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Spectrum Management and Telecommunications

Broadcasting Procedures and Rules

Part 3: Application Procedures and Rules for FM Broadcasting Undertakings

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Preface

Issue 6 of BPR-3 is hereby released.

Listed below are the changes:

(a) A new option to submit applications online has been introduced.
(b) WGS84 (World Geodetic System 1984) is defined as the new standard for geographical coordinates.
(c) A new file format has been established for antenna patterns.
(d) Contour determination for regular-power stations now requires the use of 36 HAATs (height above average terrain).
(e) The definitions for *allotment* and *allocation* have been updated.
(f) Analysis for "ghost" reflections of analog television signals from a new FM antenna structure is no longer required.
(g) Other updates have been made, including editorial changes.

Issued under the authority of the Minister of Innovation, Science and Economic Development.

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Contents

1. International Agreements

Within 320 km of the Canada-US border, FM broadcasting allotments and assignments in Canada are subject to the terms of the *Agreement Between the Government of Canada and the Government of the United States of America Relating to the FM Broadcasting Service and the Associated Working Arrangement* of 1991. The Agreement was amended in June 1997, according to the terms of the *Changes to the 1991 Working Agreement Between the Government of Canada and the Government of the United States of America Relating to the FM Broadcasting Service*.

The Agreement between the US Federal Communications Commission (FCC) and Innovation, Science and Economic Development Canada (ISED) states the basis upon which both administrations propose to consider responses to border area allotments and assignments. It also defines technical criteria for the notification of FM allotments and assignments. Acceptance of such allotments or assignments shall be obtained from the United States before authorization can be granted to implement the Canadian proposals.

Applications for new assignments or changes in facilities of existing Canadian stations within 320 km of the border with the United States must meet both domestic and bilateral criteria.

Under the revised agreement, US low-power FM (LPFM) stations are defined as having an effective radiated power (ERP) of 250 W and an interfering contour (34 dBμV/m) whose maximum extension is 60 km.

2. Applications for FM Broadcasting Stations Using Primary Assignments

2.1 Application Requirements

An application to the Department for a broadcasting certificate shall be accompanied by an application to the Canadian Radio-television and Telecommunications Commission (CRTC) for a broadcasting licence, unless the application is exempt from CRTC licensing requirements. Application requirements for a broadcasting licence can be obtained from the CRTC. The Department must receive a confirmation that an application for a broadcasting licence has been submitted to the CRTC, or that a licence is not required, within 30 days of receiving the application for a broadcasting certificate, otherwise the certificate application will be returned to the applicant.

Although the CRTC has established criteria to exempt certain categories of FM broadcasting from its licensing requirements, ISED maintains its requirements for the submission of broadcasting certificate applications because of spectrum management needs.

This section outlines departmental requirements for applying for a primary FM assignment other than low- and very low-power applications. It also deals with applications where a Subsidiary Communication Multiplex Operation (SCMO) is proposed.

All necessary forms are available on ISED's Spectrum Management and Telecommunications website at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf01700.html.

2.1.1 Online Application Requirements

When submitting an application to the Department **online**, the applicant shall use the Spectrum Management System website.

The following documentation shall be attached to the application:

- an engineering brief (in PDF format) as per Section 2.2, including any required maps prepared in accordance with Section 3 of Broadcasting Procedures and Rules BPR-1, Part 1: General Rules;
- electronic contours (in MapInfo format: *.dat/*.id/*.map/*.tab, or in GIS format: *.mif,*.mid) in accordance with Section 3.3 of BPR-1. For AM to FM conversions or change of facilities, comparative contours shall also be included, except if changing from low-power to regular power; and
- a text file containing horizontal and vertical antenna pattern data, in accordance with Annex E of BPR-1.

2.1.2 Email Application Requirements

When submitting an application to the Department by **email**, the applicant shall use the following email address: IC.broadcasting-radiodiffusion.IC@canada.ca.

In addition to the documentation required for online submissions, the following documentation shall be attached to the application:

- form ISED-ISDE3050, *Application for a Broadcasting Certificate for a Regular Power Undertaking* (in PDF format);
- form IC-2430, *Radiocommunication and Broadcasting Antenna Systems Attestation* (in PDF format); and
- a copy of the Letter of Intent to the land-use authority as described in BPR-1, Section 2, if applicable.

It is the applicant's responsibility to ensure that all electronic documents submitted have the necessary signatures.

The Department reserves the right to request a signed attestation to verify the authenticity of an application and may hold the processing of the application until a satisfactory attestation has been received.

2.1.3 Written Application Requirements

When submitting an application on paper, printed and signed versions of the application form and other documentation described in sections 2.1.1 and 2.1.2 shall be provided.

2.1.4 Other Requirements

All proposed antenna structures, whether new or modified, low or full power, must comply with the requirements of Client Procedures Circular CPC-2-0-03, Radiocommunication and Broadcasting Antenna Systems, and Section 2 of BPR-1. In addition to meeting the requirements regarding site sharing, land-use consultation and public consultation, applicants must also fulfill other important obligations, including:

- compliance with Health Canada's *Safety Code 6* guideline for the protection of the general public;
- compliance with radio frequency immunity criteria;
- notification of nearby broadcasting stations;
- environmental considerations; and
- Transport Canada / NAV CANADA aeronautical safety responsibilities.

2.2 Engineering Brief Requirements

The engineering brief should include the components described below in sections 2.2.1 to 2.2.9 in the order presented to facilitate processing by the Department. The metric system known as SI (International System) shall be used throughout the engineering brief.

2.2.1 Title Page

The title page should include the submission title, project or reference number, date, applicant's name and address, consultant's name and location of the station. The following parameters of the proposal shall also be listed: the frequency, maximum and average ERP, and effective antenna height above average terrain (EHAAT). If elliptical polarization is proposed, maximum and average ERP shall be listed for both the horizontal and vertical polarizations.

2.2.2 Table of Contents

The table of contents must present the sections of the brief with their respective page numbers.

2.2.3 Summary Sheet

The summary sheet must be prepared as per Annex B.

2.2.4 Main Section

2.2.4.1 Introduction

The introduction must include a general statement of the purpose of the brief in relation to the application and must mention the principal centre(s) to be served with the proposed grade of service.

2.2.4.2 Discussion

A discussion should be included regarding the design considerations to accomplish the applicant's objectives, including the site location and choice of frequency (refer to Section 3).

2.2.4.3 Interference Analysis

An analysis of interference to related station(s) and allotment(s) is required as detailed in sections 3.1 to 3.7, 3.11 and 3.12.

2.2.4.4 Assumptions and Sources of Information

All assumptions and sources of information used to compile the engineering brief must be listed and explained.

2.2.4.5 Transmitter

The intent to use a type-approved transmitter(s) in accordance with Broadcasting Equipment Technical Standard BETS-6, Technical Standards and Requirements for FM Broadcasting Transmitters, shall be made clear, either by specifying the make, model and type-approval number, or by including a statement that the transmitter will be type-approved prior to on-air operation. The rated power of the transmitter shall be specified.

2.2.4.6 Description of Antenna System

The description of the antenna system must be provided and include its manufacturer, type, number of bays (if applicable), power gain and vertical radiation pattern. For directional antennas, the horizontal radiation pattern of the polarization used is required. If both vertical and horizontal polarizations are used, the composite horizontal pattern is required. If elliptical polarization is used, the horizontal pattern, based on the field vector maximum, is required. The electric field is used to define the polarization. The largest dimension of the antenna shall be provided.

A description of the transmission line must be provided and include its manufacturer, type, length in metres and efficiency.

A description of the combiner must be provided and include its manufacturer and operational characteristics.

A description of the polarization must be provided and include whether it is horizontal, vertical, circular or elliptical.

2.2.4.7 Ancillary Equipment

All other equipment shall be listed.

2.2.4.8 Determination of the Location of Service Contours

The location of service contours shall be determined by the method detailed in Section 3.9 of this document and Section 3 of BPR-1. The contours to be determined are 3 mV/m (69.5 dBµV/m) and 0.5 mV/m (54 dBµV/m).

In cases where proposed FM stations are located in areas of mountainous terrain or in the proximity of other natural obstacles, an additional analysis will be necessary to establish more realistic locations for the service contours. In preparing contour maps for these cases, the contours as determined from the standard method above (refer to Section 3.9) should also be shown on the map with broken lines.

2.2.4.9 Special Analyses and Undertakings Relative to Interference to Other Broadcast Services

Analyses shall be submitted along with appropriate undertakings made in regard to all potential interference situations with other broadcasting stations resulting from the operation of the proposed FM facility.

The following are examples of interference situations with other broadcasting services that should be explored for each proposal:

(a) distortion of AM radiation patterns by the new FM tower located in the vicinity of an AM antenna array;

(b) isolation of AM, TV and FM transmissions, where such services are co-located;

(c) interference to television service due to the harmonics of the FM operation (see Section 3.12.1);

(d) interference to TV channel 6 from broadcasting stations on FM channels 201 to 220 (see Section 3.12.2);

(e) intermodulation with other broadcasting services in the vicinity of the proposed station (see Section 3.11 for further details and the requirements concerning the 115 dBµV/m contour);

(f) assessment and control of maximum field strengths for FM broadcasting stations in relation to immunity-type interference (see Section 3.11);

(g) the use of third- or fourth-adjacent channels allotted to the same centre (see Section 3.6); and

(h) interference caused to low-power and very low-power FM assignments. (Although these are unprotected assignments, they should be notified of potential interference to their service. Such notification shall be made by letter to the affected broadcaster with a copy forwarded to the Department, preferably at the time of application, but no later than one week after the application is announced in the *Canada Gazette* by the CRTC.)

2.2.4.10 Radio Frequency (RF) Exposure, Land-Use and Public Consultations, Immunity-Related Interference, Environmental Assessments and Transport Canada / NAV CANADA Safety-Related Issues

Refer to sections 2.1.4 and 3.11 of this document and to CPC-2-0-03 for the requirements regarding these issues.

2.2.5 Antenna Location and Diagrams

The location of all structures and antenna sites that are of relevance to the analyses carried out for the purpose of the application shall be provided in the engineering brief.

The engineering brief must include an elevation diagram of the structure and transmitting antenna as per Annex C and a block diagram of the transmitting system's major units.

For rooftop installations, the brief must include an elevation diagram of the building, indicating the height of the rooftop above ground.

2.2.6 Vertical Radiation Pattern

The vertical radiation pattern of the antenna (relative field versus elevation angles) shall be plotted in rectangular coordinates from 90° above (positive values) to 90° below (negative values) the horizontal plane.

2.2.7 Horizontal Radiation Pattern

If a directional antenna is employed, the horizontal radiation pattern is required. True north shall be clearly indicated on the polar plots of the horizontal radiation pattern. The relative voltage field shall be plotted using a linear scale with the option of adding the dB references if desired.

If the application is approved, the pattern shall be certified by means of range tests, scale-modelling or other recognized engineering methods, and include the effects of the mounting structure. The margin of accuracy shall also be provided. It is the applicant's responsibility to ensure that the antenna selected for installation is certified by the manufacturer and that it meets all the requirements of the proposed broadcasting undertaking, including those in Section 3.14.

2.2.8 Pattern Data Tables

Vertical and horizontal pattern data must be provided, if applicable, in tabular format in the relative field (%).

Vertical pattern data shall include a maximum of 181 points. These points shall be distributed appropriately to reflect the shape of the actual pattern from the manufacturer as closely as possible, especially along each peak and null covering the full range from -90 to +90 degrees.

Horizontal pattern data shall be provided at 1-degree intervals starting from true north.

For electronic applications, a text file containing the pattern data is required in the format defined in Annex E of BPR-1.

2.2.9 Maps

A map with a scale of 1:50 000 shall be provided and include the proposed antenna site and its geographical coordinates (latitude and longitude).

A map showing the service area contours, as required in Section 2.2.4.8, shall also be provided.

The latitude-longitude geographical projection and the datum WGS84 (up to 2 decimals for the seconds) shall be used.

Further details concerning the preparation of maps for engineering briefs are provided in BPR-1, Section 3.

2.3 Applications for Multiplex Operations

2.3.1 Application Requirements

An FM broadcasting undertaking wishing to initiate Subsidiary Communication Multiplex Operations (SCMO), including Radio Broadcast Data System (RBDS) operations, shall submit the following information to the Department for an amendment to the broadcasting certificate:

(a) a description of the program source and the method of modulating the multiplex subcarrier(s);

(b) the frequency or frequencies of the multiplex subcarrier(s); and

(c) a description of the means used to ensure that the technical requirements are being adequately met.

SCMO applications that are not related to broadcasting and have provisions for third-party communications services are authorized under the *Radiocommunication Act* and *Radiocommunication Regulations*. These are subject to authorization fees. The policy provisions for the use of multiplex services are outlined in the Spectrum Utilization Policy SP-1452, *Spectrum Policy Provisions to Permit the Use of Digital Radio Broadcasting Installations to Provide Non-Broadcasting Services*. The authorization procedure is published in the Client Procedures Circular CPC-2-1-03, *Licensing Radiocommunication Systems Using FM Subsidiary Communication Multiplex Operation (FM/SCMO) or Digital Radio Broadcasting (DRB) Installations*.

2.4 Technical Operation of Broadcast Transmitter Plants

A description of the technical equipment in compliance with the minimum requirements specified in Section 5.1 of BPR-1 shall be submitted prior to on-air tests for the approved facility.

If unattended operation is proposed, a statement that the unattended operation meets the minimum requirements of Section 5.1 of BPR-1 is required.

2.5 On-Air Testing Procedure

The procedure outlined in Section 1.4 of BPR-1 shall be followed.

2.6 FM/NAV/COM Compatibility

Aeronautical radionavigation and communications (NAV/COM) services in North America are assigned in the frequency band 108-137 MHz, upper adjacent to the FM band. As a result, there exists a potential for interference to these aeronautical services.

2.6.1 Types of Interference Mechanisms

2.6.1.1 Type A Interference

Type A interference is normally radiated by FM stations. Such interference is categorized as Type A_1 and Type A_2.

Type A_1 interference refers to spurious emissions generated by a single transmitter or intermodulation products generated by multiplexed transmitters, falling in the aeronautical frequency bands.

Type A_2 interference refers to FM sideband energy falling in the aeronautical frequency bands (only from FM transmitters operating near 108 MHz).

2.6.1.2 Type B Interference

Type B interference is normally generated in the aeronautical receiver. Such interference is categorized as Type B_1 and Type B_2.

Type B_1 interference refers to intermodulation generated as a result of two or more FM signals whose product falls on a wanted RF channel in use by the aeronautical receiver. It is noted that at least one FM signal must be large enough to drive the receiver into non-linearity.

Type B_2 interference refers to an overload of the RF section of an aeronautical receiver due to one or more FM signals, leading to desensitization.

Protection criteria for FM/NAV/COM are found in Annex H.

2.6.2 Interference Analysis

Each application for an FM transmitting undertaking (primary or secondary assignment) is subject to an FM/NAV/COM compatibility analysis. Depending on the result, the following may take place:

(a) If no interference is predicted, it is presumed that compatibility exists.

(b) If the potential for interference is low, a conditional technical acceptance is granted subject to:

- monitoring during on-air testing of the station, or occasionally,
- flight tests during on-air testing of a station in complex electromagnetic environments.

(c) If the potential for interference is high, the engineering brief is considered not acceptable and the application is returned.

When the Department conditionally accepts a broadcasting certificate application, the applicant is notified accordingly. If the broadcasting licence application is conditionally approved by the CRTC, a letter of approval is issued by ISED and specifies the period of advance notice that must be given to the Department before on-air testing can occur. Adherence to the terms of the letter of approval is mandatory.

The FM station shall be tested at the authorized parameters and pass the monitoring and/or flight tests conducted by ISED and NAV CANADA at the beginning of and during the on-air testing period. If interference is detected, remedial measures shall be taken to eliminate it. If interference is not eliminated, scheduled on-air broadcasting (i.e. regular programming) will not be authorized.

If interference to NAV/COM facilities is caused by the FM station during scheduled on-air broadcasting, the holder of the broadcasting certificate will take remedial measures to eliminate the interference, even to the extent of closing down the station, if so requested by the Department.

