are likely to have high correlation, the α factor is trimmed to 7.5 dB to be the same as the VHF case.

For 10-mile separation case, α = 7.8 dB can be used for VHF and α = 9.8 dB for UHF. Again UHF Class A is unlikely to have 10-mile (16km) separation, since its coverage radius is only 25km.

From Table 3, α = 7.5 dB meets all the requirements for up to 5-mile separation. It is also quite close to 10-mile separation case for VHF.

A "tight" emission mask is developed using α = 7.5 dB, see Figure 3 (RES BW 500kHz). From Figure 2, the 0.5 MHZ at both ends of the spectrum is the least sensitive part to the interference. The roll-off can, therefore, be slow in that range. The critical point is at 2 MHZ from the band edge, where a 15 dB attenuation must be achieved. After 3 MHZ from the band edge, the mask can level off at a slower roll-off rate to reach -88 dB, or -65 dB from the in-band flat portion, at the 6 MHZ point.

A filtered DTV spectrum is also presented in Figure 3, using the filter presented in Figure 4. The filter was built by Micro-Communications Inc, and was used for the field trial in Charlotte U.S.A. The filter has about 17 dB attenuation at 2 MHZ from the band edge, which is 2 dB better than the 15 dB requirement. The filtered spectrum is about 1-2 dB below the mask.

This "tight-mask" can also be used for co-located mixed class of stations. Since the "tight-mask" requires an additional 12 dB attenuation on the upper adjacent channel NTSC visual carrier location, the DTV power level can be increased by 12 dB, or the NTSC power can be reduced by 12 dB. This will allow DTV and NTSC transmitting at the same power level, D/N = 0 dB. For the lower adjacent channel interference into NTSC, based on the calculation in Section 2, the limiting factor is the interference into the audio carrier. Since the mask can not provide much filtering on the audio carrier location, the margin remains close to the 14 dB. This means that the lower adjacent channel NTSC station can reduce power by up to 14 dB, or that the DTV power can increase by 14 dB. In order to prevent DTV pilot interference into NTSC, exact carrier frequency offset might have to be used, where the DTV pilot should be offset 5.082139 MHZ above the NTSC visual carrier.

4. Adjacent DTV-DTV interference

From Figure 1, the unfiltered DTV spectrum out-of-band (unweighted) power level is at -51 dB [1]. Assuming that the adjacent and co-channel DTV station transmit the same power level, the desired DTV average power level is at -12 dB. In this case, the desired DTV power to undesired adjacent DTV spill-over power ratio is -12 - (-51) = 39 dB! It is much lower than the 15.2 dB C/N threshold measured by the ATTC laboratory test [2]. As an engineering approach, if the noise/interference level is 10 dB below the noise threshold level, the impact to the system performance will be very limited. This calls for a adjacent DTV spill-over tolerance level of 25 dB, which results in a 39-25 = 14 dB margin. This margin is higher than the 12.67 dB protection ratio required for 5-mile transmitter separation, see Table 1. The above analysis is based on the unfiltered DTV spectrum, The filtered DTV spectrum should have no problem to meet adjacent DTV-DTV interference requirement for 5-mile separation. For the exact co-location case, a DTV/DTV adjacent channel power level difference of up to 14 dB is allowed.

It should be pointed out that the DTV threshold is very "sharp". A few tenth of dB below the threshold will result in picture freeze and lost of sound. Every effort should be made to maintain the DTV interference level below the threshold.

5. Conclusions

Two emission masks have been proposed, see Figure 5. A "loose-mask" is used for DTV/NTSC exact co-location case. The other, "tight-mask", is designed for up to 5-mile separation between the transmitters. The tight-mask might also be used for exact co-location mixed class implementation. No polarization discrimination is assumed in the development of the masks and the DTV signal average power is 12 dB below the NTSC peak sync power.

References

[1] Carl G. Eilers, "The development of a high definition television (HDTV) terrestrial broadcasting emission mask," IEEE Transactions on Broadcasting, vol. 41, no. 4, Dec. 1995.

[2] FCC, "Sixth Report and Order," MM Docket No. 87-268, adopted April 3, 1997, FCC 97-115 (released April 10, 1997), pp. 90.

[3] Stanley J. Salamon, "Adjacent channel interference revisited," ATTC Report, 1996

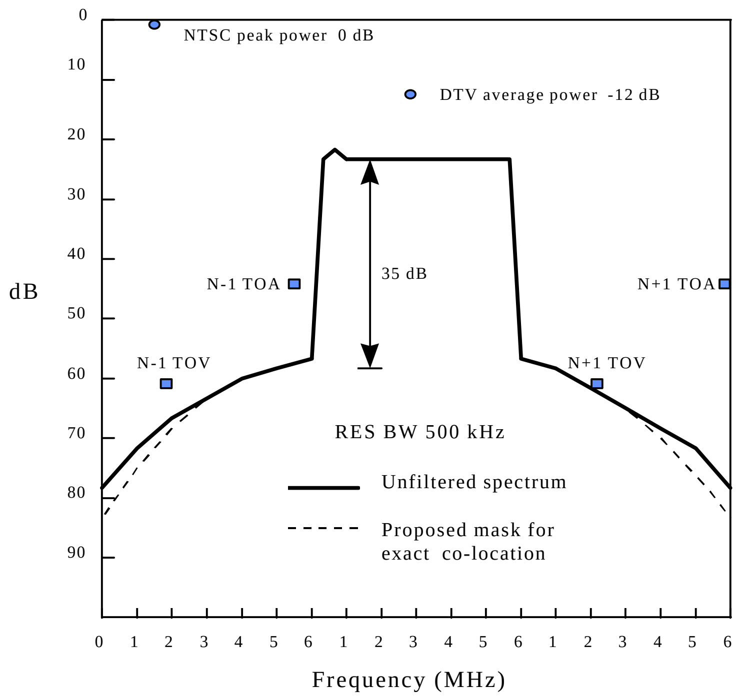

Figure 1: Unfiltered DTV spectrum and proposed "loose-mask" for exact co-location