Because FM broadcasting stations transmit at much higher powers than NAV/COM facilities, it is important to limit spurious signals from FM stations to prevent interference to NAV/COM reception. The Department requires all regular FM stations to suppress spurious emissions in the band 108-137 MHz to -85 dB as a condition of authorization. This suppression level, which is measured off-air, is more stringent than the suppression level specified in BETS-6, which is a bench test standard. The applicant may have to employ external filtering to comply with this requirement.

2.6.3 Interference Prediction Model

Compatibility analyses and interpretation of the results are performed by ISED staff and NAV CANADA.

The Department has prescribed protection criteria and developed an interference prediction model (see Annex H) that is used for FM and aeronautical frequency assignments.

3. Technical Requirements for Establishing FM Broadcasting Stations Using Primary Allotments

This section pertains to the technical requirements for the allotment and protection of FM channels and for the prediction of coverage for FM broadcasting stations in Canada.

3.1 Definitions

Allocation: An allocation is an entry in the Canadian Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions. This term also applies to the frequency band concerned.

Allotment: An allotment is the entry of a designated frequency channel in an agreed plan, for use by one or more administrations for a terrestrial or space radiocommunication service in one or more identified countries or geographical areas and under specified conditions.

An up-to-date list of Canadian channels can be found on the Department's Spectrum Management and Telecommunications website at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf01842.html.

Assignment: An assignment is the authorized use of an allotment by an FM station.

Primary Assignment: A primary assignment is a protected assignment authorized or operating on an allotment with one of the classes listed under *Classification and Maximum Permissible Parameters of Allotments and Assignments* further below in this section (i.e. classes A1, A, B1, B, C1 or C).

Secondary Assignment: A secondary assignment is an unprotected assignment authorized or operating on a channel in accordance with sections 5 or 7 (i.e. LPFM or VLPFM).

Effective Radiated Power (ERP): The ERP is the product of the transmitter output power, the transmission line (and combiner) efficiency and the power gain of the antenna relative to a half-wave dipole.

Effective Height of the Antenna Above Average Terrain (EHAAT): The EHAAT is the average of the antenna heights above the average terrain (HAATs) for 8 radials spaced every 45° of azimuth starting with true north. The HAAT is the height of the centre of radiation of the antenna above the average elevation of the terrain, based on Canadian Digital Elevation Data (CDED), or equivalent, between 3 and 16 km from the antenna for each radial. In the event of a discrepancy, the analysis by the Department shall prevail.

Maximum Permissible Parameters: Maximum permissible parameters are the values of the maximum ERP and the associated EHAAT for the six classes of stations listed under *Classification and Maximum Permissible Parameters of Allotments and Assignments* further below in this section.

Operating Parameters: The operating parameters are the values of the ERP and EHAAT at which an FM station is authorized to operate.

Limited Allotment: A limited allotment is a channel on which an FM station, for purposes of protection, is required to operate with less than maximum parameters. A limitation may apply in one or more directions.

Unlimited Allotment: An unlimited allotment is a channel on which a station may operate with maximum parameters. Any allotment on which a station could operate with maximum parameters by virtue of spacing may qualify as an unlimited allotment and may be coordinated as such.

Antenna Pattern: A horizontal pattern is considered non-directional if the variations are contained within the ± 2 dB limit from the average value (perfect circle). If these limits are exceeded, the pattern is considered directional.

FM Channels: FM broadcast channels are allotted in the band 88-108 MHz with 200 kHz spacing. The channel centre frequencies begin at 88.1 MHz (channel 201) and continue in successive steps up to and including 107.9 MHz (channel 300).

Classification and Maximum Permissible Parameters of Allotments and Assignments: The class of an FM channel is defined by the maximum permissible ERP and the associated EHAAT. The FM classes are as follows:

- Class A1: a maximum ERP of 250 W with an EHAAT of 100 m
- Class A: a maximum ERP of 6 kW with an EHAAT of 100 m
- Class B1: a maximum ERP of 25 kW with an EHAAT of 100 m

- Class B: a maximum ERP of 50 kW with an EHAAT of 150 m
- Class C1: a maximum ERP of 100 kW with an EHAAT of 300 m
- Class C: a maximum ERP of 100 kW with an EHAAT of 600 m

The maximum ERP is calculated using the maximum value of radiation from the antenna in the plane of maximum radiation (i.e. beam tilt) and in the direction of maximum radiation for directional antennas.

An assignment made on an allotment having any of the above class designations is considered to be a "primary" assignment. An unprotected assignment made on an allotment having any of the above class designations is considered a "secondary" assignment.

Minimum Operating Parameters: The minimum operating parameters of a class are the lower limits of the operating parameters allowed for that class, and they are as follows:

- Class A1: an ERP of over 50 W with no minimum on EHAAT
- Class A: an ERP of over 250 W with an EHAAT of 100 m or equivalent
- Class B1: an ERP of over 6 kW with an EHAAT of 100 m or equivalent
- Class B: an ERP of over 25 kW with an EHAAT of 100 m or equivalent
- Class C1 or C: an ERP of over 12.1 kW with an EHAAT of 300 m or equivalent

For stations of class A, B1, B, C and C1, the calculated F(50,50) 1 mV/m contour remains at the same location when equivalent parameters are used.

For directional antenna patterns, the ERP values above relate to the maximum value of the pattern.

Unless exceptional circumstances warrant it, an FM assignment shall be designed to operate above the minima defined in this paragraph. Applications proposing the under-utilization of a channel may be required to reduce the station's class.

In cases where a proposal exceeds the maximum parameters for a given class but is below the minimum parameters for the succeeding class, the Department will usually limit the proposal to its proposed parameters to indicate that protection is only afforded to the actual 0.5 mV/m contour. For illustration purposes, such would be the case for a class B station with parameters of 26 kW ERP and a 50 m EHAAT. Exceptions may be made with sufficient justification.

Antenna Height and Power Equivalence: Where antenna heights exceed the values shown in *Classification and Maximum Permissible Parameters of Allotments and Assignments* above in this section, the ERP shall be reduced to provide equivalence with the maximum or other permissible parameters. In addition, where applicable, the interference zone for equivalent parameters must not exceed that determined by the F(50,10) propagation curves using the maximum or other permissible parameters.

Equivalence requires that the 1 mV/m contour remain at the same location. In calculating equivalence, the EHAAT should be used to determine the permissible ERP. Equivalence based on individual HAATs is not acceptable. Where a limitation is concerned, the HAAT in the pertinent direction (either derived from a terrain profile in the standard manner, or interpolated from the two adjacent HAATs, calculated every 10° from true north) should be used to determine the permissible ERP.

Although equivalence permits the EHAAT to exceed the maximum for the class with a reduction in ERP, it must be noted that the reverse is not permitted. Specifically, under no circumstances may the maximum ERP for the class be exceeded.

Permissible Interference to Unassigned Allotments Due to Short-Spacing: Proposed assignments may not produce an interference area within the following distances of unassigned allotments, assuming that the allotment would be assigned at the maximum parameters for its class:

- Class A1: a distance of 12 km
- Class A limited to 3 kW: a distance of 24 km
- Class A: a distance of 28 km
- Class B1: a distance of 39 km
- Class B: a distance of 50 km
- Class C1: a distance of 72 km
- Class C: a distance of 86 km

The above should not be interpreted as a reduction in the 0.5 mV/m contour to the reduced distance for unassigned allotments. Rather, when making an interference analysis (as per Annex F), the interference zone created shall be located beyond the applicable specified distance.

If an unassigned short-spaced allotment is already limited and the 0.5 mV/m contour extends beyond the above distances, interference areas are permitted to distances down to the values outlined above. However, if the 0.5 mV/m contour extends less than the above distances, no further interference is permitted.

Service Contours and Coverage Requirements: The service contours of a primary FM assignment are the 0.5 mV/m (54 dBµV/m) and 3 mV/m (69.5 dBµV/m) contours. The distance from the station to the service contours is determined using the F(50,50) curves in Figure A1 of Annex A and in Section 3.9 on contour determination.

A minimum field strength of 3 mV/m is required to provide satisfactory service to principal target centres, where a target centre refers to any populated area defined as city, town, locality, etc. as per Natural Resources Canada maps. If, however, the service requirements are for a regional station and the applicant specifically states that such is the purpose of the station, the 3 mV/m contour is not required and should not appear on the contour map.

A minimum field strength of 0.5 mV/m (54 dBµV/m) is required to provide satisfactory service to secondary target centres, where the reception is achieved by outdoor receiving antennas. A target centre refers to any populated area defined as city, town, locality, etc. as per Natural Resources Canada maps. For a regional station, the 0.5 mV/m (54 dBµV/m) contour is the only contour required.

The dBµV/m is the field strength in dB above one microvolt per metre (1 µV/m).

Protected Contour: The protected contour of a primary FM assignment is the 0.5 mV/m (54 dBµV/m) contour established using the F(50,50) propagation curves. In cases where a realistic service contour has been submitted in accordance with item (d) of Section 3.9.1, this contour shall be considered the protected contour in any location where it does not exceed the F(50,50) service contour.

Interfering Signal Contour: The distance to the interference contour is determined using the F(50,10) curves of Figure A2 of Annex A. For distances less than 15 km, the F(50,50) curves of Figure A1 of

Annex A may be used. When an antenna beam tilt is proposed, the ERP in the plane of tilt shall be used. See Section 3.9.3 on how to determine the interference contours.

Antenna Beam Tilt (Electrical and Mechanical): The antenna beam tilt is the inclination in degrees of the horizontal radiation pattern of the antenna which causes the maximum radiation to occur at an angle below the horizontal plane. The beam tilt may be achieved by mechanical or electrical means. The maximum permissible ERP, as defined under *Classification and Maximum Permissible Parameters of Allotments and Assignments* and *Antenna Height and Power Equivalence* above in this section, shall not be exceeded in either the horizontal or tilt planes.

Polarization: The polarization of the radiated signal is the orientation of the electric component of the electromagnetic field as radiated from the transmitting antenna. Circular polarization is normally used; however, horizontal, vertical or elliptical polarization may also be used. In any plane of polarization, the ERP shall not exceed that defined under *Classification and Maximum Permissible Parameters of Allotments and Assignments* and *Antenna Height and Power Equivalence* above in this section.

Distances to Various Contours: The distances to various contours, including service, interfering or equivalence contours, can be calculated with the F(50,50) and F(50,10) curves of Annex A or with any other suitable tool. The results calculated by the Department will prevail.

3.2 Domestic Allotment Principles

For border area allotments and assignments, refer to the Agreement Between the Government of Canada and the Government of the United States of America Relating to the FM Broadcasting Service and the Associated Working Arrangement.

The distance to the 0.5 mV/m (54 dBµV/m) protected contour of FM allotments and assignments shall be determined as described under Protected Contour in Section 3.1. However, unless limited, a station will retain the right to expand to maximum parameters as described under Classification and Maximum Permissible Parameters of Allotments and Assignments in Section 3.1. In any disputes concerning the right of expansion, the Department will adjudicate using operational precedence as a first criterion. Protection is only afforded to land areas.

The Maximum Protected Contour specifies the furthest extent to which a station can require protection and is defined by a radial distance from the transmitting site according to the class of station.

Table 1: Distance to Maximum Protected Contours

Class	Distance (km) to the Maximum Protected 0.5 mV/m (54 dBµV/m) Contour
A1	18
A	38
B1	51
B	65
C1	86
C	97

The protection distance for class C stations is based on an ERP of 100 kW and an EHAAT of 450 m.

Class C channels, whose 0.5 mV/m contour extends beyond 97 km, are permitted if protection to related assignments and allotments is provided.

The protected contour of an unoccupied limited allotment is determined using the limited parameters in all directions or in the direction(s) of limitation, where applicable. Protection should be provided on the basis of a practical directional antenna meeting the limitation(s).

Where the protected contour extends beyond the boundary of the country in which the allotment is located, protection will be provided to land areas only, including islands, lying within that country. In this case, overlap of the interfering and the protected service contours may be acceptable provided that the interference zone does not fall within these areas. Annex F describes the procedure to determine the interference zone.

3.3 Protection Ratios and Permissible Interfering Signals

Protection ratios and the corresponding permissible interfering field strength levels, i.e. F(50,10), at the protected contour of another frequency-related assignment or allotment are given in Table 2:

Table 2: Protection Ratios (dB) and Permissible Interfering Field Strengths

Channel Relationship	Protection Ratio (dB)	Permissible Interfering Field Strength
Co-channel	20	0.05 mV/m (+34 dBµV/m)
First adjacent	6	0.25 mV/m (+48 dBµV/m)
Second adjacent	-26	10 mV/m (+80 dBµV/m)

3.4 Domestic Separation Distances Between Co-channel and Adjacent Channel Allotments

Table 3 specifies the minimum separation distances in kilometres for all classes of channel assignments, using the maximum protected contour levels shown in Section 3.2 and the interfering signal levels shown in Section 3.3.

The separation distances for class C channels are based on an ERP of 100 kW and an EHAAT of 450 m.

For the purposes of international analysis, refer to separation distances of the *Changes to the 1991*

Working Agreement Between the Government of Canada and the Government of the United States of America Relating to the FM Broadcasting Service.

Table 3: Minimum Domestic Separation Distances (km)

	Relationship	Class A1	Class A	Class B1	Class B	Class C1	Class C
Class A1	**Co-channel**	78					
	200 kHz	45					
	400 kHz	22					
Class A	**Co-channel**	131	151				
	200 kHz	78	97				
	400 kHz	42	47				
Class B1	**Co-channel**	164	184	197			
	200 kHz	98	118	131			
	400 kHz	55	60	63			
Class B	**Co-channel**	189	209	222	236		
	200 kHz	117	137	150	164		
	400 kHz	68	73	77	84		
Class C1	**Co-channel**	223	243	256	270	291	
	200 kHz	148	168	181	195	216	
	400 kHz	90	95	99	106	119	
Class C	**Co-channel**	238	258	271	285	306	317
	200 kHz	166	186	199	213	234	245
	400 kHz	101	106	110	117	131	139

3.5 Short-Spaced Allotments and Assignments

Allotments and assignments that do not meet the minimum separation distances are considered to be short-spaced and may be subject to an interference zone within their maximum 0.5 mV/m protected contour and, in some cases, within their the 0.5 mV/m service contour.

For a proposal predicated on the use of an existing short-spaced allotment, interference to related short-spaced allotments and assignments shall not exceed that which would have been produced by the allotment at the allotment coordinates assuming maximum parameters for its class (unless limitations are present, in which case, the interference produced should be based on the limited parameters).

An increase or change in an interference zone to another assignment may be proposed only if both parties are in agreement (refer to Section 3.5.3 for procedural details).

3.5.1 Drop-in Channel

For a proposed short-spaced assignment or allotment based on a proposed channel that is not in the table of FM allotments (i.e. a drop-in channel) and where the affected allotment is:

- **unassigned**, protection is normally required to the maximum extent of the 0.5 mV/m contour for its class (the maximum protected contour). However, protection in accordance with the definition of *Permissible Interference to Unassigned Allotments Due to Short-Spacing* in Section 3.1 may be proposed provided that it is accompanied by a study indicating that the objective cannot be met by other less drastic measures such as a directional antenna, limitation, etc.

- **assigned**, protection is normally required to the protected contour. However, if an interference zone is proposed within the protected contour, the agreement of the affected licensee shall be sought (refer to Section 3.5.3 for procedural details). Protection due to terrain factors, especially in mountainous areas, may be considered where justified by the intervening terrain. Any recognized engineering method may be used.

In cases of disagreement, the Department reserves the right to make an independent determination.

3.5.2 Limitations

In the cases described in Section 3.5, including 3.5.1, interference zones that fall over water may be disregarded.

Where an allotment or assignment is proposed to be limited, the limitation is calculated by determining the allowable ERP and associated HAAT that provide protection to the related allotment or assignment. Normally, the associated HAAT is calculated by linear interpolation between the HAATs of the radials adjacent to the pertinent radial, calculated every 10° from true north. If a disagreement exists in the calculation of this HAAT due to irregular intervening terrain, the terrain profile shall be as determined by the Department. Generally, limitations will, if necessary, be calculated and imposed by the Department in accordance with the above criteria.

3.5.3 Notifications

In most cases of short-spacing(s) to an assignment(s), the applicant shall send a copy of the engineering brief with a covering letter or email to the affected station(s) licensee(s), preferably at the date of filing the application or immediately after the CRTC has issued a Notice of Public Hearing. Exceptions to this requirement are given in Section 3.5.3.1.

The affected licensee has 30 days after receiving the engineering brief to reply, if so desired, and the Department is required to send comments to the CRTC at least 20 days prior to the hearing. Therefore, the applicant should send the letter to the affected licensee with a copy of the brief early enough so that the affected licensee may be in a position to reply at the latest 30 days before the start of the public hearing. Should the 30-day response time fall beyond this deadline, the Department may not be able to send technical comments to the CRTC. It is important to note that, in such a case, the applicant runs the risk of having the application withdrawn and shall assume full responsibility for it.

The applicant shall send a copy of this letter or email and confirmation of receipt by the affected broadcasting certificate holder, as proof of delivery, to the Department. The letter or email shall advise the affected certificate holder of the proposed short-spacing and interference zone where applicable, and shall emphasize that the certificate holder's comments shall be submitted to the Department, along with copy to the applicant, no later than 30 days after receipt of the engineering brief. Where the affected certificate holder offers an objection, the application may not be accepted by the Department, as explained in the next paragraph. If no reply is received within the specified period, the Department will assume that the affected certificate holder agrees with the proposal.

The affected licensee shall use the criteria contained herein together with established engineering practices in the analysis that the licensee will conduct. Should the affected party offer an objection, the Department reserves the right to make an independent decision predicated on efficient spectrum usage.

3.5.3.1 Exceptions

Notification is not required if the separation distance between the actual F(50,10) interfering contour of the proposed station and the protected contour of the incumbent station equals or exceeds the following:

- 15 km for a co-channel;
- 10 km for a first-adjacent channel; and
- 5 km for a second-adjacent channel.

If such is the case, the applicant must indicate in the engineering brief that the notification is not required pursuant to this exemption criterion. Furthermore, should a licensee that was not notified due to this exemption request a copy of the engineering brief, the applicant will be required to comply with the request without delay.

3.5.4 Short-Spacing in the Canada-US Coordination Zone

The domestic rules relating to the second- and third-adjacent channels differ from the ones in the Canada-US FM broadcasting agreements described in Section 1. When interference is caused by a US assignment or allotment, applicable domestic protection rules may be used to determine the interference zone within the 0.5 mV/m service contour of the Canadian assignment.

For interference from US class C allotments or assignments, interference zones shall be shown using the standard ratios per Section 3.3 based on maximum parameters for the US allotment or assignment of 100 kW ERP and 450 m EHAAT, except where limitations on the US station apply. Where limitations apply, the interference zone may reflect the appropriate reduction in interference. Where parameters exceed the maximum, the interference zone shall reflect the actual parameters.

3.5.5 Overlapping Interference Zones

Should a proposed interference zone be contained within an interference zone from another station that has previously been accepted by the incumbent, the incumbent is not obliged to accept the new interference from the proposal. However, the Department does encourage acceptance by the incumbent in cases where the channel relationships (e.g. first-adjacent, second-adjacent, etc.) of the proposed interference would have the same or a lesser effect than the previously accepted interference, and would expect justification in the event of a refusal. If required, the Department reserves the right to make an independent decision on acceptance.

3.6 Channels Separated by 600 kHz and 800 kHz

FM stations separated by 600 kHz or 800 kHz and operating in the same area may interfere with each other if not co-sited and, therefore, co-siting is strongly recommended if possible. For co-sited proposals, there are no interference remedying responsibilities; however, the ERP shall not exceed the ERP of the incumbent station by more than 20 dB in any direction. For the purposes of this section, co-siting is defined as being located within 100 m of an incumbent station.

3.6.1 Area Enclosed Within the 100 dBµV/m Contour Limit

A new station may be implemented within the F(50,50) 100 dBµV/m contour of an incumbent station, separated by 600 kHz or 800 kHz, if the new station's 100 dBµV/m contour is completely enclosed within the 100 dBµV/m contour of the incumbent station. As interference is considered highly unlikely in such a situation, no particular interference remedying responsibilities will be prescribed for the applicant, with the exception of dual third-adjacent situations as described in Section 3.6.5.

3.6.2 Area Extending Outside the 100 dBµV/m Contour Limit

If a new station is located such that its calculated 100 dBµV/m contour intercepts or overlaps the geographical zone between the 100 dBµV/m contour and the protected 54 dBµV/m contour of an incumbent station with frequency separation of 600 kHz or 800 kHz, an estimate of the population inside this zone is required. This area shall be plotted on an appropriately scaled map and submitted to the Department.

The new station shall be responsible for remedying any valid complaints of third- or fourth-adjacent channel interference (whichever is applicable) related to the reception of the incumbent station during the on-air testing period. If the new station is proposing the use of an allotment and the incumbent station has already accepted interference per Section 3.6.6, this requirement shall not apply in the previously identified interference zone to the incumbent station.

Complaints shall be considered valid where all the following criteria are met:

(a) The listener must be inside the authorized service contour of the incumbent station.

(b) The listener must have reception equivalent to ITU quality grade 3 or better when the new station is not transmitting.

(c) The listener must experience impaired reception defined as one level (or greater) reduction on the ITU quality grade scale that is attributed to the emissions of the new station.

Table 4: Quality Grade Scale

Grade	Quality
5	Excellent
4	Good
3	Fair
2	Poor
1	Bad

A complete definition of the above grades is given in the ITU-R Recommendation BS-1284, which may be obtained from the ITU website.

Should interference occur, remedies that are available at the new station's expense include, but are not limited to:

- a receiver replacement;
- receiver filters;
- the selection of an alternative transmit frequency for either station;
- a change of site;
- co-siting with the incumbent; and
- the reduction of parameters.

3.6.3 Notifications

In all cases, the incumbent station(s) shall be notified of the proposed operation in accordance with Section 3.5.3. It should be noted that the Department will not deny technical acceptability due to an objection from an incumbent station in a situation as described in Section 3.6.2. The Department will, however, advise the CRTC of the objection and provide it with details of the population count and location likely to be affected.

3.6.4 Protection of New Stations

New stations are not protected against interference from incumbent stations separated by 600 kHz or 800 kHz with overlapping service contours, except in the context of the requirements under Section 3.11.4.

3.6.5 Dual Third-Adjacent Stations

In a market where there are already two third-adjacent incumbent stations that are not co-sited, an application involving a channel third-adjacent to either incumbent will be considered only if the proposal is based on co-siting with the incumbent on the channel third-adjacent to the proposed channel and if the proposed class is equal to or lower than that of the incumbent.

Furthermore, since receiver intermodulation interference to incumbent stations is a known possibility in such dual third-adjacent situations, the applicant should be fully aware of this possibility and of its responsibility to remedy any such interference identified during the on-air testing period.

3.6.6 Existing Unassigned Allotment

Should a proposed drop-in station be third- or fourth-adjacent to an existing unassigned allotment, the applicant's responsibilities for the acceptance of related interference from a future assignment on the allotted channel shall be determined by performing a technical analysis as per sections 3.6.1 or 3.6.2, as relevant, based on the maximum parameters[1] for the allotted channel at the allotment site.

Notification of the proposed operation in accordance with Section 3.5.3 shall be provided to any party having a known interest in the use of the affected allotment. This includes instances where the affected allotment is identified in the *CBC Long Range Radio Plan*.

[1] Class C maximum parameters shall be considered as 100 kW ERP and 450 m EHAAT for the purpose of this analysis.

3.7 Limitations

3.7.1 Changes to Existing Limitations

Limitations imposed before the publication of Canada Gazette notice SMBR-003-08, Changes to the Domestic Protection Criteria for FM Broadcast Stations, were usually based on protection to the maximum protected contour for a given station. It is recognized that many of these existing limitations may now be relaxed. Requests for relaxation of a limit(s) will be assessed by the Department on a case-by-case basis.

3.7.2 Calculation of Limitations

For calculating domestic limitations, the Department will generally use the following guidelines:

(a) Limitations will be imposed on short-spaced incoming stations to provide protection to the maximum protected contour (see Section 3.2) of affected assignments and allotments where possible.

(b) If full protection is not possible, the incoming station will be limited to its proposed parameters at the pertinent range of azimuths.

(c) In cases where an incoming station would be subject to many different limitations at various azimuths, the Department may choose to limit the station to proposed parameters instead of specifying individual limitations.

As noted under *Minimum Operating Parameters* in Section 3.1, a proposed station with parameters below the minimum for its class will also usually be limited to its proposed parameters.

Notes:

(a) Incumbent stations retain the right to increase to maximum parameters for their class and will not be subject to a limitation to protect subsequent incoming assignments, but they must accept that a certain level of interference from incoming stations may exist in their expanded service area.

(b) As described above, incoming stations will be limited to protect the maximum protected contour of the incumbent or limited to their proposed parameters if this is not possible. This is intended to minimize the amount of interference that the incumbent station would need to accept in the event of future expansion to a minimum. The underlying concept is that a limitation on an incoming station that protected the actual contour of an incumbent would imply that the incoming station had the right to future expansion to these parameters and that future expansion by the incumbent would require acceptance of a level of interference based on the limitation which would greatly exceed that corresponding to the proposed parameters of the incoming station. This would place unintended constraints on incumbent stations.

(c) Given that the limitations on incoming stations may be more severe than necessary to protect incumbents to their actual protected contour, it should be understood that expansion past the limitation will still be permitted provided that the incumbent remains protected as required.

(d) For the above requirements, an incoming station is defined as either a drop-in station or an existing station proposing changes which can affect an incumbent station that predates it.

The Department reserves the right to deviate from these guidelines or modify limits if required.

3.8 Changes to the Table of Allotments

When an FM service is being contemplated for a particular area and the Canadian FM broadcasting table of allotments does not contain a suitable unoccupied allotment, changes to the table of allotments may be proposed by an applicant.

3.8.1 Types of Changes

Applicants may propose the following types of changes, separately or in combination, concerning the addition or reclassification of an allotment:

(a) Adding or changing an allotment without affecting any other allotment.

(b) Adding or changing an allotment at the expense of short spacing an existing allotment or assignment. In this case, the short-spacing and its resulting interference may be accepted without limitations or a channel limitation may be required to avoid interference. Where an assignment is concerned, the licensee's comments on the proposed limitation shall be sought (refer to Section 3.8.3). Where an allotment is concerned, refer to the definition for *Permissible Interference to Unassigned Allotments Due to Short Spacing* in Section 3.1.

(c) Adding or changing an allotment at the expense of reclassifying an existing allotment or assignment. Where the reclassification of an assignment is proposed, the licensee's agreement on the proposed reclassification shall be obtained as per Section 3.8.3.

(d) Adding or changing an allotment at the expense of deleting an existing allotment.

(e) Adding or changing an allotment at the expense of changing the frequency of an allotment or an assignment. In case of the latter, the licensee's agreement shall be obtained as per Section 3.8.3.

(f) Moving an allotment to an area and appropriately replacing the shifted allotment.

Note: The lowering of the class of existing allotments should be avoided unless exceptional circumstances warrant it.

3.8.2 Impact on the Table of Allotments

It is noted that some of the changes in Section 3.8.1 may have a positive impact on one area but a negative impact on another. If the Department accepts an applicant's proposed changes, it would report to the CRTC on the technical aspects of the changes and their impact on the provisions of the table of allotments, provided that the application containing the proposal is complete. In such a case, the changes would be considered conditionally technically acceptable pending a decision by the CRTC. Any changes to the table of allotments that may be required as the result of such applications would not be made until the Department declares them technically acceptable and the CRTC approves the application.

3.8.3 Application Requirements

When an application for a new FM undertaking requires modifications to the table of allotments, the applicant may consult with the Department regarding these modifications prior to the formal filing of an application. Where pertinent, the study shall show that the coverage objective of the proposal cannot be achieved by less drastic measures, such as through the use of a limited allotment and/or directional antenna, etc.

Any application proposing to change the frequency of an assignment will be found to be incomplete unless it is accompanied by proof that the affected station agrees to the change.

Applicants proposing to limit or reclassify a channel occupied by an assignment shall send a copy of the engineering brief along with a covering letter to the licensee of the affected station. The agreement of the affected licensee is required and the applicant shall file a copy of the agreement with the Department.

All potential interference zones to the proposal shall be shown on the proposal's service contour map and it is implicitly recognized that the applicant does not intend to serve the areas within these zones. Interference zones to the proposal shall be calculated in accordance with Annex F, based upon the maximum parameters for the class of the interfering station (unless specific limitations towards the proposed channel apply to the interfering station, in which case, the accepted interference zone may be adjusted accordingly). The applicant may, if desired, also show zones based on the actual parameters of the interfering station(s) and/or supply a separate map showing these zones only. The interference zones shall be shown as a hatched area on the map(s).

Interference zones from grandfathered, over-parameter stations are to be drawn based on the actual parameters of the interfering station where the parameters exceed the maximum for the class.

3.8.4 Incompatibilities

In all of the cases described in 3.8.1, problems can arise when changes to the plan of allotments proposed by one applicant are not compatible with changes proposed by another applicant. It should be noted that incompatibilities can occur even when the proposed service areas are geographically well separated. The Department encourages applicants to cooperate in the search for an early solution to problems of incompatibility. In this regard, the Department will, without divulging the details of the proposed changes, make any incompatibilities known to each of the applicants involved, urging their resolution prior to consideration of the applications by the CRTC.

3.8.5 Allotment Planning

Applications for modifications to the Canadian table of FM allotments may be made with, or independently from an application for an assignment. In either case, documentation with respect to the allotment change(s) shall be submitted.

An assignment does not convey a right, real or implied, to a station licensee for continued protection of the licensee's class of station if the operating parameters fall into a lower class. In such cases, the assignment may be reduced to a lower class to facilitate additional allotments and assignments.

The Department may make changes to the Canadian table of FM allotments which are independent of any application received. It will also make independent decisions, based on maximizing efficient spectrum usage, in its role as spectrum manager.

3.9 Contour Determination

All applications for new stations or for changes to an existing antenna or transmitter are required to show the service contours. In determining the service area of a broadcast station, two field strength contours are required. These are the 0.5 mV/m and 3 mV/m contours which indicate the approximate extent of coverage over average terrain in the absence of interference from other FM stations. Under actual conditions, the true coverage may vary greatly from these estimates because the terrain over any specific path is expected to be different from the average terrain on which the propagation curves are based.

3.9.1 Prediction of Coverage

The following details of the calculations and pertinent data for determining the field strength contours shall be presented in the engineering brief in the following order:

(a) the calculation of the EHAAT;

(b) the calculation of the ERP;

(c) the sources of information (such as maps) for arriving at the HAATs;

(d) a detailed analysis with profile data for unique circumstances, such as for locations in mountainous terrain, where a method other than that outlined herein is used for determining the service area contours; and

(e) a table presenting prediction of coverage modelled after Table 5 below.

Table 5: Example of Table Presenting Prediction of Coverage

Radial Number (1-36)	Azimuth (10-degree intervals starting from true north)	ERP (kW)	HAAT (metres)	Distance to 3 mV/m Contour (km)	Distance to 0.5 mV/m Contour (km)
1	0	20	191	32	64
2	10	20	207	34	64
3	20	20	232	35	66
…	…	…	…	…	…
…	…	…	…	…	…
34	330	20	200	32	64
35	340	20	311	40	76
36	350	20	296	40	74

In predicting the distances to the field strength contours, the F(50,50) curves of Annex A should be used. The F(50,50) curves represent the field strength at 9.1 m above ground which is exceeded for 50% of the time at 50% of the locations as measured in decibels above one microvolt per metre. The curves are based on an effective power of one kilowatt radiated from a half-wave dipole in free space, which produces an unattenuated field strength at one kilometre of about 107 dB above one microvolt per metre.

3.9.2 Location of Service Contours

The distances to the 0.5 mV/m and 3 mV/m contours shall be predicted by using the ERP in the plane of maximum radiation, the HAATs in the direction of 36 radials equally spaced starting from true north, and the F(50,50) propagation curves.

Service contours shall be defined using at least one point at every 5° starting at 0° true north, using F(50,50) on the interpolated HAAT[2] and actual ERP in that direction. For highly directional patterns, more points shall be added, as required, to properly define the nulls and the shape of the directionality in the pattern.