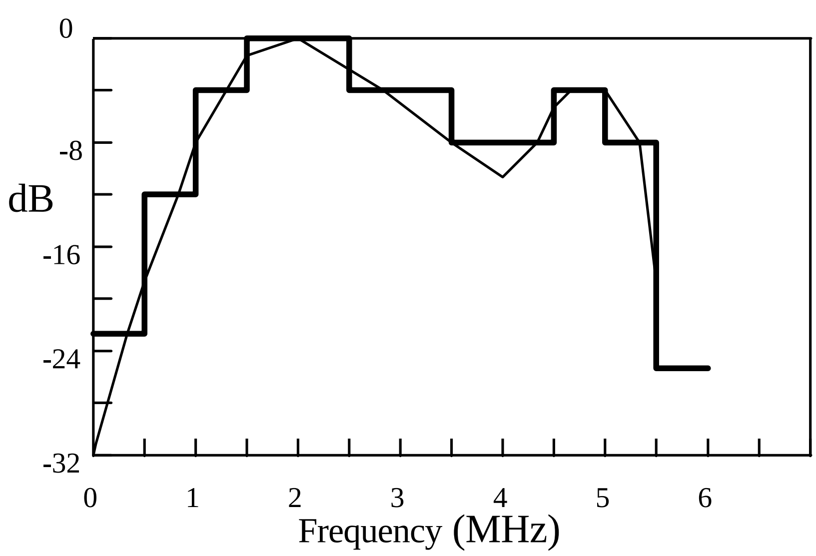

Figure 2: NTSC signal RF subjective weighting curve

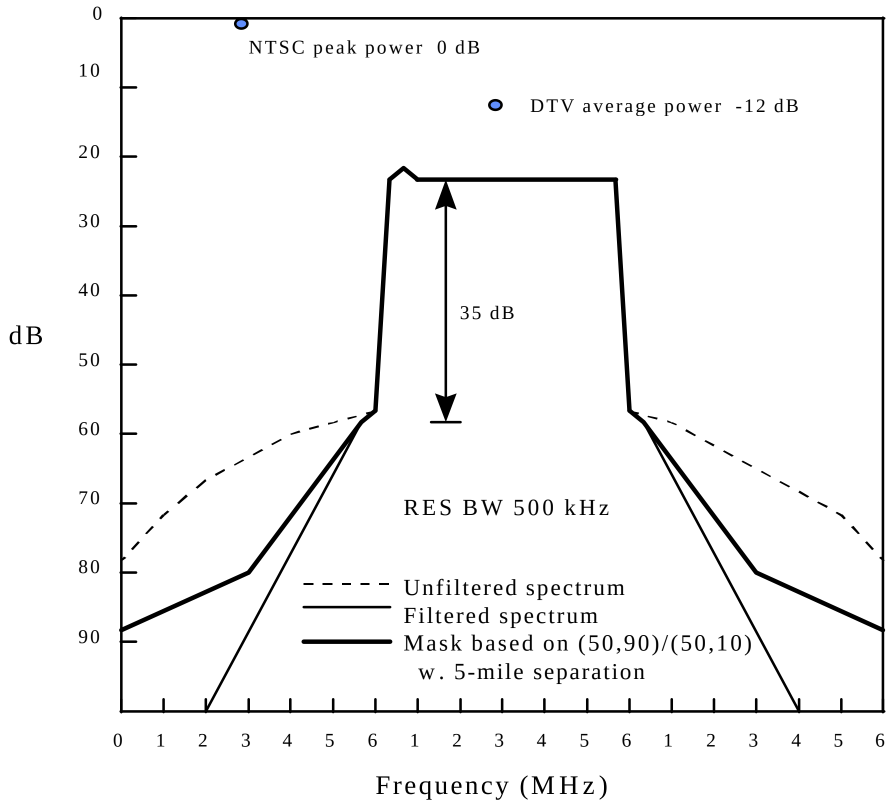

Figure 3: Proposed "tight-mask" for 5-mile separation and filtered spectrum

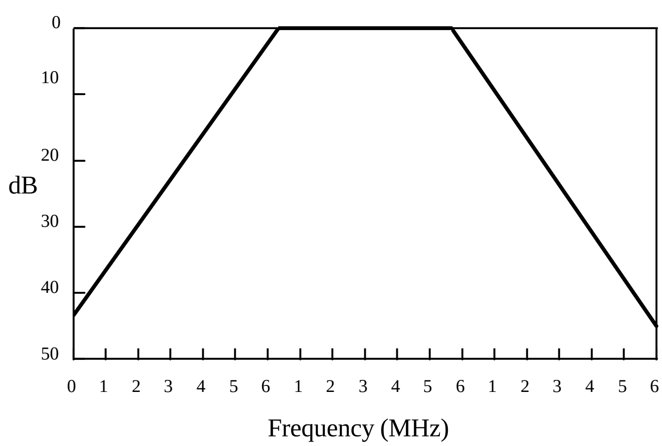

Figure 4: Charlotte field test transmitter filter response

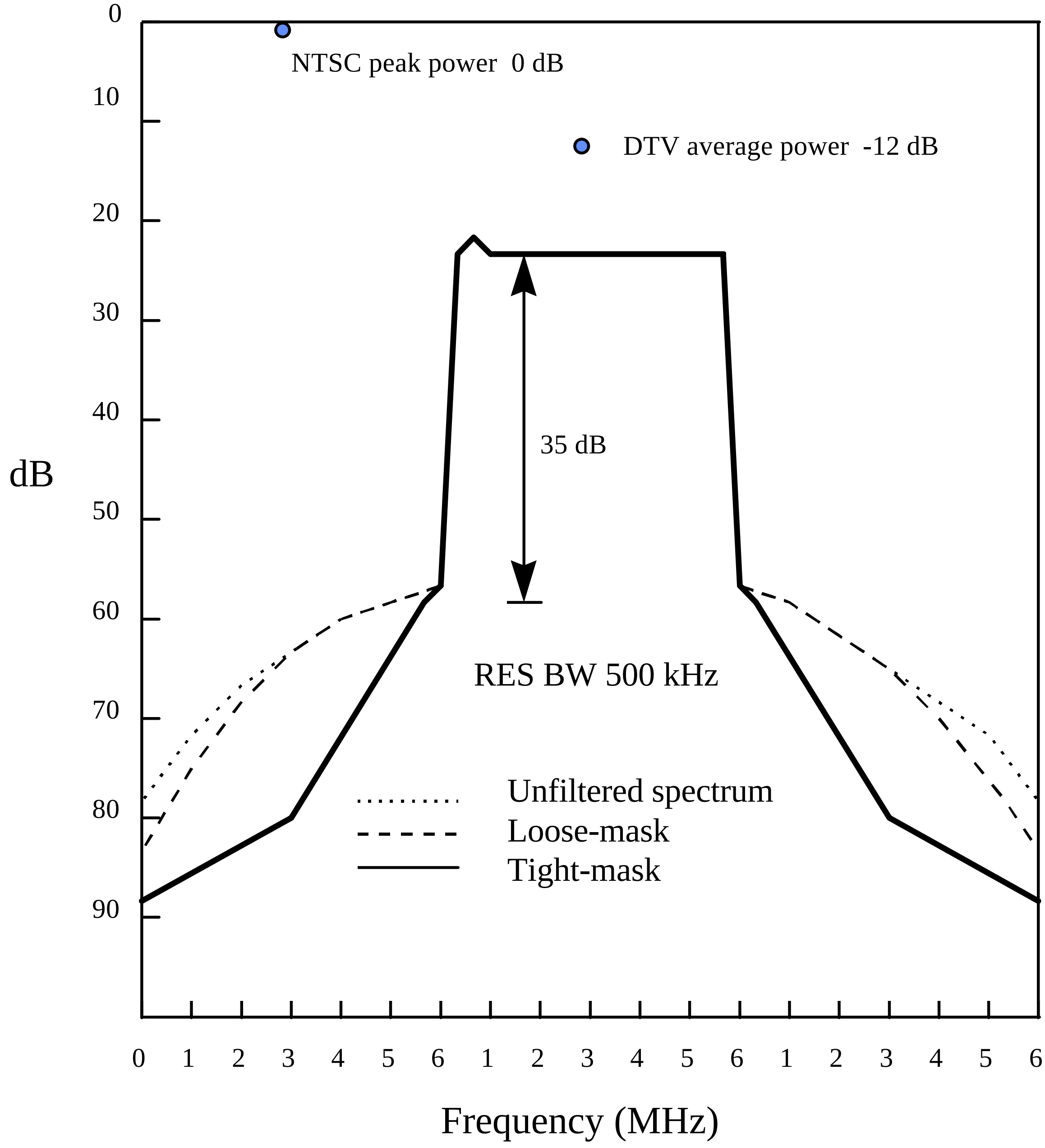

Figure 5: Proposed emission masks

Impact of Mixing Transmitter Classes on Flexibility Distance for First Adjacent Channel DTV-DTV and DTV-NTSC Interference

Communications Research Centre

July 9, 1997

Premises and Methodology

This study on adjacent channels is investigating the possibilities of mixing DTV/DTV and DTV/NTSC transmitter classes and the effect it would have on the permissible distance (flex) between the co-located transmitters.

Computer simulations were conducted based on the propagation model CCIR 370, in the Low VHF, High VHF and UHF frequency band. For all stations, the maximum ERP and antenna height in each class and frequency band were used. In the case of DTV, six classes in each frequency band (L-VHF, H-VHF, UHF) were used, see Tables 1 to 3. In the case of NTSC, six classes were used: L-VHF, H-VHF, UHF-C, UHF-B, UHF-A, and LP, see Table 4 to 6. The median frequency of each band was selected for the simulation. The desired signal propagation curves used was F(50,90) and the undesired signal propagation curve was (50,10).

DTV into DTV:

In the document "DTV Emission Mask Revisit", if relaxed emission masks are used, there is a 14 dB margin for adjacent channel DTV-DTV interference. This 14 dB margin can be used for possible mixed classes operation. The simulation results are listed in Tables 1 to 3.

DTV into NTSC:

For adjacent channel DTV interference into NTSC, the relaxed DTV emission mask provides no margin for mixed classes operation. However, if the tight emission mask is used, there would be 12 dB additional attenuation on the adjacent channel NTSC signal visual carrier. This 12 dB margin can be allocated for possible mixed classes operation. The simulation results are presented in Tables 4 to 6.

NTSC into DTV:

For a given class of transmitter, the ERP of DTV station is typically 12 dB lower than the adjacent NTSC station. When a lower class DTV station is mixed with a higher class NTSC station, it is very likely to result in a saturation of DTV reception, especially when a LNA is used, because the desired DTV signal, in this case, is much lower than the undesired adjacent NTSC signal. The inter-modulation products, due to front-end over-load, may be the limiting factor. The performance will depend on the dynamic range of receiver front-end or LNA.

Results of simulations

Table 1: L-VHF : DTV to DTV Separation Distance Between Different Classes (assuming relaxed emission masks are used).

	L-VHF	L-VHF-HV	L-VHF-C	L-VHF-B	L-VHF-A	LP
L-VHF	18km	11 km	0	X	X	X
L-VHF-HV		19 km	7 km	X	X	X
L-VHF-C			20 km	X	X	X
L-VHF-B				18 km	X	X
L-VHF-A					11 km	X
LP						12 km

Table 2: H-VHF : DTV to DTV Separation Distance Between Different Classes (assuming relaxed emission masks are used).

	H-VHF-LV	H-VHF	H-VHF-C	H-VHF-B	H-VHF-A	LP
H-VHF-LV	18 km	11 km	0 km	X	X	X
H-VHF		19 km	7 km	X	X	X
H-VHF-C			20 km	X	X	X
H-VHF-B				18 km	X	X
H-VHF-A					11 km	X
LP						12 km

Table 3: UHF: DTV to DTV Separation Distance Between Different Classes (assuming relaxed emission masks are used).

	UHF-LV	UHF-HV	UHF-C	UHF-B	UHF-A	LP
UHF-LV	6 km	0 km	X	X	X	X
UHF-HV		7 km	X	X	X	X
UHF-C			10 km	X	X	X
UHF-B				13 km	X	X
UHF-A					9 km	X
LP						4 km

Table 4: L-VHF : DTV to NTSC (assuming tight emission mask is used).

	NTSC L-VHF (dB)	Flex Distance (km)
L-VHF	8.69	11
L-VHF-HV	5.46	14
L-VHF-C	0.07	34
L-VHF-B	-10.77	69
L-VHF-A	-22.99	74
LP	-34.19	> 89

Table 5: H-VHF : DTV to NTSC (assuming tight emission mask is used).

	NTSC H-VHF (dB)	Flex Distance (km)
H-VHF-LV	10.52	1
H-VHF	7.65	10
H-VHF-C	-0.15	26
H-VHF-B	-9.19	50
H-VHF-A	-20.99	66
LP	-33.45	> 82

Table 6 UHF: DTV to NTSC Separation Distance Between Different Classes (assuming tight emission masks are used).

	NTSC UHF-C (km)	NTSC UHF-B (km)	NTSC UHF-A (km)	NTSC LP (km)
UHF-LV	X	X	X	X
UHF-HV	X	X	X	X
UHF-C	8	X	X	X
UHF-B		12	X	X
UHF-A			8	X
LP				3

Recommendation

Avoid mixing transmitters classes, as much as possible. When absolutely necessary respect the flex distance given in Tables 1 to 6. Practically, adjacent stations, whether DTV-DTV or NTSC-DTV, should be in comparable classes. When mixing classes, ensure that it is a valid combination and that the sites chosen respect the flex distance, Tables 1-6.