All contours must define a closed region, thus covering 360°.

3.9.3 Interference Contours

Interference contours shall be determined using the same method as for the service contours except that the F(50,10) propagation curves are to be used. The level of detail provided shall be similar to that of the service contour.

3.10 Computation of Distance and Azimuth

Where transmitter sites have been established, the actual coordinates of the transmitter sites shall be used as reference points. If a transmitter site has not been established, the community's reference coordinates (the coordinates of the centre of the city) shall be used unless the coordinates have been specified in the table of allotments.

The distance between reference points is considered to be the length of the hypotenuse of a right angle triangle, one side of which is the difference in latitude of the reference points and the other side the difference in longitude of the two reference points, and shall be computed as follows:

(a) Convert latitude and longitude into degrees and decimal parts of a degree. Determine the middle latitude of the two reference points (average the latitudes of the two points):

$$LATM = \frac{LAT1+LAT2}{2}$$

(b) Determine the number of kilometres per degree of latitude difference for the actual middle latitude in (a) above:

$$LATK = 111.108 - 0.566 \cos (2LATM)$$

(c) Determine the number of kilometres per degree of longitude difference for the actual middle latitude in (a) above:

$$LONGK = 111.391 \cos (LATM) - 0.95 \cos (3LATM)$$

[2] HAAT values for the service contours shall be linearly interpolated from 36 radials equally spaced starting from true north.

(d) Determine the north-south distance in kilometres:

$$LAT = LATK (LAT1 - LAT2)$$

(e) Determine the east-west distance in kilometres:

$$LONG = LONGK (LONG1 - LONG2)$$

(f) Determine the distance between the reference points by the square root of the sum of the squares of the distances obtained:

$$DIST = \sqrt{LAT^2 + LONG^2}$$

where:

LAT1 & LONG1 = coordinates of the first location in decimal degrees;

LAT2 & LONG2 = coordinates of the second location in decimal degrees;

LATM = middle latitude between points;

LATK = kilometres per degree of latitude difference;

LONGK = kilometres per degree of longitude difference;

LAT = north-south distance in kilometres;

LONG = east-west distance in kilometres; and

DIST = distance between two reference points in kilometres.

In computing the above, sufficient decimal figures shall be used to determine the distance to the nearest kilometre. The method for computing distances provides adequate accuracy for determining distances of less than 350 km.

The azimuth or the bearing between true north and the radial connecting one reference point to the other shall be calculated as follows:

$$BEAR = \arccos\left(\frac{\sin(LAT2) - \sin(LAT1)\cos(d)}{\cos(LAT1)\sin(d)}\right)$$

(a) Convert latitude and longitude into degrees and decimal parts of a degree.

(b) Determine the arc length in degrees between the two reference locations:

$$d = \arccos[\sin(LAT2)\sin(LAT1) + \cos(LAT2)\cos(LAT1)\cos(LONG1 - LONG2)]$$

(c) Calculate the bearing (if the second location is west of the initial location, subtract the result from 360°; i.e., 360 - BEAR),

where:

LAT1, LAT2, LONG1 and LONG2 are as specified previously in this section;

d = arc length between locations in decimal degrees; and

BEAR = angle between true north (0°) and the connecting radial in decimal degrees.

In computing the above, sufficient decimal figures shall be used to determine the bearing to the nearest degree.

3.11 Assessment and Control of High Field Strength of FM Broadcasting Stations

Service requirements and constraints related to the siting of FM broadcasting stations may result in high signal strength levels in populated areas. Under these conditions, FM receivers are susceptible to intermodulation interference. In addition, broadcast receivers are susceptible to immunity-type interference, and non-radio frequency equipment (radio-sensitive equipment) may be affected as well.

To avoid or to minimize such problems, applicants are encouraged to locate their transmitters away from populated areas. Where this is unavoidable, it is necessary to assess the potential for interference.

3.11.1 Purpose

The purpose of this section is to:

- identify the analysis required from applicants in determining interference potential;
- define the responsibilities of broadcasters in response to interference complaints; and
- identify non-valid complaints of interference.

The requirements of this section apply to all applications for the issue or amendment of broadcasting certificates for FM broadcasting stations using primary frequency assignments.

3.11.2 Requirements for Interference Analyses and Population Estimates

In addition to the departmental requirements outlined in Section 2.2 regarding the engineering brief, interference analyses as per sections 3.11.2.1, 3.11.2.2 and 3.11.2.3 are required. In specific cases, the Department may accept a common assessment for co-located stations, diplexed or otherwise.

3.11.2.1 Intermodulation Interference

Two types of intermodulation interference can take place. Transmitter-generated intermodulation interference may occur when two or more FM stations are in close proximity. FM receiver-generated intermodulation interference takes place in an FM receiver and depends on the intensity of the FM signal of the proposed station.

3.11.2.2 Receiver-generated Intermodulation Interference

Receiver-generated intermodulation interference can take place in the vicinity of an FM station and the severity of the interference potential depends on the broadcasting radio environment. Consequently, the Department requires that applicants requesting a new station or changes to an existing station submit an estimate of the population within the 115 dBµV/m contour.

The location of the contours shall be determined using the appropriate F(50,50) field strength curves and shown on a suitable map. For distances of less than 1.5 km, the free space formula should be utilized (refer to Section 3.11.3 for contour calculation).

Every attempt shall be made to keep the population within the 115 dBµV/m contours to a minimum. The Department reserves the right to request changes to the antenna site, to the antenna height, to the antenna itself, or to the radiated power to reduce the population within these high signal level contours.

3.11.2.3 Immunity-Type Interference

Broadcast receivers and their associated equipment, as well and non-radio equipment (radio-sensitive devices), are expected to operate properly within field strengths lower than those indicated in the Department's Electromagnetic Compatibility Advisory Bulletin EMCAB-2, *Criteria for Resolution of Immunity Complaints Involving Fundamental Emissions of Radiocommunications Transmitters*. The Department uses EMCAB-2 to make determinations on interference or immunity cases.

3.11.3 Method for Calculating High Field Strength Contours

The antenna radiation patterns, vertical and horizontal (if antenna is directional), are normally supplied by the antenna manufacturer. In predicting high field strength contours, the ERP should be based on the appropriate antenna vertical plane radiation pattern for the azimuthal direction concerned.

For distances of less than 1.5 km from the transmitting site, the field strength should be determined from the following free space formula:

$$F = 137 + 10 \log (ERP) - 20 \log(d)$$

where:

F is the field strength in dBµV/m (decibels above one microvolt per metre);

ERP is the effective radiated power in watts at the pertinent depression angle; and

d is the slant distance (in metres) between the centre of radiation of the antenna and the receiving location.

For distances between 1.5 and 4 km, the field strength should be determined from the F(50,50) curves using the height of the antenna radiation centre with respect to the location under consideration.

For distances beyond 4 km, the field strength should be determined from the F(50,50) curves using the pertinent HAAT.

Whenever F(50,50) curves are being used, the antenna height and the distance from the tower should be used to determine the depression angle as per Figure C1 of Annex C. The ERP for that direction shall be determined.

High field strength prediction may involve nulls in the vertical radiation pattern which shall be taken into consideration. The distances (d_i) along the ground where the field strength is at minimum due to a vertical pattern null can be calculated using the following relationship:

$$d_i = \frac{H}{\tan(\theta_i + A)}$$

where:

A and θ_i are the beam tilt angle and the angles corresponding to the different nulls in the vertical pattern respectively (both in degrees);

H is the height (in metres) to radiation centre of antenna; and

d_i is the distances in metres along the ground.

For values of $\theta_i + A \leq 10°$:

$$d_i = \frac{57.3H}{\theta_i + A}$$

3.11.4 Resolving Issues

3.11.4.1 Responsibilities

In the case of intermodulation-type interference, broadcasters will accept responsibility to:

(a) remedy valid complaints of receiver-generated intermodulation interference within the 115 dBμV/m contour if the receiver was introduced within the contour before the station started operating with the new facilities (refer to Section 3.11.4.2 for the list of complaints judged not valid by the Department);

(b) provide technical advice to complainants located within the service contour of the station concerning appropriate action to resolve interference problems of this type attributed to the station;

(c) keep the appropriate district office of the Department fully informed of all complaints received and actions taken; and

(d) assume their appropriate share of responsibility to immediately remedy the problem when more than one FM station is involved in transmitter-generated intermodulation products.

In the case of immunity-type interference, broadcasters will be responsible for remedying valid complaints.

The guidelines on resolving immunity issues related to radio-sensitive equipment are outlined in ISED's Client Procedures Circular CPC-3-14-01, *Determinations of Harmful Interference with Respect to Radio-Sensitive Equipment*. CPC-3-14-01 can also be used as a guide for resolving immunity-related interference to broadcast receivers and associated equipment.

3.11.4.2 Complaints Judged Not Valid by the Department

The following are the types of complaints judged not valid by the Department and for which broadcasters are not responsible for remedial action:

(a) where the complaint is attributed to the use of a malfunctioning or mistuned receiver or an improperly installed or defective antenna system;

(b) where the complaint is attributed to the desired signal being received at a location outside the coverage area of the station;

(c) where the complaint is attributed to the desired signal not being favourably received because of adverse local propagation conditions or building penetration losses;

(d) where the complaint involves the reception of signals originating from outside Canada;

(e) where the complaint involves a high gain receiving antenna and/or an antenna booster amplifier intended for reception of distant stations which, as a consequence, overloads the receiver or creates intermodulation in the amplifier output;

(f) where the complaint involves intermodulation interference inside the 115 dBµV/m contour, if the devices were introduced within the contour after the station started operating with the new facilities;

(g) where the complaint is attributed to immunity-type interference to broadcast receivers and associated equipment that are located in an area where the measured field strength does not exceed 125 dBµV/m;

(h) where the complaint is attributed to immunity-type interference to radio-sensitive equipment that is located in an area where the measured field strength does not exceed 130 dBµV/m; and

(i) any other complaint that, in the judgment of the Department, is considered not valid.

3.12 Potential Interference to TV From FM Broadcasting Station Assignments

These guidelines identify a number of potential interference situations involving FM and television reception and establish appropriate requirements applicable to each situation. They apply to both analog and digital TV.

3.12.1 Second Harmonic Interference

Second harmonic radiation from FM transmitters may cause objectionable interference to the reception of TV signals on channels 7 to 13 in areas where the TV signal level is relatively low compared to the FM signal. Present standards in Canada require that the second harmonics of FM transmitters be attenuated by 80 dB or more below the level of unmodulated carrier, depending on the operating power. In areas where the ratio of FM to TV signals is quite large, the relative level of the FM second harmonic may interfere with TV reception. Since there are a number of cases where such second harmonic relationships exist in the present table of allotments for FM and TV, care may need to be exercised in selecting sites for new stations in order to avoid high ratios of FM to TV signal levels which might result in objectionable interference.

In circumstances where it is difficult to avoid the aforementioned channel relationships, the engineering brief shall indicate that the applicant is aware of the situation and shall include an undertaking from the applicant that complaints of interference will be investigated and appropriate measures will be taken to remedy the situation at the applicant's own expense.

3.12.2 Interference to Channel 6 From FM Broadcasting Stations on Channels 201 to 220

To minimize possible interference to TV channel 6 from FM transmissions on channels 201 to 220 inclusive, the FM and TV signal strengths at TV receiver locations must not exceed certain levels. To achieve this objective, the siting of FM stations and their power levels, in relation to TV channel 6, have to be considered.

Interference to TV channel 6 depends on the frequency separation and the levels of both the FM and TV signal strengths. To minimize interference, it is desirable to equalize the ratio of the FM to TV signal strengths at all receiver locations and therefore co-location or near co-location of the FM and TV stations is highly recommended. Near co-location means within 400 m of the TV channel 6 transmitter site. Alternatively, if co-location or near co-location is not possible, an FM transmitter site outside the service contour of the TV station may be considered.

FM stations on channel numbers 201 to 220 that are co-located or near co-located with a TV station on channel 6 shall have ERP (horizontally polarized component) ratios that do not exceed the values of Table 6, provided that both antennas have similar heights. If the height of the FM antenna differs by 30 m or more from the height of the TV antenna, the power of the FM station shall be adjusted to take into account the difference in height of both antennas. Where directional antenna patterns are used, the FM to TV ERP ratios shall not exceed those given in Table 6 at any azimuth.

Table 6: Permissible FM to TV Power Ratio for FM Channels 201 to 220 Inclusive, When Co-located or Near Co-located With TV Channel 6

Channel	FM/NTSC TV (dB)	FM/DTV (dB)
201	-9.0	+17
202	-7.5	+25
203	-6.2	+31
204	-5.0	+40
205	-4.4	+40
206	-4.4	+40
207	-4.4	+40
208	-4.4	+40
209	-4.4	+40
210	-4.4	+40
211	-4.0	+40
212	-3.4	+40
213	-2.4	+40
214	-1.3	+40
215	0.0	+40
216	+1.5	+40
217	+3.5	+40
218	+6.0	+40
219	+8.8	+40
220	+11.5	+40

Notes:

- The NTSC (National Television System Committee) TV power is the ERP of the visual power and is referenced to the root-mean-square (r.m.s.) of sync peak. The FM power is the ERP and is referenced to the r.m.s. power.

- The FM to NTSC TV power ratios are based on a quality of a TV picture defined as an ITU-R picture impairment grade of 4.0 and the FM to TV signal ratio at the receiver is taken at a TV receiver input signal of -25 dBm. The ratio applies to 70% of all receiver locations.

The FM to TV power ratios shown are for horizontal polarization of the TV and FM stations. If beam tilt is to be used for either the TV or FM antenna, the maximum power(s) at the beam tilt angle(s) is (are) to be used. If elliptical polarization is used for the FM station, the FM power for the vertical polarized component may be up to 6 dB greater than the horizontal component.

FM to NTSC TV power ratios in excess of the values shown in the above table may be allowed when there is no resident population near the FM transmitting site or when indoor receiving antennas are used. For such cases, the applicant shall demonstrate that the NTSC TV channel 6 signal at the receiver input in the viewers' homes is less than -25 dBm. The FM to NTSC TV power ratio can be increased by selecting a lower TV receiver input signal level. The protection to NTSC TV channel 6 from an FM signal at various frequencies and at various TV receiver input levels of the channel 6 signal is shown in Annex G.

For FM stations located outside the protected contour of channel 6, the permissible horizontally polarized field strength of the proposed FM station, at the protected contour of the TV station, shall not exceed the value shown in Table 7, using the F(50,10) propagation curves. If elliptical polarization is used for the FM station, the field strength level of the vertical polarized component may be up to 6 dB greater than the horizontal component.

In the case of protection to a DTV channel 6, the protected contour is the noise-limited bounding contour as defined in BPR-10.

Table 7: Permissible Field Strength Levels of FM Channels 201 to 220 Inclusive at Grade B Contour of TV Channel 6 and at the 28 dBµV/m Noise-Limited Bounding Contour for DTV

Channel	Field (dBµV/m) at the Grade B NTSC	Field (dBµV/m) at the 28 dBµV/m Contour of DTV
201	57	44
202	60	52
203	63	59
204	66	68
205	70	68
206	74	68
207	77	68
208	77	68
209	77	68
210	78	68
211	78	68
212	78	68
213	79	68
214	81	68
215	82	68
216	84	68
217	86	68
218	89	68
219	92	68
220	95	68

Note: For NTSC TV, the above table is derived on the basis of an FM to TV channel 6 ratio at a TV receiver input signal level of -65 dBm (or -84 dBm for DTV reception). This is equivalent to the field strength obtained at the grade B contour (or the noise-limited bounding contour in DTV). The value in the table includes a 6 dB directivity discrimination for the antenna together with a quality of TV picture defined as an ITU-R picture impairment grade of 4.0.

3.13 Technical Requirements for Multiplex Operations

The following technical requirements govern the use of multiplex subcarrier transmissions by frequency modulated broadcasting stations in the band 88-108 MHz for purposes of providing subcarrier services

other than stereophonic broadcasting. These requirements set forth the technical standards to be followed by applicants in establishing a multiplex operation.

3.13.1 Multiplex Subcarrier

A multiplex subcarrier is a subcarrier having a frequency within the range 20-99 kHz of the FM baseband and which is modulated with the subsidiary communication information.