Annex:

DTV-DTV Interference

Presented in the Annex are the difference in field strength between the desired signal and the interfering signal at the equivalent grade B contour.

Table A1: L-VHF :DTV- DTV 0 mile separation (in dB)

(assuming relaxed emission masks are used).

	L-VHF	L-VHF HV	L-VHF-C	L-VHF-B	L-VHF-A	LP
L-VHF	8.63	10.50	14.21	24.79	37.46	51.90
L-VHF-HV	5.60	7.48	11.18	21.76	34.43	48.82
L-VHF-C	-0.08	1.79	5.50	16.08	28.75	43.19
L-VHF-B	-10.55	-9.03	-5.22	3.84	15.47	30.63
L-VHF-A	-22.07	-20.73	-17.66	-8.88	2.20	17.05
LP	-35.21	-34.04	-31.75	-24.23	-13.43	0.44

Table A2: H-VHF : DTV- DTV 0 mile separation (in dB)

(assuming relaxed emission masks are used).

	H-VHF LV	H-VHF	H-VHF-C	H-VHF-B	H-VHF-A	LP
H-VHF-LV	8.60	10.50	14.22	24.79	37.47	51.91
H-VHF	5.61	7.48	11.19	21.76	24.44	48.88
H-VHF-C	-0.08	1.79	5.50	16.07	28.75	43.19
H-VHF-B	-10.58	-9.05	-5.45	3.86	15.48	30.64
H-VHF-A	-22.16	-20.73	-17.66	-8.85	2.20	17.05
LP	-35.21	-34.04	-31.75	-24.22	-13.43	0.44

Table A3: UHF : DTV- DTV 0 mile separation (in dB)

(assuming relaxed emission masks are used).

	UHF-LV	UHF-HV	UHF-C	UHF-B	UHF-A	LP
UHF-LV	11.98	14.35	19.00	31.29	45.72	61.36
UHF-HV	8.78	11.14	15.80	28.09	42.52	58.15
UHF-C	2.14	4.50	9.16	21.45	35.88	51.51
UHF-B	-10.82	-8.77	-4.81	6.03	19.66	36.05
UHF-A	-24.94	-23.12	-19.54	-9.34	3.89	20.09
LP	-35.35	-32.94	-31.23	-23.23	-11.45	4.58

Table A4: UHF: DTV to NTSC Interference Between Different Classes

(assuming tight emission masks are used).

	NTSC UHF-C (dB)	NTSC UHF-B (dB)	NTSC UHF-A (dB)	NTSC LP (dB)
UHF-LV	18.91	31.20	45.63	61.27
UHF-HV	15.84	28.13	42.56	58.20
UHF-C	9.19	21.48	35.91	51.55
UHF-B	-5.16	5.79	19.41	35.81
UHF-A	-19.73	-9.53	3.70	19.90
LP	-30.35	-22.35	-10.58	5.46

Appendix 4

Effects of the Short Spacings of the Required Separations for Digital Television on the Total Coverage

1.0 Calculation of the required separation distances

The required distances were calculated using the protection ratios and the class parameters as described in the document AHG_DTV003_ Digital Television: Service Considerations and Allotment Principles. Knowing the field strength value of the wanted signal at the protected contour and the required protection ratio, the maximum interfering field at that location can be easily determined. The maximum interfering field value is given by the value of the wanted signal at the protected contour minus the protection ratio plus the antenna discrimination minus the location variability factor to convert from F(50,10) to F(10,10) values when applicable. The antenna discrimination for the band is defined in the ITU-R recommendation BT.419-3.

The F(50,10) curves were used to calculate the distance from the interfering station to the interfering contour. For the cases where the service was calculated with the F(90,90) values, a location variability factor was subtracted from the maximum interfering field strength to compensate for the change in the percentage of locations, in order to obtain an equivalent F(10,10) value. The factor used was obtained from the figures 5 and 12 of the ITU-R recommendation P.370-7. Once the distance to the interfering contour was calculated, it was added to the Grade B distance of the protected contour to obtain the total required distance separation between the protected and interfering stations.

When the distance of the interfering station to the protected contour was less than 1.5 km, no value could be returned from the F(50,10) curve. In that case, 10 dB was added to the interfering station power and a new distance was computed. If that new distance was greater or equal to 1.5 km, it was assumed that a distance of 1 km was required between the interfering station and the protected contour. But if the new distance was still less than 1.5 km, then an additional 10 dB was added to the interfering station power (for a total increase of 20 dB) and another new distance was computed. If this final distance was greater or equal to 1.5 km, it was assumed that the interfering station had to be located on the protected contour in order to avoid interference. But if the final distance was still lower than 1.5 km, then it was assumed that the interfering station would never cause interference to the protected station and there was no required distance separation in that case. Of course, these cases happened only when calculating required distances for adjacent channels. The symmetrical required separation distance was computed the same way and the larger distance was retained as the final required separation.

2.0 <u>Calculation of the service contours</u>

Once the required distance was computed, it was short spaced according to the percentage chosen. If the resulting distance was still greater than the radius of the Grade B contour of the protected station, the service contours were computed by finding, for different azimuths around the protected station, the point where the protection ratio was reached. These points were found at every 5 degrees around the protected station and gave the shape of the final service contour. The total area of the final service contour was calculated using the MapInfo software.

If the resulting short spaced distance was less than the Grade B distance of the protected station, i.e. the short spacing moved the interfering station inside the Grade B contour of the wanted station, the service contours were computed differently. First it was found, for different azimuths around the interfering station, the point at which the protected ratio was sufficient, within the Grade B contour of the protected station. The points found gave the shape of the hole that the interfering station caused in the protected contour. To obtain the area of the total service contour, the area of the hole was subtracted from the protected contour area.

The calculation of the protection ratios used basically the same factors as the ones involved in the calculation of the required separation distances. The only difference was in the use of the antenna discrimination. At each potential reception point, the angle between the signal coming from the desired station and the signal coming from the interfering station was computed and it was possible to obtain a more accurate value of the antenna discrimination by interpolating the value from the figure 1 of the ITU-R recommendation BT.419-3.

3.0 <u>The results</u>

The results for low VHF band, high VHF band and UHF band for co-channel short spacings are given in the Tables 1 to 3 respectively for F(50,90) values and in the Tables 4 to 6 for F(90,90) values. The equivalent results for the first adjacent channel short spacings are presented in the Tables 7 to 12.

As expected, the short spacing of the adjacent channel required separation distances has a much smaller effect than the short spacing of the co-channel separation distances. Also, one can note that, in the case of the co-channel short spacings, the percentage of coverage loss is much higher in the cases of small size ('LP' and 'A') protected stations. But the effect of the short spacing of those small size stations on large ones ('C', 'VU' and 'VL') is almost negligible. Two examples showing the shapes of the reduced service contours are shown in the Figures 1 and 2. In the Figure 1, the service contour of a class 'A' station is shown when reduced by 30% short-spacing on co-channel in the UHF band. The 6 reduced contours correspond to stations of the different classes: 'A', 'B', 'C', 'LP', 'VU' and 'VL'. In the Figure 2, a similar graphic is given for a class 'VU' station in the upper VHF band. In this case there is no reduction in the coverage due to a class 'LP' station.

In the case of the first adjacent channel required distances, a short spacing of up to 30% never results in a decrease of more than 5% of the service coverage. There is only one exception to that rule, the LP station in the UHF band, and it is shown in the Figure 3.   In that case, the required separation distance allows the LP station to be within the Grade B contour of the bigger class stations and the short spacing of the required distance has a noticeable effect on the 'LP' service contour.

An unexpected result of this short spacing study is the reduction of coverage when there is no short spacing at all. This reduction appears on small power stations in the co-channel study and is due to the fact that, when the protected and the interfering stations are aligned, there is no antenna discrimination in the far side of the coverage and the Grade B diameter of the small station is insufficient to provide a reduction in the maximum interfering field strength, corresponding to the lack of antenna discrimination. This is worse in the UHF band where the antenna discrimination is the greatest, i.e. 16 dB; so on the opposite side of the protected contour, the maximum permissible field strength is 16 dB lower than the maximum permissible field strength on the side of the protected contour which is closer to the interference station. The Figure 4 shows an example of this coverage reduction for a LP class in the UHF band with F(90,90) values.

4.0 Recalculating the separation distances

The coverage reduction observed in some small class stations with no short spacing led to the recalculation of some of the required distances. To do so, the first step is to determine on the protected contour, the closest point to the interfering station where there is no antenna discrimination. Then knowing the maximum permissible interference field strength without antenna discrimination, it is easy to obtain the required distance between that point and the interfering station. And using some simple geometry concepts, the required distance between the two stations can be computed. The resulting changes in the co-channel required separation distances are shown in the Tables 13a, b, c, d, e and f for the Digital Television (DTV->DTV). The separation values between NTSC and Digital Television were also reviewed and the required changes are shown in the Tables 14a, b and c (DTV->NTSC) and the Tables 15a, b and c (NTSC->DTV).

Table 1. Percentage of coverage loss due to co-channel short spacing in the lower VHF band F(50,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-3.8	-9.8	-22.2
A	B	1961	-6.6	-25.4	-48.0
A	C	1961	-14.4	-40.2	-60.8
A	LP	1961	0.0	0.0	-0.9
A	VU	1961	-19.1	-46.8	-65.9
A	VL	1961	-22.1	-50.6	-69.5
B	A	6354	0.0	-0.6	-4.3
B	B	6354	-3.4	-9.4	-18.0
B	C	6354	-4.7	-13.3	-35.3
B	LP	6354	0.0	0.0	0.0
B	VU	6354	-5.8	-17.9	-45.8
B	VL	6354	-6.4	-22.3	-51.8
C	A	15374	0.0	0.0	-0.3
C	B	15374	0.0	-1.2	-5.3
C	C	15374	-2.8	-8.1	-15.2
C	LP	15374	0.0	0.0	0.0
C	VU	15374	-3.5	-9.7	-18.4
C	VL	15374	-3.8	-10.9	-22.1
LP	A	452	-11.1	-28.8	-46.9
LP	B	452	-20.8	-42.9	-61.1
LP	C	452	-27.9	-51.1	-68.1
LP	LP	452	-2.9	-10.6	-24.6
LP	VU	452	-32.5	-55.3	-71.2
LP	VL	452	-34.5	-58.8	-74.1
VU	A	21097	0.0	0.0	0.0
VU	B	21097	0.0	0.0	-2.1
VU	C	21097	-0.2	-3.4	-8.9
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-2.9	-8.2	-15.2
VU	VL	21097	-3.2	-9.2	-17.1
VL	A	24853	0.0	0.0	0.0
VL	B	24853	0.0	0.0	-0.8
VL	C	24853	0.0	-1.5	-6.0
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-1.0	-5.1	-11.2
VL	VL	24853	-2.8	-8.3	-15.4

Table 2. Percentage of coverage loss due to co-channel short spacing in the upper VHF band F(50,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-3.1	-7.6	-21.5
A	B	1961	-7.3	-23.2	-42.6
A	C	1961	-19.5	-38.6	-61.1
A	LP	1961	0.0	-0.4	-3.1
A	VU	1961	-23.3	-43.6	-63.5
A	VL	1961	-25.3	-47.1	-65.6
B	A	6354	0.0	-1.5	-4.8
B	B	6354	-3.1	-8.2	-14.6
B	C	6354	-4.2	-14.6	-33.3
B	LP	6354	0.0	0.0	-0.6
B	VU	6354	-4.7	-21.7	-42.1
B	VL	6354	-6.5	-25.0	-47.2
C	A	15374	0.0	0.0	-1.3
C	B	15374	0.0	-1.8	-5.5
C	C	15374	-2.4	-6.9	-12.9
C	LP	15374	0.0	0.0	0.0
C	VU	15374	-2.5	-7.3	-14.1
C	VL	15374	-2.8	-8.0	-16.7
LP	A	452	-17.0	-28.8	-43.1
LP	B	452	-22.8	-43.1	-61.9
LP	C	452	-29.6	-53.5	-71.5
LP	LP	452	-6.4	-14.4	-24.1
LP	VU	452	-31.9	-53.8	-71.0
LP	VL	452	-34.1	-55.5	-71.2
VU	A	21097	0.0	0.0	-0.1
VU	B	21097	0.0	-0.1	-2.5
VU	C	21097	-0.2	-3.0	-7.6
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-2.1	-6.2	-11.9
VU	VL	21097	-2.4	-6.7	-12.8
VL	A	24853	0.0	0.0	0.0
VL	B	24853	0.0	0.0	-1.0
VL	C	24853	0.0	-1.1	-4.9
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-0.5	-3.5	-8.4
VL	VL	24853	-2.2	-6.2	-11.7

Table 3. Percentage of coverage loss due to co-channel short spacing in the UHF band F(50,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-0.0	-0.0	-0.1
A	B	1961	-0.1	-0.2	-0.4
A	C	1961	-0.2	-0.4	-0.5
A	LP	1961	0	-0.0	-0.0
A	VU	1961	-0.2	-0.5	-0.6
A	VL	1961	-0.3	-0.5	-0.7
B	A	6354	0	-0.0	-0.0
B	B	6354	-0.0	-0.0	-0.1
B	C	6354	-0.0	-0.1	-0.3
B	LP	6354	0	0	-0.0
B	VU	6354	-0.1	-0.2	-0.4
B	VL	6354	-0.1	-0.2	-0.4
C	A	15374	0	0	0
C	B	15374	0	0	-0.0
C	C	15374	-0.0	-0.0	-0.1
C	LP	15374	0	0	0
C	VU	15374	-0.0	-0.0	-0.2
C	VL	15374	-0.0	-0.1	-0.2
LP	A	452	-0.1	-0.2	-0.4
LP	B	452	-0.2	-0.4	-0.6
LP	C	452	-0.3	-0.5	-0.6
LP	LP	452	-0.0	-0.1	-0.2
LP	VU	452	-0.3	-0.5	-0.7
LP	VL	452	-0.3	-0.6	-0.7
VU	A	21097	0	0	0
VU	B	21097	0	0	0
VU	C	21097	0	-0.0	-0.0
VU	LP	21097	0	0	0
VU	VU	21097	-0.0	-0.0	-0.1
VU	VL	21097	-0.0	-0.0	-0.1
VL	A	24853	0	0	0
VL	B	24853	0	0	0
VL	C	24853	0	0	-0.0
VL	LP	24853	0	0	0
VL	VU	24853	-0.0	-0.0	-0.1
VL	VL	24853	-0.0	-0.0	-0.1

Table 4. Percentage of coverage loss due to co-channel short spacing in the lower VHF band F(90,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-6.8	-26.3	-47.2
A	B	1961	-14.3	-40.2	-59.5
A	C	1961	-22.7	-51.9	-71.0
A	LP	1961	0.0	-0.9	-7.8
A	VU	1961	-27.4	-57.5	-75.6
A	VL	1961	-30.2	-60.7	-78.3
B	A	6354	0.0	0.0	-4.2
B	B	6354	-4.8	-13.7	-37.1
B	C	6354	-6.9	-25.3	-54.9
B	LP	6354	0.0	0.0	0.0
B	VU	6354	-8.2	-34.2	-62.6
B	VL	6354	-9.2	-39.4	-66.8
C	A	15374	0.0	0.0	-0.1
C	B	15374	0.0	-2.3	-8.1
C	C	15374	-4.1	-11.6	-24.5
C	LP	15374	0.0	0.0	0.0
C	VU	15374	-4.9	-13.8	-31.9
C	VL	15374	-5.4	-15.3	-38.2
LP	A	452	-21.5	-41.8	-59.1
LP	B	452	-28.8	-50.2	-66.2
LP	C	452	-36.1	-60.4	-75.9
LP	LP	452	-16.4	-29.4	-41.8
LP	VU	452	-40.0	-64.6	-79.6
LP	VL	452	-42.5	-67.3	-81.6
VU	A	21097	0.0	0.0	0.0
VU	B	21097	0.0	-0.1	-3.8
VU	C	21097	-0.5	-5.5	-13.3
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-4.1	-11.6	-23.4
VU	VL	21097	-4.5	-12.8	-27.2
VL	A	24853	0.0	0.0	0.0
VL	B	24853	0.0	0.0	-2.0
VL	C	24853	0.0	-2.9	-9.4
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-1.6	-7.5	-16.3
VL	VL	24853	-4.0	-11.5	-23.1

Table 5. Percentage of coverage loss due to co-channel short spacing in the upper VHF band F(90,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-9.8	-24.1	-42.0
A	B	1961	-19.7	-36.6	-56.8
A	C	1961	-25.2	-47.8	-66.2
A	LP	1961	0.0	-0.1	-6.6
A	VU	1961	-29.0	-54.6	-72.1
A	VL	1961	-31.0	-57.9	-75.4
B	A	6354	0.0	-1.6	-7.0
B	B	6354	-3.7	-15.3	-32.8
B	C	6354	-7.1	-26.2	-49.0
B	LP	6354	0.0	0.0	0.0
B	VU	6354	-10.9	-33.3	-57.8
B	VL	6354	-13.6	-37.2	-62.3
C	A	15374	0.0	0.0	-0.1
C	B	15374	0.0	-0.4	-4.1
C	C	15374	-3.0	-8.3	-18.3
C	LP	15374	0.0	0.0	0.0
C	VU	15374	-3.7	-10.4	-26.7
C	VL	15374	-4.1	-12.0	-32.3
LP	A	452	-23.7	-42.9	-60.8
LP	B	452	-29.0	-50.2	-67.5
LP	C	452	-35.6	-56.9	-72.1
LP	LP	452	-19.0	-29.4	-41.8
LP	VU	452	-40.0	-62.6	-76.3
LP	VL	452	-42.5	-65.3	-79.0
VU	A	21097	0.0	0.0	0.0
VU	B	21097	0.0	0.0	-1.1
VU	C	21097	-0.1	-3.4	-8.9
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-3.1	-8.7	-16.8
VU	VL	21097	-3.4	-9.8	-21.5
VL	A	24853	0.0	0.0	0.0
VL	B	24853	0.0	0.0	-0.2
VL	C	24853	0.0	-1.4	-5.9
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-1.0	-5.4	-11.9
VL	VL	24853	-3.1	-8.8	-17.0

Table 6. Percentage of coverage loss due to co-channel short spacing in the UHF band F(90,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-17.2	-27.5	-40.9
A	B	1961	-24.2	-39.2	-55.5
A	C	1961	-31.3	-54.8	-71.8
A	LP	1961	-4.5	-9.0	-16.7
A	VU	1961	-35.4	-61.1	-77.5
A	VL	1961	-37.4	-63.3	-79.4
B	A	6354	0.0	0.0	0.0
B	B	6354	-7.6	-18.0	-31.2
B	C	6354	-13.4	-30.1	-50.4
B	LP	6354	0.0	0.0	0.0
B	VU	6354	-16.6	-37.2	-58.7
B	VL	6354	-18.1	-39.9	-61.5
C	A	15374	0.0	0.0	0.0
C	B	15374	0.0	0.0	-1.1
C	C	15374	-3.2	-12.6	-27.2
C	LP	15374	0.0	0.0	0.0
C	VU	15374	-5.3	-18.0	-35.7
C	VL	15374	-6.5	-20.1	-38.9
LP	A	452	-25.0	-40.0	-58.0
LP	B	452	-31.2	-48.9	-62.4
LP	C	452	-40.9	-62.2	-76.3
LP	LP	452	-21.0	-30.5	-42.7
LP	VU	452	-44.9	-67.5	-80.8
LP	VL	452	-46.9	-69.2	-82.3
VU	A	21097	0.0	0.0	0.0
VU	B	21097	0.0	0.0	0.0
VU	C	21097	0.0	-2.5	-8.6
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-3.6	-13.7	-29.5
VU	VL	21097	-3.9	-15.6	-32.7
VL	A	24853	0.0	0.0	0.0
VL	B	24853	0.0	0.0	0.0
VL	C	24853	0.0	-1.4	-6.8
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-2.1	-8.5	-23.2
VL	VL	24853	-4.0	-14.1	-30.6