3.13.2 Multiplex Transmission Standards

Any form of modulation may be used on any SCMO subcarrier except for RBDS, as explained below in this section.

More than one subsidiary communications subcarrier may be used simultaneously provided that:

- during stereophonic or monophonic transmission, multiplexed subcarriers shall be within the baseband frequency range of 53 to 99 kHz; and

- during periods when no broadcast programs are transmitted, multiplexed subcarriers may be within the baseband frequency range of 20 to 99 kHz.

During stereophonic or monophonic program transmissions, the modulation of the carrier by the arithmetic sum of all multiplex subcarriers may not exceed 20% referenced to ± 75 kHz deviation and the modulation of the carrier by the arithmetic sum of all multiplex subcarriers above 76 kHz shall not exceed 10% referenced to ± 75 kHz deviation. When more than one subcarrier is used, the total modulation may be increased by 0.5% for each 1% subcarrier injection modulation, and under no circumstances may the total modulation of the carrier exceed 110% (82.5 kHz peak deviation).

During periods when no broadcast programs are being transmitted, the modulation of the carrier by the arithmetic sum of all multiplex subcarriers above 76 kHz may not exceed 10% (7.5 kHz) and the modulation of the carrier by the arithmetic sum of all subcarriers may not exceed 30% referenced to 75 kHz (22.5 kHz peak deviation).

During monophonic or stereophonic program transmission, the cross-talk, within the range of 50 Hz to 53 kHz caused by all multiplex subcarriers, shall be at least 60 dB below the 100% modulation (75 kHz peak deviation) reference.

Broadcasting undertakings that wish to transmit Radio Broadcast Data System (RBDS) shall use the RBDS standard of the US National Radio Systems Committee (NRSC). The specifications of the NRSC standard are available from the National Association of Broadcasters (NAB), Washington, DC, USA.

The 57 kHz subcarrier (54.6-59.4 kHz occupied bandwidth) in the base band of the FM signal is reserved for RBDS applications using the NRSC standard.

3.14 Directional Antennas

Directional antennas may be used by stations operating on unlimited allotments, but their use shall not prevent future increases up to the maximum parameters. Directional antennas may also be used by stations occupying or proposing the use of limited allotments to render protection to co-channel and adjacent channel stations.

For protection purposes, the ratio of maximum to minimum fields of a directional antenna system may not be greater than 20 dB. The radiation from a directional antenna shall not vary from the notified radiation pattern by more than ± 2 dB. Where limitations are involved, the radiation in the direction(s) of protection shall not exceed the limitation. For antenna patterns not meeting this tolerance, the radiation shall be reduced accordingly.

The notified radiation pattern shall include the effect of the mounting structure and the margin of accuracy, and shall be certified by the manufacturer or the supplier.

3.15 Transmitter Locations

FM station transmitters shall be located to serve the principal centre to which the channel is assigned. Transmitter sites shall be located so that the separations are not less than those set forth in Section 3.4, except when specifically agreed to in accordance with Section 3.5.

4. Applications for Low-Power FM (LPFM) Broadcasting Stations

This section outlines the procedure to be followed in preparing and submitting technical information required in support of applications for LPFM stations using standard FM channels on an unprotected non-interfering basis (an LPFM assignment is considered to be a secondary assignment as per the definition for *Secondary Assignment* in Section 3.1).

4.1 Application Requirements

An application to the Department for a broadcasting certificate shall be accompanied by an application to the CRTC for a broadcasting licence, unless the application is exempt from CRTC licensing requirements. Application requirements for a broadcasting licence can be obtained from the CRTC. The Department must receive a confirmation that an application for a broadcasting licence has been submitted to the CRTC, or that a licence is not required, within 30 days of receiving the application for a broadcasting certificate, otherwise the certificate application will be returned to the applicant.

All necessary forms are available on ISED's Spectrum Management and Telecommunications website at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf01700.html.

4.1.1 Online Application Requirements

When submitting an application to the Department **online**, the applicant shall use the Spectrum Management System website.

The following documentation shall be attached to the application:

- a text file containing horizontal and vertical antenna pattern data, in accordance with Annex E of BPR-1; and
- an engineering brief in accordance with Section 4.2, except if the station complies with the minimum separation distances in tables 8 and 9, in which case an engineering brief is not mandatory. The Department will, if advised in writing by the applicant, also process engineering briefs prepared by qualified technical staff as per Section 1.1 of BPR-1.

4.1.2 Email Application Requirements

When submitting an application to the Department by **email**, the applicant shall use the following email address: IC.broadcasting-radiodiffusion.IC@canada.ca.

In addition to the documentation required for online submissions, the following documentation shall be attached to the application:

- form ISED-ISDE3051, *Application for a Broadcasting Certificate for a Low-Power or Very Low-Power Undertaking* (in PDF format);
- form IC-2430, *Radiocommunication and Broadcasting Antenna Systems Attestation* (in PDF format) and, as applicable, a copy of the Letter of Intent to the land-use authority as described in BPR-1, Section 2.

It is the applicant's responsibility to ensure that all electronic documents submitted have the necessary signatures.

The Department reserves the right to request a signed attestation to verify the authenticity of an application and may hold the processing of the application until a satisfactory attestation has been received.

4.1.3 Written Application Requirements

When submitting an application **on paper**, printed and signed versions of the application form and other documentation described in sections 4.1.1 and 4.1.2 shall be provided.

4.1.4 Other Requirements

The applicant must indicate that the antenna system complies with the requirements of BPR-1, Section 2, and CPC-2-0-03.

4.2 Engineering Brief Requirements

The engineering brief should include the components described below in sections 4.2.1 to 4.2.8 in the order presented to facilitate processing by the Department. The metric system known as SI shall be used throughout the engineering brief.

4.2.1 Summary Sheet

The summary sheet must show the submission title, type of station proposed, applicant's name and address, technical representative's name, proposed transmitting channel, location of proposed broadcasting station and submission date.

4.2.2 Introduction

The introduction must consist of a general statement of the purpose of the brief relative to the application. The programming source(s), method of programming feed and network affiliation shall be indicated.

4.2.3 Transmitting Channel

A brief interference analysis in support of the transmitting channel selected should be included in the brief, with particular reference to its relation to existing FM assignments and allotted channels under the table of FM allotments. This analysis should demonstrate that no interference will be caused by or to the service of authorized stations using standard parameters or low-power stations currently being received in the area. Moreover, every effort should be made to avoid affecting the off-air receiving systems of neighbouring broadcasting undertakings.

4.2.4 Received Channel (Using Off-Air Pick-up)

The applicant is responsible for ensuring that the signal received from the off-air pick-up antenna is of adequate quality and reliability. Off-air pick-ups are generally not protected from interference, and the applicant must be prepared to either accept interference or switch to another means of reception, such as microwave or satellite.

4.2.5 System Description and Design

A description of the major components of the system, including a block diagram, shall be provided.

4.2.6 Equipment

The brief shall provide the specifications of receiving and transmitting antennas, including their type, manufacturer, gain relative to a half-wave dipole and radiation patterns and largest dimension. The orientation of the transmitting antenna shall be indicated.

The transmitting unit shall be type-approved. The intent to use a type-approved transmitter(s) shall be made clear, either by specifying the make, model and type-approval number, or by including a statement that the transmitter will be type-approved prior to on-air operation. The rated power shall be specified.

The brief shall provide the specifications of the antenna transmission lines, including their manufacturer, type and length.

4.2.7 Service Area Calculations

Calculations of the service area, as outlined in Section 5.7, shall be submitted upon request by the Department when separation distances are less than those required in Table 8.

4.2.8 Predicted Quality of Service

A statement shall be made concerning the quality and reliability of the proposed service as evaluated per Section 5.6.

5. Technical Requirements for the Establishment of LPFM Stations on Unprotected Channels

5.1 Definitions and Conditions

Low-Power FM (LPFM) Station: An LPFM station is a secondary assignment operating on an unprotected channel.

Power: Power refers to the effective radiated power (ERP) in any direction and shall not exceed 50 W. The ERP is equal to the transmitter power supplied to the antenna multiplied by the relative gain (dipole) of the antenna in a given direction.

Antenna: Normally, the maximum transmitting antenna height is 60 m when the ERP is 50 W. Should the transmitting antenna height exceed 60 m, the ERP and height, when plotted on Figure D1 of Annex D, should fall below or to the left of the curve. In this procedure, transmitting antenna height (HAAT) is the height of the radiation centre of the antenna above the arithmetic average of the elevation of the terrain measured in metres from 0 to 5 km along either 4, 8 or 36 radials equally spaced starting from true north.

Coverage and Protection: An LPFM station provides service only within its 3 mV/m (69.5 dBµV/m) contour. Service may also be provided within the 0.5 mV/m (54 dBµV/m) contour (see Section 5.3).

Under no circumstances shall the 3 mV/m contour extend beyond a distance of 8 km in any direction from the antenna site even if this requires a reduction in the ERP.

Transmitter: The transmitter shall be a model which has been type-approved under BETS-6.

Special Applications: In locations of mountainous terrain, where the transmitting antenna height is more than 300 m above the elevation of the community to be served, it may not be possible to provide an adequate service as per the conditions under *Antenna* previously stated in this section. In such cases, additional studies may be required by ISED to demonstrate that the existing stations and allotments shall be protected from interference. In addition, the Department will consider proposals with parameters engineered to provide adequate service to the centre to be served with the following limiting conditions:

(a) the ERP shall not exceed 50 W in any direction; and
(b) the 3 mV/m contour shall not extend beyond a distance of 8 km from the transmitting site.

5.2 Status Regarding Interference to and From Other Stations

LPFM stations will be considered as secondary assignments. In other words, except as provided for in Section 5.4, LPFM stations shall not create interference to primary FM broadcasting stations, whether established before or after them. Conversely, an LPFM station is not entitled to protection from interference caused by normally functioning primary FM stations. LPFM stations are entitled to protection from other LPFM stations that are authorized at a later date.

Interference caused to and by existing stations and allotments is not deemed to exist if the distance separation requirements set forth in Table 8 are met.

The Department may require an LPFM station to take remedial action if the calculated protection ratio at the protected contour of an existing primary station is not provided, or if a change in channel allotments results in the prediction of interference to the new allotment from the LPFM station. In case of the latter, it is expected that the applicant for the primary station will consider, calculate and notify the interference impact to the LPFM station. Normally, it is expected that only a frequency change by the LPFM station would be necessary, but cessation of operation by the LPFM station would be required if no other suitable remedial action is practicable. An LPFM station would not be expected to cease operation to protect a vacant allotment.

Should a new primary station or one which has changed parameters cause interference to an LPFM station but not receive any, the latter may either accept the interference or make an application to change its operation to alleviate the interference. Interference should be deemed to exist when the desired to undesired field strength ratios of 10 to 1, 2 to 1, 1 to 20 from the co-channel, first-adjacent channel and second-adjacent channel, respectively, are not met. These ratios may be determined from F(50,50) field strength curves for the desired signal and F(50,10) field strength curves for the undesired signal, or by any recognized engineering method.

5.3 Choice of Frequency

Channels in the band 88-108 MHz are assigned on the basis of 200 kHz separations with carrier frequencies every odd 100 kHz. For convenience, these channels are numbered consecutively from 201 to 300. The LPFM applicant should avoid choosing channels 201 to 220 if the proposed LPFM station is to be located inside the service area of a channel 6 TV station because of the potential of interference with the reception of the TV signal. However, if these are the only channels available in the area, the Department will consider it on a case-by-case basis. The Department can ask for additional analysis when such a channel is proposed.

A frequency that meets the distance separations from existing stations and allotments, as shown in Table 8, shall be chosen.

Table 8: Minimum Separations (km) Required to Provide Interference-Free (3 mV/m) Coverage

Frequency Relationship (Difference)	Class of Station							
	A1	A	B1	B	C1	C	LPFM	VLPFM
Co-channel	50	70	83	97	124	144	17	15
First-adjacent channel	32	52	65	79	100	111	10	8
Second-adjacent channel	20	40	53	66	88	109	5	5

Minimum separation distances with respect to class C allotments or assignments are based on an ERP of 100 kW and an EHAAT of 450 m.

The separations in Table 8 are based on LPFMs giving protection to the 0.5 mV/m contour of class A1, A, B1, B, C1 and C stations and, in return, receiving protection from other LPFMs to at least the 3 mV/m contour. Although not mandatory, Table 9 below shows the required separations for an LPFM station from an LPFM and other classes of stations to provide interference-free coverage up to the 0.5 mV/m contour. Applicants are encouraged to select channels that provide the separations given in Table 9 whenever possible.

Table 9: Minimum Separations (km) Required to Provide Interference-Free 0.5 mV/m Coverage

Frequency Relationship (Difference)	Class of Station							
	A1	A	B1	B	C1	C	LPFM	VLPFM
Co-channel	70	122	154	179	215	231	42	23
First-adjacent channel	37	69	69	109	140	159	24	15
Second-adjacent channel	20	40	40	66	88	109	12	11

The separations in tables 8 and 9 are based on an ERP of 50 W with an antenna height of 60 m for LPFM stations, and maximum permissible parameters for other stations. Minimum separation distances with respect to class C allotments and assignments are based on an ERP of 100 kW and an EHAAT of 450 m.

One systematic method of determining which channels are available is outlined in Annex E.

For applications with the special conditions described under *Special Applications* in Section 5.1, a frequency that meets the limiting conditions identified in that section shall be chosen.

5.4 Channels Separated by 600 kHz or 800 kHz

The incoming station will be responsible for remedying interference complaints from incumbent stations.

5.5 Separations Less Than the Minimum

If it is impossible to find a frequency that meets all the minimum distance separations to primary FM stations, a submission based on separations, none of which are more than 8 km short of the distances in Table 8, may be considered only when the mutual consent of all stations involved as well as departmental approval are obtained. In such cases, a licensed broadcast engineering consultant shall conduct a detailed channel search and will determine and plot on a map the theoretical interference zones, as well as the interference-free coverage.

5.6 Quality of Rebroadcast Signal

An applicant requesting a rebroadcasting LPFM station shall provide assurance that the transmitted signal will be of acceptable technical quality.

5.7 Coverage Predictions

Estimates of the predicted coverage shall be submitted with the application. The F(50,50) field strength curves in figures D2 and D3 of Annex D should be used to determine the distance to the 0.5 mV/m and 3 mV/m contours.

The distance to each contour should be determined in the direction of either 4, 8 or 36 radials equally spaced starting from true north, using the transmitting antenna height in the pertinent direction. When a directional antenna is proposed, the ERP in the pertinent direction should be used.

Suitable point-to-point type field strength calculations may be used to replace or supplement the above paragraph if the irregularity of the terrain justifies the use of such techniques.

The coverage predictions should be presented in tabular form and on a suitably detailed map with the transmitting site marked and the 0.5 mV/m and 3 mV/m contours labelled. The map referred to in Section 4.2.7 would be suitable, supplemented by a map of the adjacent area if necessary.

When interference zones are predicted, as per Section 5.4, they shall be shown on the contour map as hatched areas.

6. Applications for Very Low-Power FM (VLPFM) Broadcasting Stations in Small Remote Communities

VLPFM stations shall only be established in those communities that are both outside the major urban/suburban areas and that are remote in the sense of lacking access to a complete range of Canadian broadcasting services. These stations shall use FM channels on an unprotected non-interfering basis with an ERP of 10 W or less.

6.1 Application Requirements

An application to the Department for a broadcasting certificate shall be accompanied by an application to the CRTC for a broadcasting licence, unless the application is exempt from CRTC licensing requirements. Application requirements for a broadcasting licence can be obtained from the CRTC. The Department must receive a confirmation that an application for a broadcasting licence has been submitted to the CRTC, or

that a licence is not required, within 30 days of receiving the application for a broadcasting certificate, otherwise the certificate application will be returned to the applicant.

All necessary forms are available on ISED's Spectrum Management and Telecommunications website at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf01700.html.

6.1.1 Online Application Requirements

When submitting an application to the Department **online**, the applicant shall use the Spectrum Management System website.

The following documentation shall be attached to the application:

- a text file containing horizontal and vertical antenna pattern data, in accordance with Annex E of BPR-1.