Table 7. Percentage of coverage loss due to adjacent channel (-1) short spacing in the lower VHF band F(50,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-0.3	-0.3	-0.3
A	B	1961	0.0	0.0	0.0
A	C	1961	0.0	0.0	0.0
A	LP	1961	-0.2	-0.2	-0.2
A	VU	1961	0.0	0.0	0.0
A	VL	1961	0.0	0.0	0.0
B	A	6354	-0.1	-0.1	0.0
B	B	6354	-0.4	-0.6	-0.4
B	C	6354	0.0	0.0	-0.1
B	LP	6354	0.0	0.0	0.0
B	VU	6354	0.0	0.0	0.0
B	VL	6354	0.0	0.0	0.0
C	A	15374	0.0	0.0	0.0
C	B	15374	-0.2	-0.2	-0.1
C	C	15374	-0.5	-1.0	-0.8
C	LP	15374	0.0	0.0	0.0
C	VU	15374	0.0	-0.8	-1.7
C	VL	15374	0.0	-0.5	-1.6
LP	A	452	0.0	0.0	0.0
LP	B	452	0.0	0.0	0.0
LP	C	452	0.0	0.0	0.0
LP	LP	452	-0.7	-0.7	-0.4
LP	VU	452	0.0	0.0	0.0
LP	VL	452	0.0	0.0	0.0
VU	A	21097	0.0	0.0	0.0
VU	B	21097	-0.2	-0.1	-0.1
VU	C	21097	-0.4	-0.8	-0.5
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-0.6	-1.2	-1.4
VU	VL	21097	-0.4	-1.2	-2.2
VL	A	24853	0.0	0.0	0.0
VL	B	24853	-0.1	-0.1	0.0
VL	C	24853	-0.4	-0.6	-0.3
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-0.5	-1.1	-1.0
VL	VL	24853	-0.6	-1.3	-2.0

Table 8. Percentage of coverage loss due to adjacent channel (-1) short spacing in the upper VHF band F(50,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-0.2	-0.2	-0.2
A	B	1961	0.0	0.0	0.0
A	C	1961	0.0	0.0	0.0
A	LP	1961	-0.1	-0.1	-0.1
A	VU	1961	0.0	0.0	0.0
A	VL	1961	0.0	0.0	0.0
B	A	6354	-0.1	-0.1	0.0
B	B	6354	-0.2	-0.2	-0.1
B	C	6354	0.0	0.0	0.0
B	LP	6354	0.0	0.0	0.0
B	VU	6354	0.0	0.0	0.0
B	VL	6354	0.0	0.0	0.0
C	A	15374	0.0	0.0	0.0
C	B	15374	-0.1	-0.1	0.0
C	C	15374	-0.3	-0.6	-0.2
C	LP	15374	0.0	0.0	0.0
C	VU	15374	0.0	-0.5	-1.0
C	VL	15374	0.0	-0.4	-1.1
LP	A	452	0.0	0.0	0.0
LP	B	452	0.0	0.0	0.0
LP	C	452	0.0	0.0	0.0
LP	LP	452	-0.4	-0.2	-0.2
LP	VU	452	0.0	0.0	0.0
LP	VL	452	0.0	0.0	0.0
VU	A	21097	0.0	0.0	0.0
VU	B	21097	-0.1	0.0	0.0
VU	C	21097	-0.2	-0.3	-0.1
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-0.4	-0.8	-0.7
VU	VL	21097	-0.3	-0.8	-1.4
VL	A	24853	0.0	0.0	0.0
VL	B	24853	0.0	0.0	0.0
VL	C	24853	-0.2	-0.2	-0.1
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-0.3	-0.7	-0.5
VL	VL	24853	-0.4	-0.9	-1.4

Table 9. Percentage of coverage loss due to adjacent channel (-1) short spacing in the UHF band F(50,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-0.3	-0.2	-0.2
A	B	1961	0.0	0.0	0.0
A	C	1961	0.0	0.0	0.0
A	LP	1961	0.0	0.0	0.0
A	VU	1961	0.0	0.0	0.0
A	VL	1961	0.0	0.0	0.0
B	A	6354	-0.1	-0.1	0.0
B	B	6354	-0.2	-0.4	-0.2
B	C	6354	0.0	0.0	-0.1
B	LP	6354	0.0	0.0	0.0
B	VU	6354	0.0	0.0	0.0
B	VL	6354	0.0	0.0	0.0
C	A	15374	0.0	0.0	0.0
C	B	15374	-0.2	-0.1	-0.1
C	C	15374	-0.4	-0.9	-1.4
C	LP	15374	0.0	0.0	0.0
C	VU	15374	-0.1	-0.8	-1.6
C	VL	15374	0.0	-0.7	-1.7
LP	A	452	-0.9	-1.1	-0.9
LP	B	452	0.0	-1.5	-2.4
LP	C	452	-1.3	-3.5	-6.2
LP	LP	452	0.0	0.0	0.0
LP	VU	452	-2.0	-6.4	-15.7
LP	VL	452	-3.1	-12.4	-22.3
VU	A	21097	0.0	0.0	0.0
VU	B	21097	-0.1	-0.1	0.0
VU	C	21097	-0.4	-0.8	-0.9
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-0.6	-1.2	-1.9
VU	VL	21097	-0.4	-1.2	-2.0
VL	A	24853	0.0	0.0	0.0
VL	B	24853	-0.1	-0.1	0.0
VL	C	24853	-0.3	-0.7	-0.7
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-0.6	-1.1	-1.8
VL	VL	24853	-0.6	-1.3	-2.1

Table 10. Percentage of coverage loss due to adjacent channel (-1) short spacing in the lower VHF band F(90,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-0.7	-1.4	-1.8
A	B	1961	0.0	0.0	0.0
A	C	1961	0.0	0.0	0.0
A	LP	1961	-0.3	-0.3	-0.3
A	VU	1961	0.0	0.0	0.0
A	VL	1961	0.0	0.0	0.0
B	A	6354	-0.4	-0.6	-0.4
B	B	6354	-0.7	-1.6	-2.5
B	C	6354	0.0	0.0	-1.3
B	LP	6354	-0.1	-0.1	-0.1
B	VU	6354	0.0	0.0	-1.1
B	VL	6354	0.0	0.0	-1.4
C	A	15374	-0.2	-0.2	-0.1
C	B	15374	-0.5	-1.0	-0.7
C	C	15374	-0.7	-1.8	-3.0
C	LP	15374	0.0	0.0	0.0
C	VU	15374	-0.5	-1.9	-3.4
C	VL	15374	-0.5	-2.0	-3.9
LP	A	452	0.0	0.0	0.0
LP	B	452	0.0	0.0	0.0
LP	C	452	0.0	0.0	0.0
LP	LP	452	-0.2	-1.1	-1.5
LP	VU	452	0.0	0.0	0.0
LP	VL	452	0.0	0.0	0.0
VU	A	21097	-0.2	-0.1	-0.1
VU	B	21097	-0.4	-0.7	-0.4
VU	C	21097	-0.6	-1.6	-2.6
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-0.8	-2.0	-3.3
VU	VL	21097	-0.8	-2.3	-3.9
VL	A	24853	-0.1	-0.1	0.0
VL	B	24853	-0.4	-0.6	-0.3
VL	C	24853	-0.6	-1.4	-2.4
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-0.7	-1.8	-3.0
VL	VL	24853	-0.8	-2.1	-3.5

Table 11. Percentage of coverage loss due to adjacent channel (-1) short spacing in the upper VHF band F(90,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-0.4	-0.9	-0.8
A	B	1961	0.0	0.0	0.0
A	C	1961	0.0	0.0	0.0
A	LP	1961	-0.3	-0.3	-0.2
A	VU	1961	0.0	0.0	0.0
A	VL	1961	0.0	0.0	0.0
B	A	6354	-0.2	-0.2	-0.2
B	B	6354	-0.5	-1.0	-1.4
B	C	6354	0.0	0.0	-0.5
B	LP	6354	-0.1	-0.1	0.0
B	VU	6354	0.0	0.0	-0.3
B	VL	6354	0.0	0.0	-0.3
C	A	15374	-0.1	-0.1	0.0
C	B	15374	-0.3	-0.5	-0.3
C	C	15374	-0.6	-1.2	-2.0
C	LP	15374	0.0	0.0	0.0
C	VU	15374	-0.3	-1.3	-2.5
C	VL	15374	-0.2	-1.4	-2.9
LP	A	452	0.0	0.0	0.0
LP	B	452	0.0	0.0	0.0
LP	C	452	0.0	0.0	0.0
LP	LP	452	-0.4	-1.1	-1.1
LP	VU	452	0.0	0.0	0.0
LP	VL	452	0.0	0.0	0.0
VU	A	21097	-0.1	0.0	0.0
VU	B	21097	-0.3	-0.3	-0.2
VU	C	21097	-0.5	-1.1	-1.7
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-0.6	-1.5	-2.3
VU	VL	21097	-0.7	-1.8	-2.9
VL	A	24853	-0.1	0.0	0.0
VL	B	24853	-0.2	-0.2	-0.1
VL	C	24853	-0.5	-1.0	-1.6
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-0.5	-1.4	-2.2
VL	VL	24853	-0.7	-1.7	-2.7