6.1.2 Email Application Requirements

When submitting an application to the Department by **email**, the applicant shall use the following email address: IC.broadcasting-radiodiffusion.IC@canada.ca.

In addition to the documentation required for online submissions, the following documentation shall be attached to the application:

- form ISED-ISDE3051, *Application for a Broadcasting Certificate for a Low-Power or Very Low-Power Undertaking* (in PDF format);

- form IC-2430, *Radiocommunication and Broadcasting Antenna Systems Attestation* (in PDF format) and, as applicable, a copy of the Letter of Intent to the land-use authority as described in BPR-1, Section 2.

6.1.3 Written Application Requirements

When submitting an application **on paper**, printed and signed versions of the application form and other documentation previously described in sections 6.1.1 and 6.1.2 shall be provided.

6.2 Siting of Antenna Systems

The applicant is to refer to BPR-1, Section 2, and to CPC-2-0-03 for guidance on this matter.

7. Technical Requirements for the Establishment of VLPFM in Small Remote Communities

7.1 Conditions

Power: The ERP, which shall not exceed 10 W, is equal to the transmitter power supplied to the antenna multiplied by the relative gain (dipole) of the antenna in a given direction.

Antenna Parameters: The maximum antenna height above ground shall not exceed 30 m.

Equipment: Recommended minimum technical standards for the transmitter are outlined in Broadcasting Equipment Technical Standard BETS-8, *Technical Standards and Requirements for FM Transmitters Operating in Small Remote Communities*.

Service: Because of the nominal cost and the limited capability of the equipment, the quality of the signal provided may be limited. Service is only provided to the 3 mV/m contour.

7.2 Selection of Frequency

In selecting a channel, care should be taken to minimize the disruption of the existing pattern of off-air reception of distant stations in the community. The channel selected shall comply with the minimum distance separations shown in Table 10. VLPFM applicants should avoid choosing channels 201 to 220 if the proposed VLPFM station is to be located inside the service area of a channel 6 TV station because of the potential of interference with the reception of the TV signal.

Table 10: Minimum Distance Separations Between VLPFM Stations and Primary and Low-Power Stations

Frequency Relationship	Separation Between Stations (km)							
	VLP	**LP**	**A1**	**A**	**B1**	**B**	**C1**	**C**
Co-channel	8	15	32	52	75	94	122	142
First-adjacent channel	5	8	24	44	57	71	92	103
Second-adjacent channel	3*	4	20	40	53	67	88	109

Note: The distance marked with an asterisk (*) may be eliminated if stations are co-sited. The frequency of the transmitted signal shall correspond to the carrier frequency specified for allotted channels.

7.3 Interference

7.3.1 Interference Caused to and by Other Stations

VLPFM stations are not protected from interference caused by primary FM stations and by LPFM stations. VLPFM stations shall not cause interference to any new or existing stations, and such stations are only entitled to protection from other very low-power stations established in accordance with this section. Protection of VLPFM stations applies at the 3 mV/m contour.

7.3.2 Remedial Measures

Should the operation of a VLPFM established in accordance with this section cause interference to existing broadcasting stations or to other radio services, remedial measures shall be taken by the licensee even to the extent of closing down the station if another suitable channel cannot be found. These remedial measures also apply to the protection of future broadcasting stations established in accordance with new or existing allotments.

7.4 Service and Coverage Guidelines

The signal strength normally required to provide a satisfactory service to the low-density population areas is the 3 mV/m contour. As a guideline, for a 10 W ERP using an antenna at a height of 30 m above ground, the distance from the transmitter to the above contour is estimated to be slightly over 2 km (non-directional antenna with a gain of 0 dB).

7.5 Channels Separated by 600 kHz or 800 kHz

Refer to Section 5.4 for requirements relating to channels separated by 600 kHz or 800 kHz.

8. Applications for FM Rebroadcasting Stations Within the 0.5 mV/m Contour of an FM Originating Station

This section outlines the procedure to be followed in preparing and submitting technical information required in support of applications for full-time rebroadcasting stations carrying programming identical to that of the originating station.

8.1 Conditions of Assignment

Full-time rebroadcasting stations may be assigned in areas within the protected contour of the originating station where the signal of the originating station is deficient (i.e. field strengths less than 0.5 mV/m due to terrain factors, severe multipath distortion, etc.). In general, full-time rebroadcasting stations may be assigned as class A1, LPFM or VLPFM stations or they may be assigned as "on-channel"[3] boosters.

8.2 Application Requirements

An application for a broadcasting certificate for a full-time rebroadcasting station shall be made in accordance with the requirements of sections 2, 3, 4 and 5, as appropriate.

If necessary, studies will be required to demonstrate that all related short-spaced stations remain protected in accordance with the requirements of this document for on-channel booster applications. An analysis on the quality of service to be provided will also be required.

In all cases, the applicant shall provide full justification for the need for a rebroadcasting undertaking. This may take the form of a realistic propagation study and/or field strength measurements for the signal of the

[3] "On-channel" booster stations use the same frequency as that of the originating station. For these types of assignments, the 0.5 mV/m contour shall not extend beyond the 0.5 mV/m contour of the originating station.

originating station or other evidence deemed acceptable by the Department. It should be noted that a revision to the service contour map of the originating station may be required to show realistic contours.

Both types of rebroadcasting station applications are subject to an FM/NAV/COM compatibility analysis.

8.3 Special Cases

It is recognized that, due to the nature of terrain and signal propagation, there may be instances where the options given previously may not be adequate. Therefore, the Department may, at its discretion, authorize other classes for use as rebroadcasting undertakings should the applicant provide sufficient justification. Such exceptions will only be permitted if the applicant can demonstrate that the proposed channel, due to impairments such as short-spacings, is unusable for any other purpose and that an assignment per Section 8.1 is inadequate.

Similarly, in exceptional cases, the Department may, at its discretion, authorize a rebroadcasting assignment within the 3 mV/m contour of the originating station given sufficient justification.

Annex A — F(50,50) and F(50,10) Curves

For the purposes of estimating field strength, when using the propagation curves in this annex, any HAAT values exceeding 1600 m will have to be entered as 1600 m.

Figure A1 — Estimated Field Strength Exceeded at 50% of the Potential Receiver Locations for at Least 50% of the Time at a Receiving Antenna Height of 9.1 m

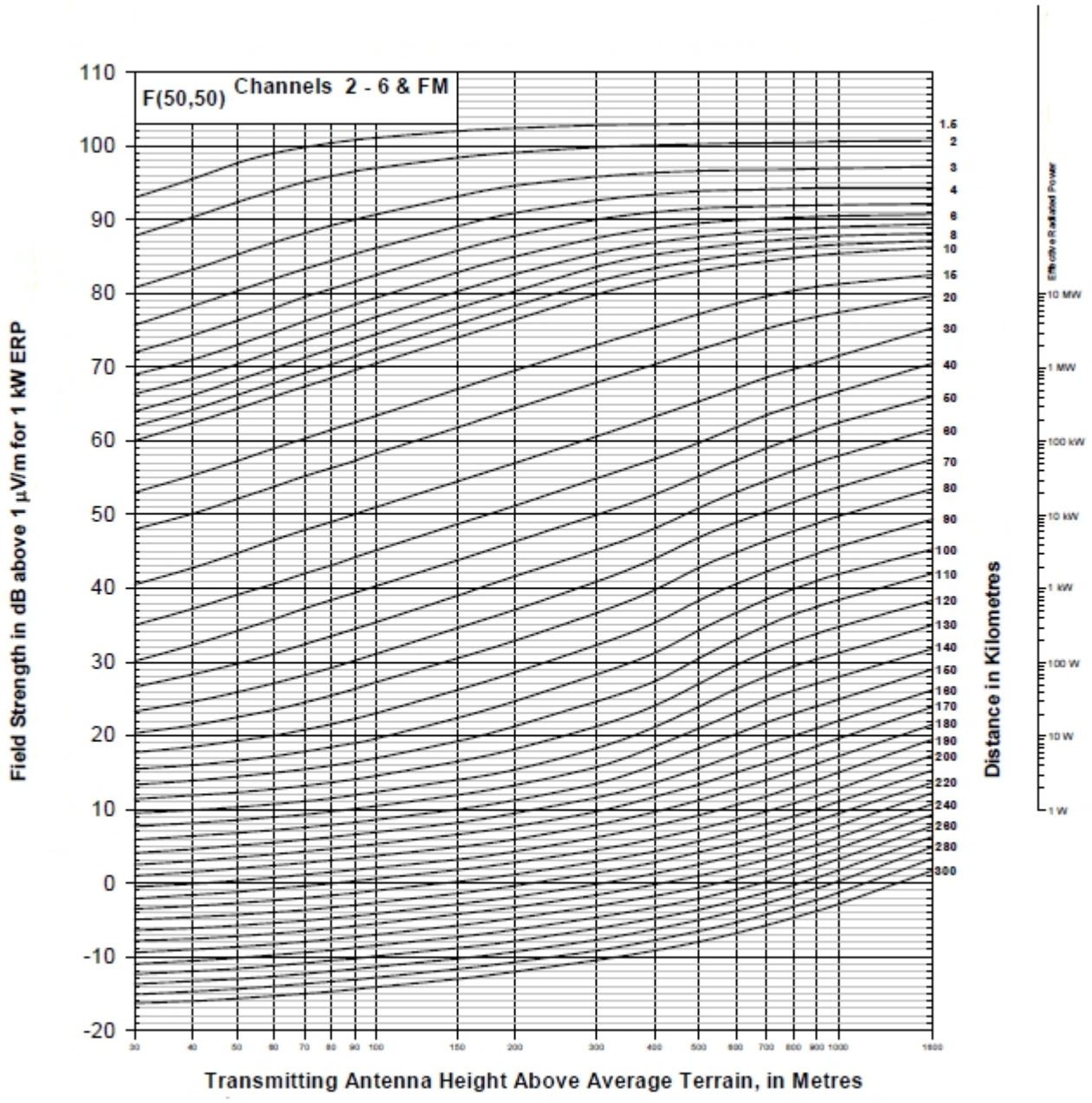
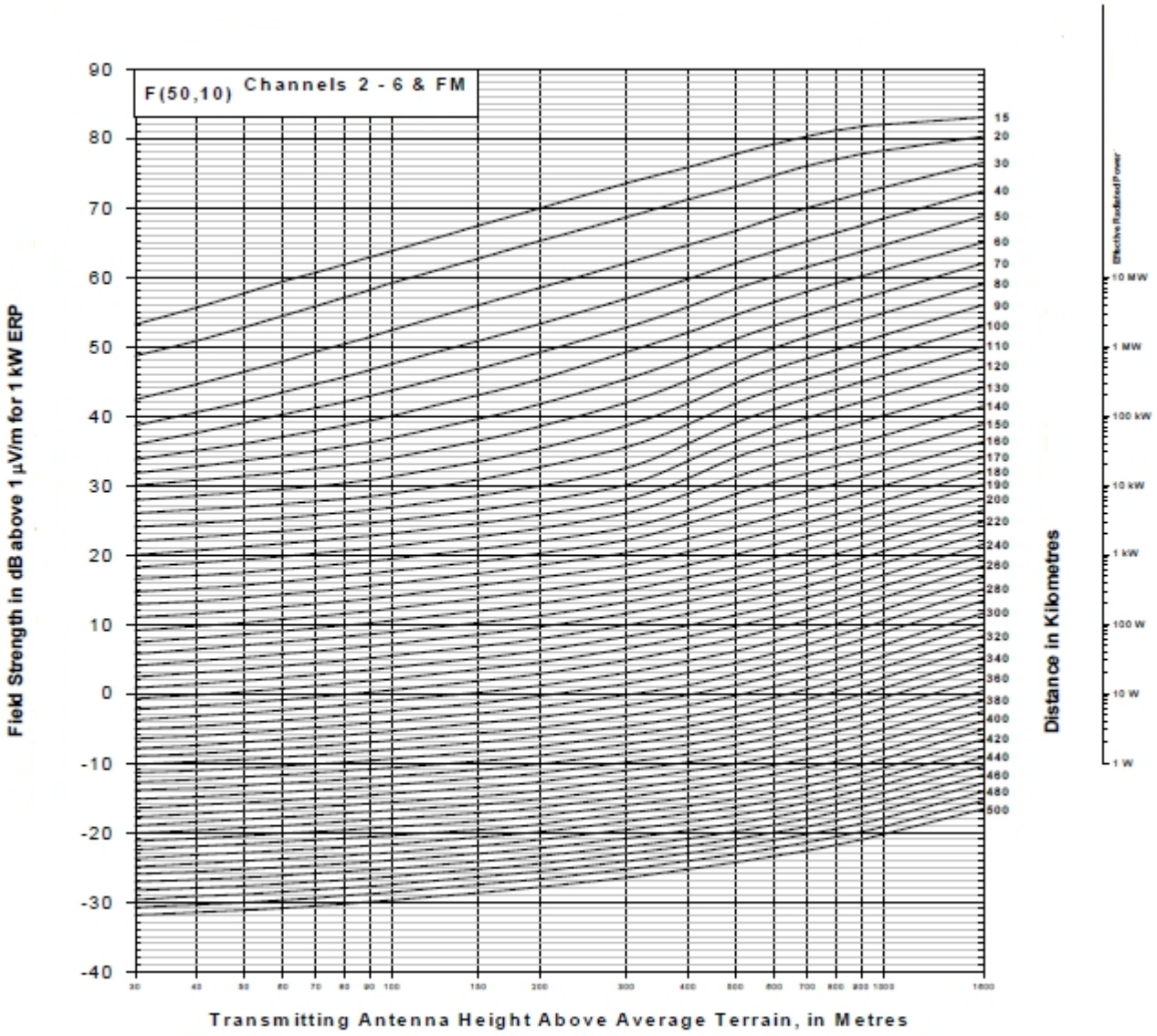


Figure A2 — Estimated Field Strength Exceeded at 50% of the Potential Receiver Locations for at Least 10% of the Time at a Receiving Antenna Height of 9.1 m



Annex B — Summary Sheet

Applicant:_____
Account Number:_____

Station: New □ Change □

Principal Service Location (including province): _____
Station Call Sign: _____
Originating Station (if rebroadcasting): _____

Channel Number: _____
Frequency: _____ MHz
Class of Station: _____

Site Details:

Street Address or Site Name: _____
City: _____
Province or Territory: _____

Antenna Coordinates (WGS84):

N. Lat. _____ °_____ '_____ "
W. Long. _____ °_____ '_____ "

Transmitter:

Manufacturer / Model / Certification Number:_____
Output Power: _____ kW:

Transmission Line:

Manufacturer/Type: _____
Length (m): _____
Line Loss (dB/100m): _____
Line Efficiency**:** _____**%**

Other Losses: _____%

Antenna:

Manufacturer / Model: _____
Polarisation: _____
Directional / Non-directional: _____
Number of Bays: _____
Largest Dimension: _____ metres
Maximum Gain: _____ dBd (Horizontal/Vertical/Circular Polarization)
Average Gain: _____ dBd (Horizontal/Vertical/Circular Polarization)

ERP:

Maximum:	_____	kW (Horizontal/Vertical/Circular Polarization)
Average:	_____	kW (Horizontal/Vertical/Circular Polarization)
At Beam Tilt:	_____	kW Maximum
At Beam Tilt:	_____	kW Average