Table 12. Percentage of coverage loss due to adjacent channel (-1) short spacing in the UHF band F(90,90), for 10 %, 20% and 30% short spacings

PROT	INTERF	AREA	PERC_10	PERC_20	PERC_30
A	A	1961	-0.4	-0.9	-1.1
A	B	1961	0.0	0.0	0.0
A	C	1961	0.0	0.0	0.0
A	LP	1961	-0.3	-0.3	-0.3
A	VU	1961	0.0	0.0	0.0
A	VL	1961	0.0	0.0	0.0
B	A	6354	-0.2	-0.3	-0.2
B	B	6354	-0.6	-1.1	-1.8
B	C	6354	0.0	-0.2	-1.7
B	LP	6354	-0.1	-0.1	-0.1
B	VU	6354	0.0	-0.4	-2.5
B	VL	6354	0.0	-0.3	-2.7
C	A	15374	-0.1	-0.1	0.0
C	B	15374	-0.4	-0.7	-0.6
C	C	15374	-0.7	-1.7	-2.6
C	LP	15374	0.0	0.0	0.0
C	VU	15374	-0.9	-2.3	-3.9
C	VL	15374	-0.8	-2.4	-4.3
LP	A	452	0.0	0.0	0.0
LP	B	452	0.0	0.0	0.0
LP	C	452	0.0	0.0	0.0
LP	LP	452	-0.4	-1.1	-1.3
LP	VU	452	0.0	0.0	0.0
LP	VL	452	0.0	0.0	0.0
VU	A	21097	-0.1	-0.1	0.0
VU	B	21097	-0.3	-0.6	-0.4
VU	C	21097	-0.6	-1.5	-2.3
VU	LP	21097	0.0	0.0	0.0
VU	VU	21097	-0.8	-2.1	-3.5
VU	VL	21097	-0.9	-2.4	-4.0
VL	A	24853	-0.1	0.0	0.0
VL	B	24853	-0.3	-0.6	-0.3
VL	C	24853	-0.6	-1.5	-2.3
VL	LP	24853	0.0	0.0	0.0
VL	VU	24853	-0.8	-2.1	-3.4
VL	VL	24853	-0.9	-2.3	-3.0

Figure 1. Reduced service contour for a 30% short spacing of the co-channel required separation distance for a class A station in the UHF band F(50,90).

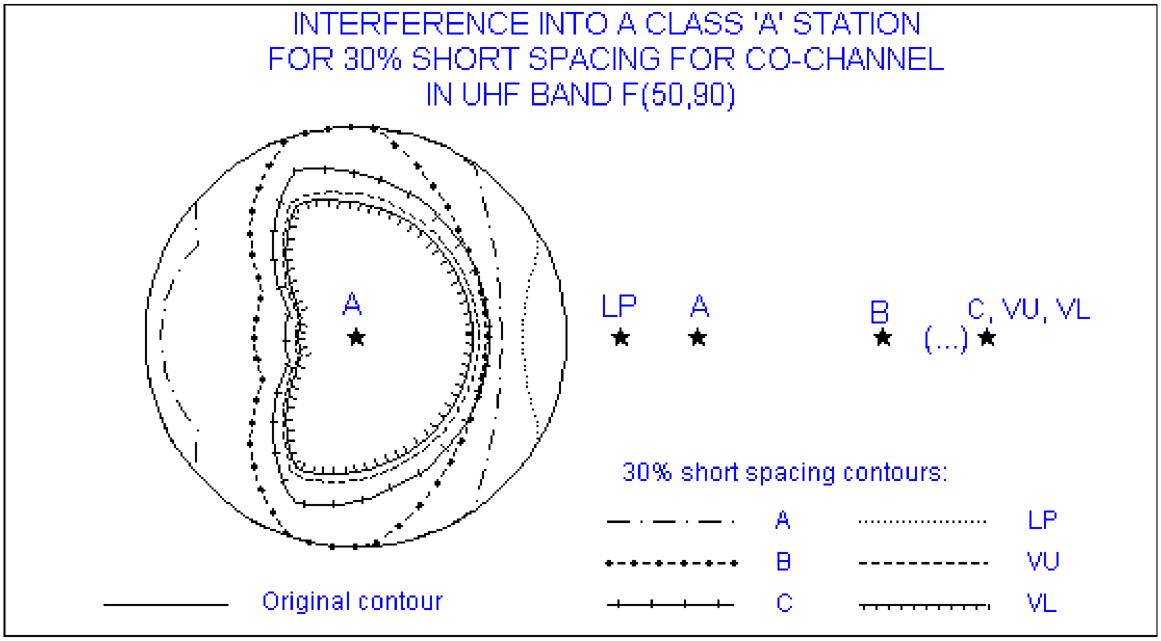

Figure 2. Reduced service contour for a 30% short spacing of the co-channel required separation distance for a class VU station in the upper VHF band F(50,90).

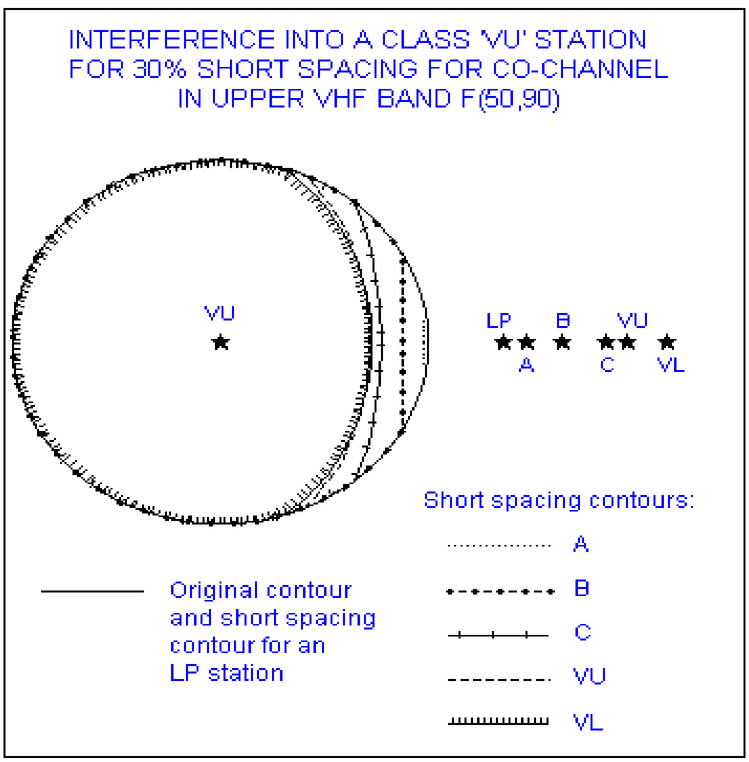

Figure 3. Reduced service contour for a 30% short spacing of the first adjacent channel required separation distance for a class LP station in the UHF band F(50,90).

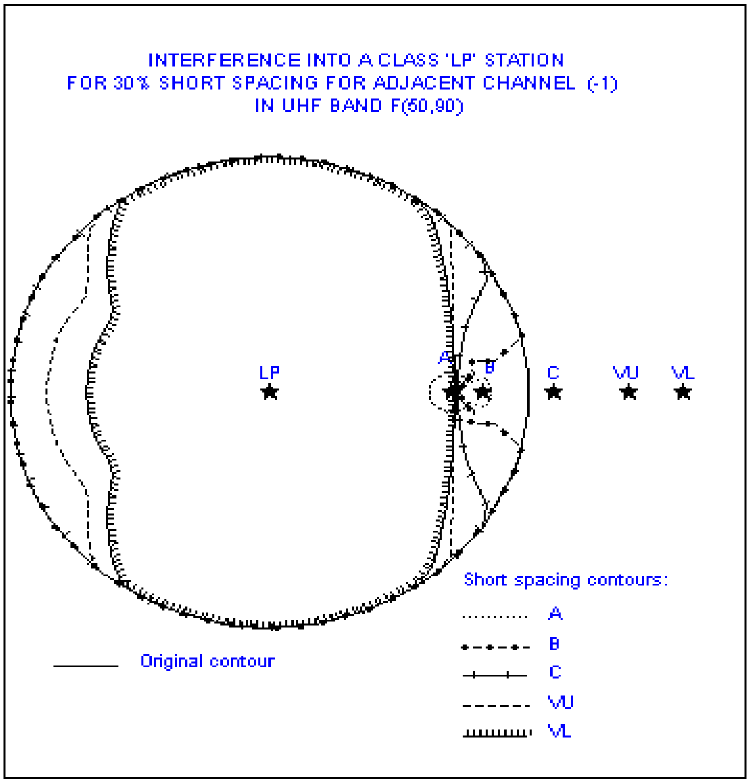

Figure 4. Reduced service contour without any short spacing of the co-channel required separation distance for a class LP station in the UHF band F(90,90).