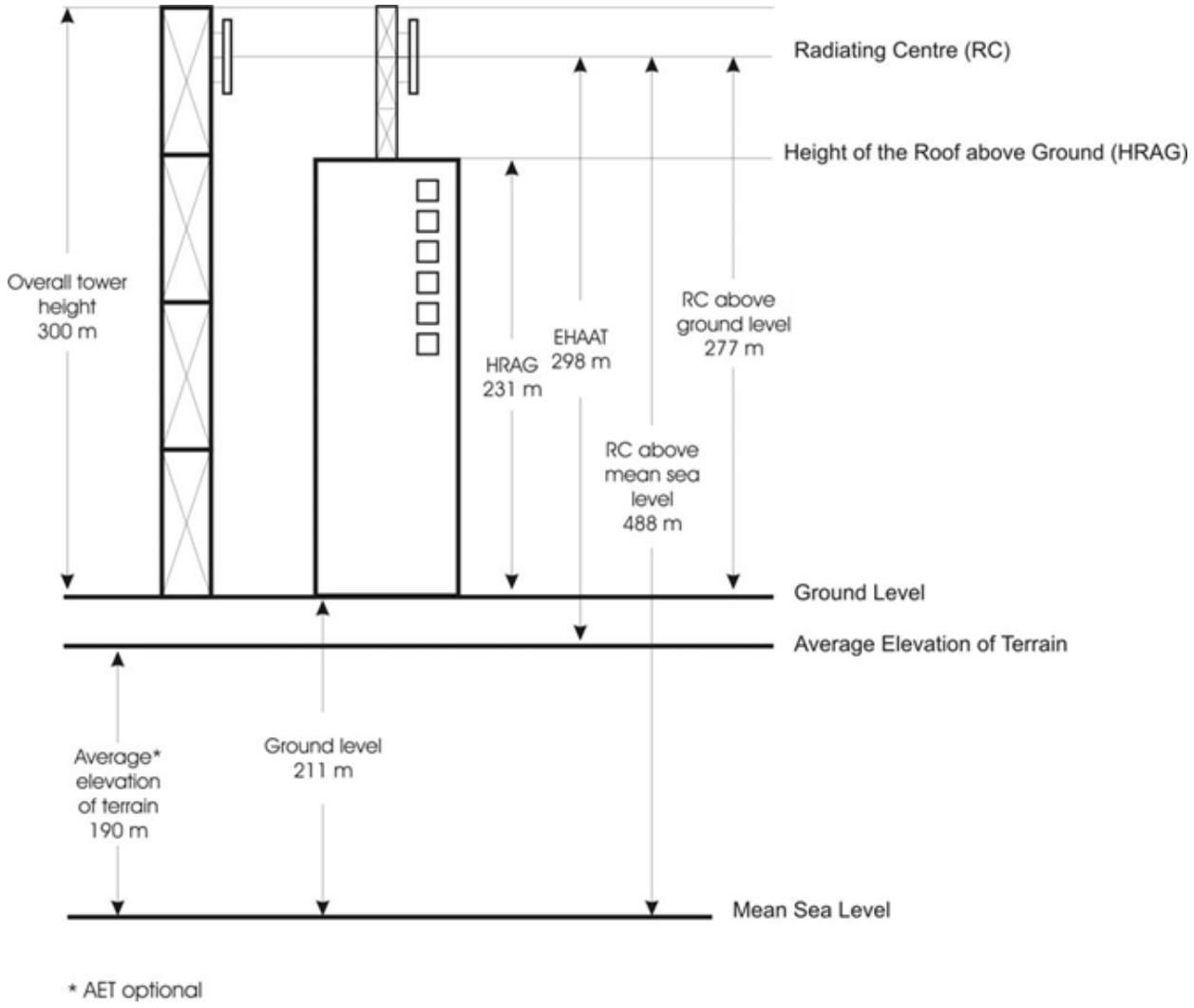
Heights:

EHAAT:	_____	metres
Radiating Centre (Above Ground Level):	_____	metres
Overall tower height (Above Ground Level):	_____	metres
Ground elevation (Above mean sea level):	_____	metres

Modes: Mono ( ), Stereo ( ), Unattended ( ), Automatic ( ), SCMO ( )

Annex C — Elevation Diagram of Typical Tower and Transmitting Antenna

Figure C1 — Elevation Diagram of Typical Tower and Transmitting Antenna



Annex D — Calculators

Figure D1 - Parameters Equivalent to an Effective Radiated Power of 50 W at a Transmitting Antenna Height of 60 m

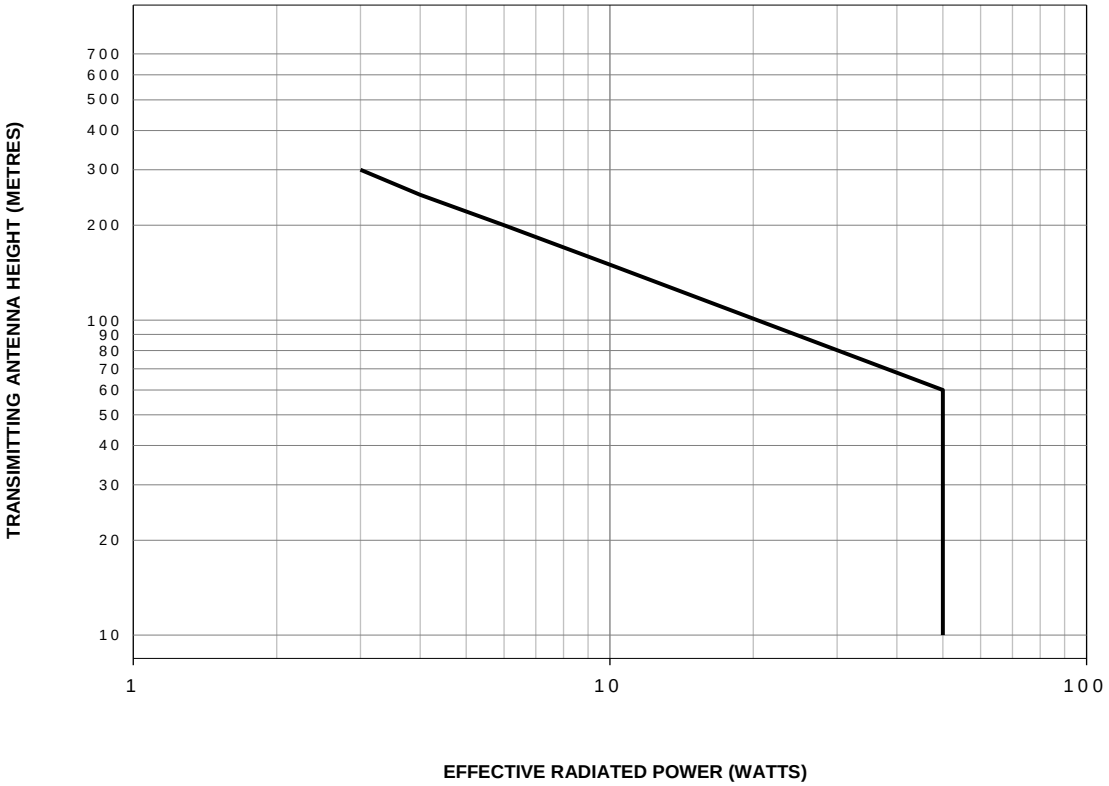
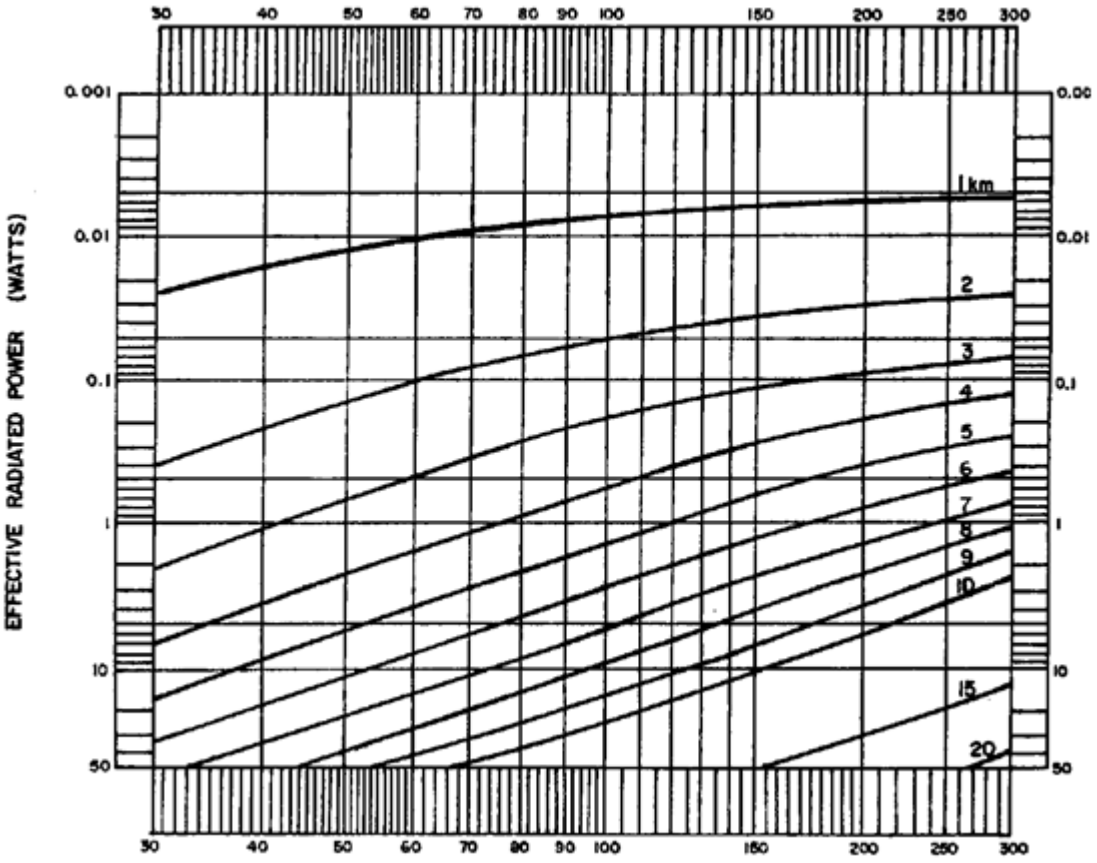
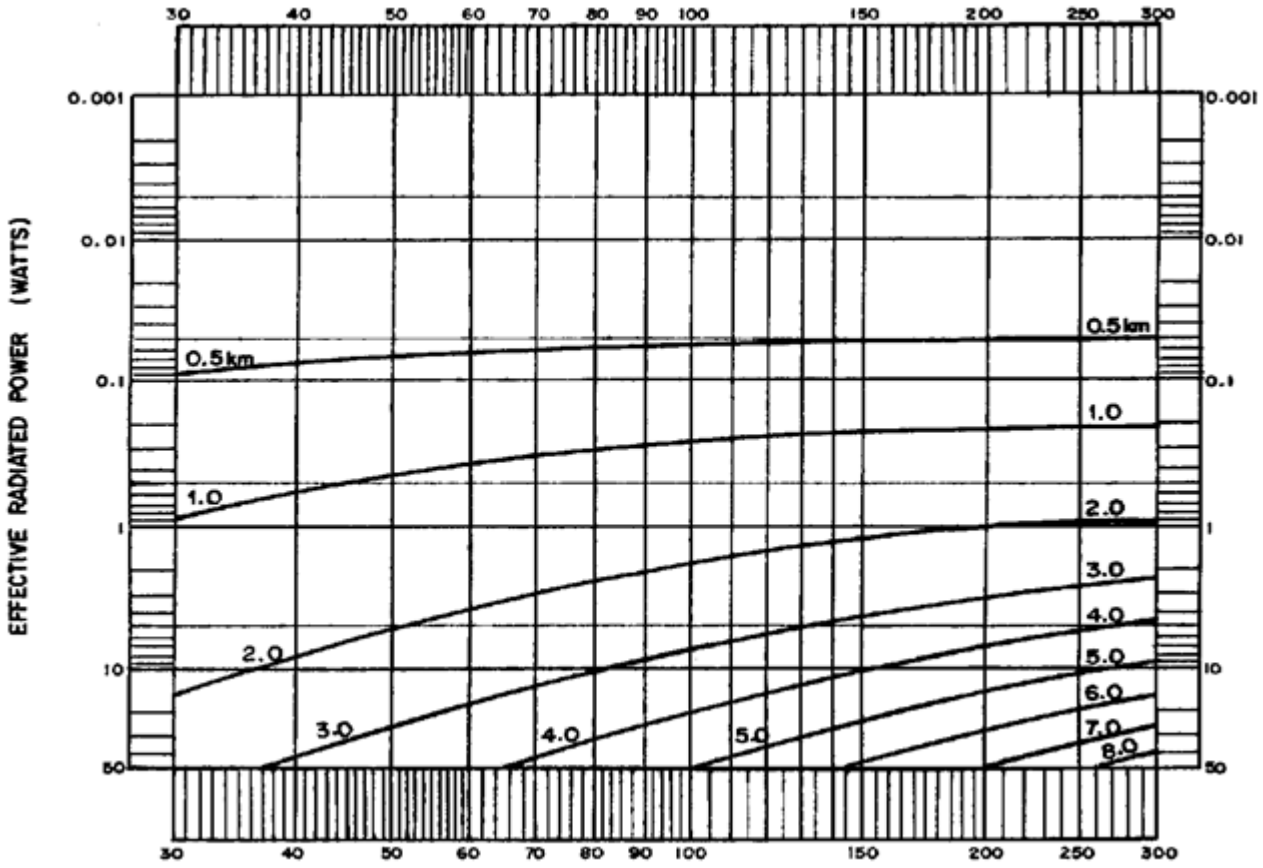


Figure D2 — 0.5 Millivolt per Metre Contour Calculator



Transmitting Antenna Height (Metres)

Figure D3 — 3 Millivolt per Metre Contour Calculator



Transmitting Antenna Height (Metres)

Annex E — Systematic Method for Determining Low-Power FM (LPFM) Channel Availability

The following presents a systematic method for making a channel search.

(a) List the numbers 201 to 300. Channels 201 to 220 should not be considered if there is reception of TV channel 6 in the proposed coverage area, or if there is a channel 6 allotment within 95 km of the LPFM transmitting site. If there is a limitation on the parameters of a channel 6 allotment, this distance may be somewhat reduced. Departmental advice can be sought in this regard.

(b) On a suitable map, draw a circle centred at the proposed antenna site with a radius of 144 km (3 mV/m) if Table 8 is used, or 231 km if Table 9 is used.

(c) Using the Canadian table of FM allotments starting at channel 201 and working up, check for centres located within the circle in (b). Measure on the map the distance to these centres and, using either Table 8 or Table 9, eliminate those channels whose allotments would preclude assignment to that centre. Take for example a centre that is 90 km away has an allotment listed as 250B. From Table 8 under class B, the required separation for co-channel operation is 97 km, but for first- adjacent channels, it is only 79 km. Thus, channel 250 is eliminated from the list in (a). If 0.5 mV/m coverage is wanted, from Table 9, the required separation for first-adjacent channels is 109 km. Thus, channels 249, 250 and 251 cannot be used in this example.

(d) If there are available channels after eliminating those affected by Canadian allotments, check whether the circle in (b) encloses any US territory. If there are still available channels, select one and enter it in the application form as part of the required technical data.

(e) If no channels are available using Table 9, repeat from step (b) using Table 8.

(f) If no channels are available based on Table 8, check whether any channel is eliminated by being less than 8 km short of any required separation, excluding those to other LPFM stations (see Section 5.4). A proposal based on such a channel might be considered acceptable under these circumstances.

(g) If there are still no channels available, the services of a broadcast engineering consultant should be retained to perform a channel search.

Annex F — Procedure to Determine the Interference Zone

Plot the transmitter sites on an appropriately scaled map and do the following:

(a) Plot the protected service contour for the assignment or allotment to be protected based on the maximum or other permissible parameters, as shown in Section 3.2.

(b) Plot the interfering contour for the proposed assignment or allotment based on its proposed parameters in accordance with the interfering signal levels, as shown in Section 3.3.

(c) Mark the two points where the contours intersect.

(d) Repeat steps (a), (b) and (c), but increase the value of each contour while maintaining the same protection ratio until the protected and interfering contours are tangential.

(e) Draw a line joining the intersection points obtained above. The area contained within this line and the protected service contour drawn in step (a) define the interference zone.

Example

The following example shows the interference zone between an existing class B station and a proposed class A station which are short-spaced and on the same channel (co-channel):

(a) The protected service contour from Section 3.2 is 54 dBµV/m, which extends to 65 km.