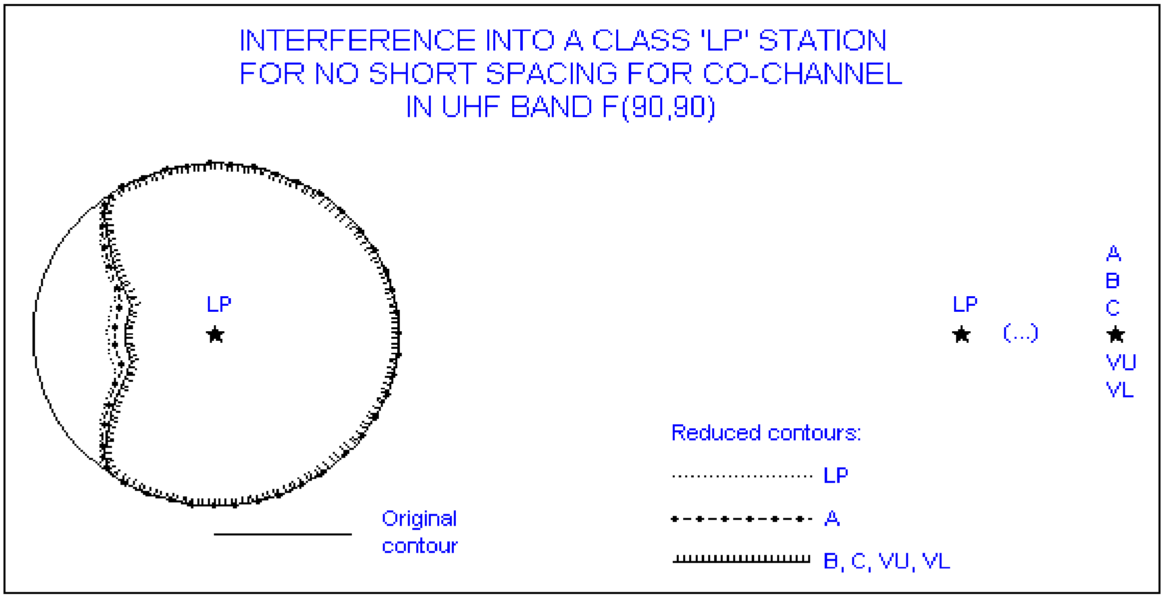

Table 13a. Adjustments in the required separation distances for the DTV->DTV table for the low VHF band F(50,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
B	LP	115	124
C	LP	168	181
LP	B	115	124
LP	C	168	181
LP	VU	202	216
LP	VL	224	239
VU	LP	202	216
VL	LP	224	239

Table 13b. Adjustments in the required separation distances for the DTV->DTV table for the high VHF band F(50,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
A	C	142	154
A	LP	55	63
A	VU	173	191
A	VL	195	215
B	LP	87	103
C	A	142	154
C	LP	129	166
LP	A	55	63
LP	B	87	103
LP	C	129	166
LP	LP	31	33
LP	VU	160	203
LP	VL	182	227
VU	A	173	191
VU	LP	160	203
VL	A	195	215
VL	LP	182	227

Table 13c. Adjustments in the required separation distances for the DTV->DTV table for the UHF band F(50,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
A	B	91	114
A	C	162	204
A	LP	45	56
A	VU	209	258
A	VL	231	283
B	A	91	114
B	C	182	185
B	LP	78	126
B	VU	229	239
B	VL	251	264
C	A	162	204
C	B	182	185
C	LP	149	216
LP	A	45	56
LP	B	78	126
LP	C	149	216
LP	LP	27	30
LP	VU	196	270
LP	VL	218	296
VU	A	209	258
VU	B	229	239
VU	LP	196	270
VL	A	231	283
VL	B	251	264
VL	LP	218	296

Table 13d. Adjustments in the required separation distances for the DTV->DTV table for the low VHF band F(90,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
A	LP	119	131
B	LP	178	192
C	LP	236	253
LP	A	119	131
LP	B	178	192
LP	C	236	253
LP	LP	85	96
LP	VU	273	290
LP	VL	296	316
VU	LP	273	290
VL	LP	296	316

Table 13e. Adjustments in the required separation distances for the DTV->DTV table for the high VHF band F(90,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
A	B	140	157
A	C	203	224
A	LP	87	109
A	VU	240	266
A	VL	264	292
B	A	140	157
B	LP	127	168
C	A	203	224
C	LP	190	236
LP	A	87	109
LP	B	127	168
LP	C	190	236
LP	LP	56	77
LP	VU	227	277
LP	VL	251	303
VU	A	240	266
VU	LP	227	277
VL	A	264	292
VL	LP	251	303

Table 13f. Adjustments in the required separation distances for the DTV->DTV table for the UHF band F(90,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
A	A	87	112
A	B	153	195
A	C	242	297
A	LP	74	124
A	VU	295	363
A	VL	315	386
B	A	153	195
B	B	173	177
B	C	262	278
B	LP	140	207
B	VU	315	344
B	VL	335	368
C	A	242	297
C	B	262	278
C	LP	229	309
LP	A	74	124
LP	B	140	207
LP	C	229	309
LP	LP	49	88
LP	VU	282	375
LP	VL	302	398
VU	A	295	363
VU	B	315	344
VU	LP	282	375
VL	A	315	386
VL	B	335	368
VL	LP	302	398

Table 14a. Adjustments in the required separation distances for the DTV->NTSC table for the low VHF band F(50,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
B	LP	104	109
C	LP	159	172
LP	A	81	82
LP	B	124	136
LP	C	180	194
LP	LP	44	47
LP	VU	214	230
LP	VL	236	253
VU	LP	185	199
VL	LP	202	216

Table 14b. Adjustments in the required separation distances for the DTV->NTSC table for the high VHF band F(50,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
A	LP	81	97
A	VL	158	167
B	A	127	139
B	LP	114	150
C	A	187	206
C	LP	174	218
LP	C	109	121
LP	LP	51	70
LP	VU	122	155
LP	VL	138	178
VU	A	221	243
VU	LP	208	254

Table 14c. Adjustments in the required separation distances for the DTV->NTSC table for the UHF band F(50,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
A	A	81	99
A	C	126	143
A	LP	68	111
A	VU	150	192
A	VL	171	215
B	A	125	162
B	LP	112	174
B	VL	191	197
C	A	196	241
C	B	216	223
C	LP	183	254
LP	A	59	68
LP	C	104	155
LP	LP	46	80
LP	VU	137	204
LP	VL	158	227

Table 15a. Adjustments in the required separation distances for the NTSC->DTV table for the low VHF band F(50,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
A	LP	81	82
B	LP	124	136
C	LP	180	194
LP	B	104	109
LP	C	159	172
LP	LP	44	47
LP	VU	185	199
LP	VL	202	216
VU	LP	214	230
VL	LP	236	253

Table 15b. Adjustments in the required separation distances for the NTSC->DTV table for the high VHF band F(50,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
A	B	127	138
A	C	187	206
A	VU	221	243
C	LP	109	121
LP	A	81	97
LP	B	114	150
LP	C	174	218
LP	LP	51	70
LP	VU	208	254
VU	LP	122	155
VL	A	158	166
VL	LP	138	178

Table 15c. Adjustments in the required separation distances for the NTSC->DTV table for the UHF band F(50,90)

Protected Class	Interfering Class	Old Separation Distance (km)	New Separation Distance (km)
A	A	81	99
A	B	125	162
A	C	196	241
A	LP	59	68
B	C	216	223
C	A	126	143
C	LP	104	155
LP	A	68	111
LP	B	112	174
LP	C	183	254
LP	LP	46	80
VU	A	150	192
VU	LP	137	204
VL	A	171	215
VL	B	191	197
VL	LP	158	227

Glossary

JTCAB	Joint Technical Committee on Advanced Broadcasting
DTV	Digital Television
ATV	Advanced Television
NTSC TV	Existing analog TV system
FCC	Federal Communications Commission (United States)
VU	Upper or High VHF TV band comprised of channels 7-13
VL	Lower or Low VHF TV band comprised of channels 2-6
Grade B	Limit of service at which an acceptable picture is available at 50% of the locations for 90% of the time
ERP	Effective Radiated Power from a dipole radiator
EIRP	Effective Isotropic Radiated Power from an isotropic radiator
EHAAT	Effective Height Above Average Terrain
HAAT	Height Above Average Terrain
dBkW/dBk	Power expressed in dB referenced to one kilowatt
kW	Power expressed in kilowatts
C/N	Ratio of carrier power to noise power expressed in dB
LNA	Low Noise Amplifier
T_a equiv	Value in dB for man-made noise expressed as the equivalent of antenna noise temperature
Balun	Device to convert the balanced 300 ohm antenna output to 75 ohm unbalanced output to match the 75 ohm downlead
C/I	Ratio of carrier power to interfering signal power expressed in dB
C/N+I	Ratio of carrier power to noise + interfering signal power expressed in dB
TOV	Threshold of Visibility; in digital television, the point at which degradations in the picture quality are visible
VSB	Vestigial Side Band

GA	Grand Alliance, the consortium of companies who formed an alliance to develop a single Digital Television system from several comparable competing systems
G/T	Receiver figure of merit; the ratio of the receiving system gain to the system noise temperature expressed in dB
Comb filter	A filter used to reduce the effect of NTSC interference by filtering out components of the NTSC spectrum
E_{RX}	required field strength at the receive system antenna
Φ	power flux density at the receive system antenna
k	Boltzmann's constant
B	system bandwidth
$G_i(1m^2)$	gain of a theoretical antenna with an aperture of 1 metre squared
G_A/T_e	G/T of the receive system
G_A	gain of the receive system (isotropic)
T_e	effective noise temperature
T(90) dB	dB increase required to assure that the E_{RX} is present for 90% of the time
L(70) dB	dB increase required to assure that the E_{RX} is present at 70% of the locations
L(90) dB	dB increase required to assure that the E_{RX} is present at 90% of the locations

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ADDENDUM

DIGITAL TELEVISION

Service Considerations

and

Allotment Principles

Prepared by

JTCAB Ad Hoc Group on DTV Planning Parameters

ADDENDUM
DIGITAL TELEVISION
Service Considerations and Allotment Principles

Introduction

This addendum provides an update of the planning criteria presented in the planning document issued in August 1997. The DTV to DTV adjacent channel criteria is improved as a result of information derived from recent tests. A summary of the final planning criteria used to prepare the Transition Plan is given.

Adjacent Channel Criteria

Background

The technical planning factors of the planning document AHG_DTV003K for adjacent channel interference (same as used by FCC) are based on the performance of the ATSC DTV system measured under laboratory conditions. In the adjacent channel interference tests, the interfering DTV signal had little or no out-of-band emissions with the result that the emissions were well below the proposed RF Mask limiting sideband emissions. Recent adjacent channel interference tests (done after the issue of the FCC Report and the Planning Document AHG_DTV003K) were conducted using a DTV signal with out-of-band emissions which approximated the shape of the RF emission mask. The evaluation clearly demonstrated that the planning factors underestimated adjacent channel DTV to DTV interference by as much as 22 dB.

Investigation and Results

The results of the adjacent channel interference analysis showed the need for new protection ratios. CRC and the planning committee investigated first adjacent channel DTV-DTV and DTV-NTSC interference using different channel filters which provide rejection of out-of-band emissions greater than that required by the FCC emission mask. New protection ratios matched with the filter characteristics were developed to meet the adjacent channel interference threshold. The results show that filtering alone cannot provide the necessary discrimination to meet the DTV to DTV adjacent channel protection requirements. The DTV-DTV adjacent channel protection ratio was established at -27 dB for the “tight mask” filter and for higher order and more expensive filters, the protection ratios were -29 dB for a 7th order Chebychev filter and -37 dB for a 6th order elliptic filter. In addition, in a report on tests of an actual transmitter installation it is shown that transmitter optimization for correction and linearity can achieve as much as 13 dB reduction below the FCC mask for the out-of-band emissions at the channel band edge and beyond. Thus with this optimization improvement, it may be possible to reduce adjacent channel interference criteria and in many cases the external filtering required would be much less.   For the DTV to NTSC case, use of the "tight mask" (see appendix 3 of Planning Document AHG_DTV003K) provides the required margin. The results of this investigation are included in Appendix 1 of this Addendum.

New Adjacent Channel Planning Criteria

Based on the results of the investigation, the planning committee adopted new DTV-DTV adjacent channel protection ratios and the use of the "tight mask" for the RF Emission Mask for the allotment planning of adjacent channel placements. The protection ratio for adjacent channel DTV to DTV interference was set at -27 dB for both upper and lower adjacent channels. Based on this protection ratio, the following revised Canadian Separation Distance Tables were produced and used for the development and allotment of the DTV channels in the transition plan.

Revised Canadian Separation Distance Tables

TABLE 1

UHF BAND TABOOS - DTV -> DTV   Separation distances in km

UND	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
DES	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-30	-50	75	-27	87	94	-50	-58	-83	47	98	105	75	-83	-108	72	-123	-130
0	112	194	296	124	363	386	194	175	277	207	344	367	296	277	287	309	340	359
1	-30	-50	75	-27	87	94	-50	-58	-83	47	98	105	75	-83	-108	72	-123	-130

UND	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
DES	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-27	47	72	-14	86	101	87	98	-123	86	-135	-142	94	105	-130	101	-142	-149
0	124	207	309	88	375	398	363	344	340	375	352	371	386	367	359	342	371	378
1	-27	47	72	-14	86	101	87	98	-123	86	-135	-142	94	105	-130	101	-142	-149

A minus sign means that either co-siting or the indicated separation is OK.

Classes VU and VL have protected coverage equivalent to full power NTSC stations in the upper or lower VHF bands respectively, i.e. 82 or 89 km.

Channel -1 means lower first adjacent.

Protection was assessed in both directions and the greater separation distance was used.

TABLE 2

UPPER VHF BAND TABOOS - DTV -> DTV   Separation distances in km

UND	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
DES	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-30	-50	75	-27	87	94	-50	-57	-82	47	94	101	75	-82	-99	72	-112	-122
0	100	156	224	109	265	291	156	160	223	168	260	284	224	223	248	236	285	309
1	-30	-50	75	-27	87	94	-50	-57	-82	47	94	101	75	-82	-99	72	-112	-122

UND	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
DES	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-26	-46	71	-13	83	90	84	86	-93	83	-100	-105	91	93	-100	90	-107	-111
0	109	168	236	76	277	303	265	260	285	277	297	321	291	284	309	303	321	328
1	-26	-46	71	-13	83	90	84	86	-93	83	-100	-105	91	93	-100	90	-107	-111

TABLE 3

LOWER VHF BAND TABOOS - DTV -> DTV   Separation distances in km

UND	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
DES	A	A	A	A	A	A	B	B	B	B	B	B	C	C	C	C	C	C
CHAN.																		
-1	-33	-53	78	-29	90	97	-53	-62	-87	-49	-99	108	78	-87	-109	74	-123	-133
0	132	191	249	130	286	309	191	211	269	191	306	329	249	269	294	252	331	354
1	-33	-53	78	-29	90	97	-53	-62	-87	-49	-99	108	78	-87	-109	74	-123	-133

UND	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL	A	B	C	LP	VU	VL
DES	LP	LP	LP	LP	LP	LP	VU	VU	VU	VU	VU	VU	VL	VL	VL	VL	VL	VL
CHAN.																		
-1	-29	-49	74	-16	86	93	90	-99	-123	86	-135	-145	97	108	-133	93	-145	-152
0	130	191	252	95	290	315	286	306	331	290	343	366	309	329	354	315	366	373
1	-29	-49	74	-16	86	93	90	-99	-123	86	-135	-145	97	108	-133	93	-145	-152

Planning Criteria Summary

General

The primary objective in allotment planning for the introduction of Over the Air (OTA) Digital Television (DTV) is to provide a DTV channel for each existing NTSC TV assignment and allotment and to provide a DTV coverage comparable to the existing TV broadcasting service.

Each DTV channel is allotted/assigned based on service replication of the coverage of the existing NTSC allotment or station using the maximum parameters for the class of the existing allotment or station or the present parameters if less. The DTV channel is paired with the NTSC station or allotment and assumed to be located at the same site as the paired NTSC station or allotment. A flex factor of 8 km is included for the location of the DTV transmitter to allow for cases where the DTV service cannot be accommodated at the existing NTSC site.

Protection from interference to both NTSC and DTV services extends to the coverage contours based on their maximum parameters. The planning approach will attempt to minimize interference into both NTSC and DTV equally.

The service availability is based on providing coverage in a service area with an availability of (90,90) i.e. at 90% of the locations and 90% of the time.

Receiving Considerations

For DTV service in Canada, the figure of 5 dB is used (achieved by the use of a low noise preamplifier installed on the antenna mast to minimize down lead loss effect).

For the final allotment planning in Canada, the following receiving system parameters are used.

Parameter	Low VHF	High VHF	UHF
Frequency MHz	69	195	645
Antenna Gain (dipole) dB	6	8	10
Front-to-Back Ratio dB	6	12	16
Downlead Loss dB	1.05	1.81	3.29
Balun 300/75 Loss dB	0.5	0.5	0.5
Receiver Noise Figure dB	5	5	10

Man-made Noise dB (T_a equiv.)	8.2	1	0
LNA Noise Figure (dB)	5	5	5
LNA Gain (dB)	20	20	20

Based on partitioning equally divided between noise and interference, a C/N = C/I = 19.5 dB is proposed at the DTV protected contour.

The minimum required field strength for the three TV bands using the parameters proposed for the final Canadian allotment planning is **35 dBµV/m** for the low VHF band, **33 dBµV/m** for the high VHF band and **39 dBµV/m** for the UHF band compared to 47, 56 and 64 dBµV/m respectively for NTSC.

The protection ratios adopted for Canadian allotment planning are based upon the values resulting from analysis of noise partitioning and interference for co-channel and first adjacent channel and the values from the measurements and tests of the Grand Alliance DTV system.

DTV/NTSC System Protection Ratios

Parameter	Value (dB)
Carrier-to-Noise Ratio	+19.5
Co-channel D/U Ratio	
DTV into NTSC	+33.8
NTSC into DTV	+7.2
DTV into DTV	+19.5
Adjacent Channel D/U Ratio	
Lower DTV into NTSC	-16
Upper DTV into NTSC	-12
Lower NTSC into DTV	-48
Upper NTSC into DTV	-49
Lower DTV into DTV	-27.2
Upper DTV into DTV	-27.2
Taboo D/U Ratio, DTV into NTSC	

N-2	-24
N+2	-28
N-3	-30
N+3	-34
N-4	-34
N+4	-25
N-7	-35
N+7	-34
N-8	-32
N+8	-43
N+14	-33
N+15	-31

Taboo D/U Ratio, NTSC into DTV

N-2	-62
N+2	-60
N-3	-62
N+3	-62
N-4	-58
N+4	-57
N-7	-58
N+7	-58
N-8	-58
N+8	-58
N+14	-58
N+15	-58

Transmitting Considerations

The necessary ERP to produce the required field strength for the noise limited contour at a given distance for the different classes of stations assuming replacement channels in the three TV bands, low VHF, high VHF and UHF, was selected for the required time and location availabilities.

Separation Tables

Separation distances provide an efficient and effective means for managing interference between NTSC stations and DTV allotments and this approach was used to determine the technical acceptability of DTV channel allotments. The separation tables are based on an equal partitioning between noise and interference in the DTV to DTV case and to keep a degree of balance between interference from NTSC to DTV and from DTV to NTSC. The tables give the separation distances required to protect the TV services of the different classes of stations and form the basis for allotting the frequencies to the DTV service areas.

Short Spacing of Channels

Although most of the channels in the transition plan were originally selected using the appropriate separation distances and an 8 km siting flexibility, the addition of the remaining channels led to a majority being short-spaced. To permit review of the most serious cases without excessive delay, the following guidelines were set:

a) regular stations (DTV or NTSC) - interference up to 10% of the service area (calculated at maximum parameters for the class) is permitted.

b) low power stations or unused allotments - interference up to 20% of the service area is permitted.

All cases not meeting these guidelines were studied using PREDICT and MAPINFO and areas not over Canadian land were eliminated. If the guidelines were still not met, appropriate power reductions were indicated or if the interference was between two DTV channels, one or both were designated as a transition channel only. In a few cases, a low power station is permitted higher power as an alternate to limiting a regular station's power.