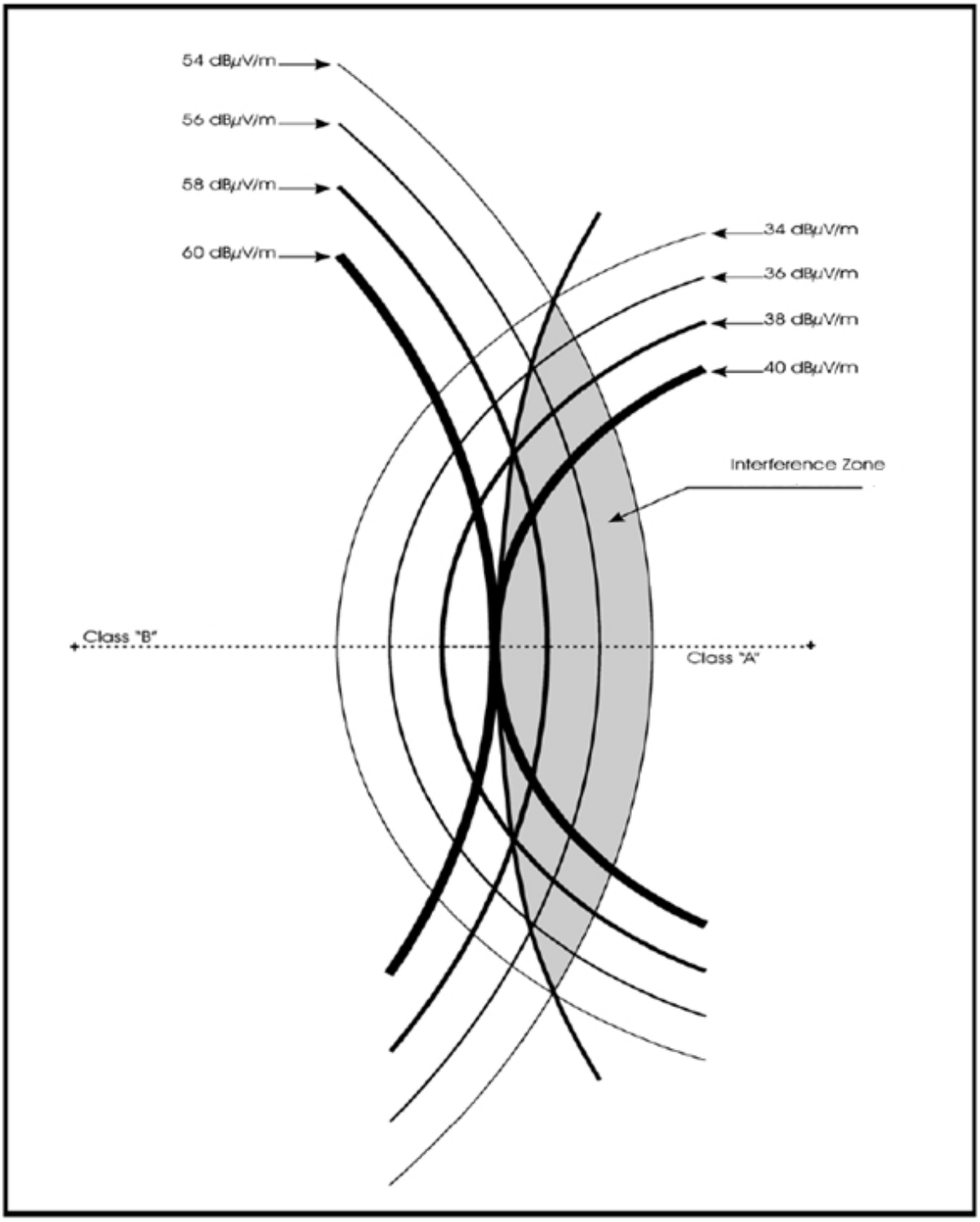
(b) The interfering contour from Section 3.3 is 34 dBµV/m (the extent of this contour will vary depending on the proposed operating facilities).

(c) Mark the two points where the contours intersect.

(d) Plot the 56 dBµV/m service contour and the 36 dBµV/m interfering contour and mark the two points of intersection. Continue to increase the value of the contours, plot them, and mark the intersection points until the contours are tangential.

(e) Draw a line joining the intersection points obtained above. The area contained within this curve and the protected service contour drawn in step (a) define the interference zone. This area is shown in grey in Figure F1.

Figure F1 - Interference Zone



Annex G — Procedure for Determining FM to TV Channel 6 Protection Requirements

G1. Purpose

To define the factors and to present a method for determining the protection requirements for TV channel 6 from FM broadcasting stations on channels 201 to 220 when co-located with TV channel 6 and when located outside the grade B contour of TV channel 6.

G2. TV Channel 6 Receiver Measurements

Laboratory measurements were taken on a number of TV receivers to determine the level at which the interference from FM signals on channels 201 to 220 was viewed as being just perceptible. The results are shown in Figure G1. The data showed an improvement of approximately 6 dB over earlier data. The curves of Figure G1 show the average FM to TV channel protection ratio for TV receivers for a picture quality of just perceptible interference. Since the protection varies with the level of the TV signal, separate curves are shown for different TV input levels.

G3. FM to TV Channel 6 Protection

The protection of TV channel 6 from FM stations is related to their field strength ratio by the following formula:

$$F_u - F_d = P_r + G_r + A_d - L \qquad (1)$$

where:

F_u is the FM undesired signal and F_d is the desired TV signal levels both in dBµV/m; P_r is the protection ratio in decibels obtained from the receiver measurement;

G_r is the value in decibels to be added (or subtracted) to change the TV grade of picture from the just perceptible interference value to a specified picture quality;

A_d is the TV receiving antenna discrimination against the FM signals in decibels; and

L is the adjustment made in decibels with respect to the percentage of locations where the field strength level will be above the stated value.

G4. Co-located FM and TV Stations

For co-located FM and TV stations, the field strength of the TV signal will be very high in the vicinity of the TV antenna and therefore outdoor receiving antennas are not normally used. Measurement tests have indicated that the maximum TV signal into the receiver, using an indoor antenna, does not usually exceed -25 dBm. The reduced antenna size (rabbit ears) and its reduced height above ground limit the actual level.

The receiver level of -25 dBm has been used to derive the FM to TV protection ratios as shown in Table 6. It is recognized that a TV receiver input level of less than -25 dBm could be used, when justified, by the type of receiving antenna and possible shielding effect of the type of buildings where the receivers are

located. The "antenna system gain" (antenna gain over any losses) can be as low as -29 dB (loss) for an antenna at a height of 2 m. This would place the receiver input signal at -38 dBm for an incident field of 115 dBµV/m, as determined from the F(50,50) field strength curves.

For co-located FM and TV transmitter sites, the TV receiving antenna provides no discrimination against the FM transmissions for horizontal polarization. In such cases, the antenna discrimination factor is zero. The FM power for vertical polarization can be increased 6 dB above the value determined for horizontal polarization.

The picture quality for coverage inside the grade A contour is defined as a picture of acceptable quality for at least 70% of the receiving locations, 90% of the time. Using the ITU-R five-point impairment scale, this acceptable quality has been equated to a picture impairment grade of 4.0.

As the laboratory measurements on the TV receivers were performed using an interference criterion of just perceptible or a picture impairment grade of 4.5, a correction of 3 dB is required to change to a picture impairment grade of 4.0. Given that the goal is to protect 70% of the receiver locations, which is the same percentage of receiver locations as used in the definition of the grade A contour, a 5 dB correction factor is used for "L" to equate the 50% used in the measurements (median value of the ratio) to 70% of protected receiver locations. Table 6 has been derived using the above factors in equation (1).

G5. FM Stations Outside the Grade B Contour

For FM stations located outside the grade B contour, the B contour (F_d = 47 dBµV/m) is protected and the FM to channel 6 field strength values shown in Table 7 have been calculated using the formula in equation (1) with the following considerations:

- the FM to TV channel 6 protection ratio (P_r) is based on measured values for a TV receiver input of -65 dBm; and
- for the antenna discrimination, a value of 6 dB is used. This value represents the performance of an average outdoor antenna as used at locations near the grade B contour.

The picture quality for coverage within the grade B contour is defined as a picture of acceptable quality for at least 50% of the receiving locations, 90% of the time. The acceptable quality has been equated to "interference is not annoying." As it is desirable to have an interference that does not degrade the picture, an ITU-R picture impairment grade of 4.0 is used.

To change an ITU-R picture impairment grade of 4.5 (the condition under which the TV receivers were measured) to an impairment grade of 4.0, a value of 3 dB for G_r is used.

"L" in the equation represents the adjustment made in decibels with respect to the percentage of locations in excess of 50%. By using the F(50,10) propagation curves, and given that the interference value is exceeded for 50% of the locations, 10% of the time, the value of "L" is zero. Table 7 has been derived using the above factors in the formula of equation (1).

G6. Step-by-Step Procedure

Use the following steps to determine the maximum power of the FM station that is co-located with a channel 6 TV station:

1. Using Table 6, which shows the permissible power ratio for FM channels 201 to 220 inclusive, select the FM to TV power ratio for the proposed FM channel.

2. Using the ERP of the TV station, determine the power of the FM station by adding the power ratio in step 1 to the ERP of the TV station as converted to decibels. If the TV antenna pattern is directional, the permissible FM power shall be calculated for the different azimuths.

3. If the FM antenna height differs by 30 m or more from the height of the TV antenna, the ERP of the FM antenna shall be adjusted to correspond to its equivalent value.

The equivalent value is calculated by the following procedure:

(a) Using the FM ERP as determined in step 2 above and the EHAAT for the TV station, determine the distance to the FM 100 dBµV/m contour using the F(50,50) field strength curves.

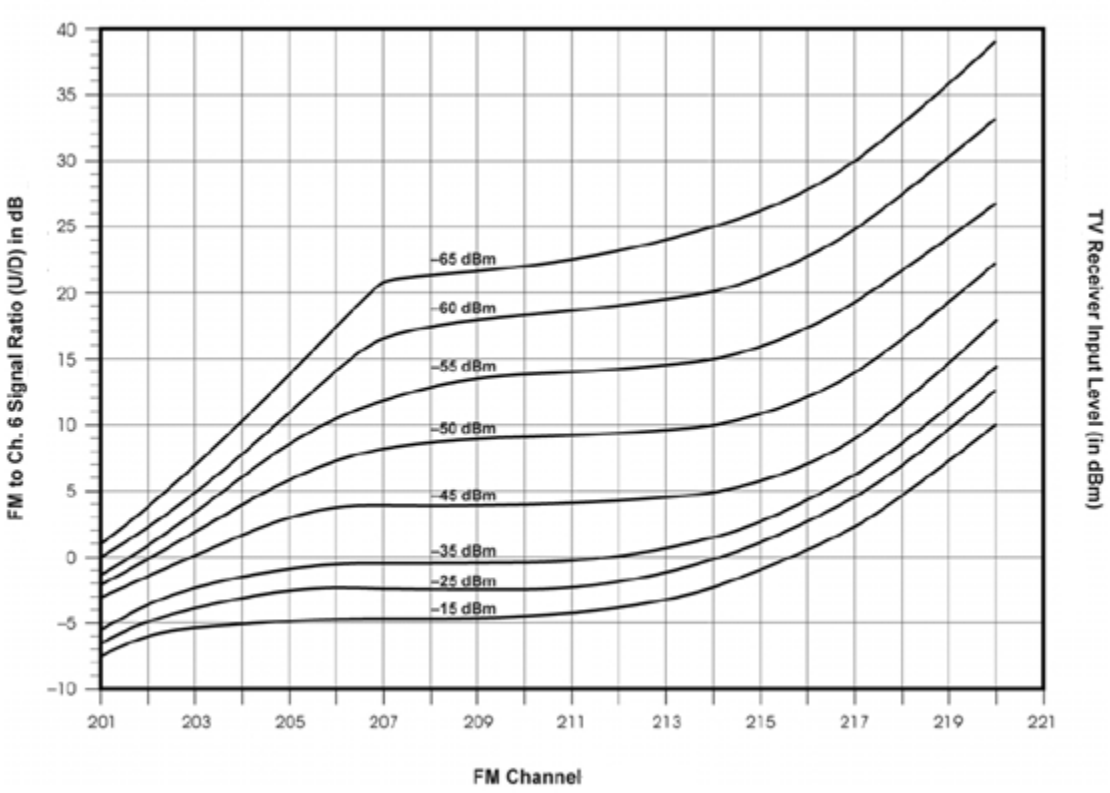
(b) Using the same curves, determine the FM ERP that will place the 100 dBµV/m contour at this same distance using the EHAAT of the FM station.

To determine the maximum power (ERP) of the FM station when the station is located outside the grade B contour of the channel 6 TV station, use the following steps:

(a) Using Table 7, which shows the permissible FM field strength level, select the field strength level of the proposed FM channel.

(b) From the field strength level in step 1 above, determine the maximum ERP using the F(50,10) propagation curves and the EHAAT of the station. The ERP represents the maximum radiation in the direction of the channel 6 grade B contour.

Figure G1— FM/Channel 6 Protection Ratios (Just Perceptible Interference)



Annex H — FM/NAV/COM Protection Criteria

H1. Interference Mechanisms and Compatibility Criteria

H1.1 Type A_1 Interference

For the analysis of type A_1 interference, the following two categories of spurious emissions exist:

- spurious emissions resulting from an intermodulation process caused at the transmitter site, e.g. by multiple transmitters feeding the same antenna; and
- other spurious emissions.

Where the actual frequency of the spurious emission is known, Table H1 gives the values of protection ratio used for frequency differences up to 200 kHz from aeronautical frequencies (radionavigation and radiocommunication). Type A_1 interference does not need to be considered for frequency differences greater than 200 kHz.

Table H1 — Protection Ratios for Type A_1 Interference

Frequency Difference Between Spurious Emission and NAV/COM Signal (in kHz)	Protection Ratio (in dB)
0	17
50	10
100	-4
150	-19
200	-38

H1.2 Type A_2 Interference

The protection ratio values used are given in Table H2.

Table H2 — Protection Ratios for Type A_2 Interference

Frequency Difference Between NAV Signal and Broadcasting Signal (kHz)	Protection Ratio (in dB)
150	-41
200	-50
250	-59
300	-68

A frequency difference of less than 150 kHz cannot occur. For frequency differences greater than 300 kHz, this type of interference does not need to be considered.

Note: FM sound broadcasting stations may, in some regions, employ compression techniques and/or provide services on subcarrier frequencies up to 99 kHz. Combinations of these practices, especially when associated with a carrier deviation larger than ± 75 kHz, may result in a 0 to 10 dB increase in susceptibility to type A_2 interference of an instrument landing system (ILS) receiver. Also, type A_2 interference does not need to be considered for COM receivers.

H1.3 Type B_1 Interference

Third-order intermodulation products of the form:

(1) $f_{intermod} = 2f_1 - f_2$ (two-signal case); or
(2) $f_{intermod} = f_1 + f_2 - f_3$ (three-signal case)

with $f_1 > f_2 > f_3$, generated in the airborne ILS or very-high-frequency omnidirectional range (VOR) receiver will cause an unacceptable degradation of receiver performance, if $f_{intermod}$ coincides with the frequency of the wanted signal and if the inequalities given below are fulfilled.

Intermodulation of the second order is irrelevant and intermodulation of a higher order than three has not been considered.

(1) Two-signal case:

$$2\left(N_1 - 20\log\frac{\max(0.4;108.1-f_1)}{0.4}\right) + N_2 - 20\log\frac{\max(0.4;108.1-f_2)}{0.4} + 120 \geq 0$$

(2) Three-signal case:

$$N_1 - 20\log\frac{\max(0.4;108.1-f_1)}{0.4} + N_2 - 20\log\frac{\max(0.4;108.1-f_2)}{0.4} + N_3 - 20\log\frac{\max(0.4;108.1-f_3)}{0.4} + 126 \geq 0$$

N_1, N_2 and N_3 have the following meaning:

N_1: level (dBm) of the broadcasting signal of frequency f_1 (MHz) at the input of the NAV receiver;

N_2: level (dBm) of the broadcasting signal of frequency f_2 (MHz) at the input of the NAV receiver; and

N_3: level (dBm) of the broadcasting signal of frequency f_3 (MHz) at the input of the NAV receiver.

max (0.4; 108.1 - f) means either 0.4 or 108.1 - f, whichever is greater.

H1.3.1 Frequency Offset Conditions

When the intermodulation product falls close to the frequency of the wanted signal, a correction is applied to each signal level which is a function of the frequency difference between the NAV signal and the intermodulation product. This correction is shown in Table H3.

$N_{1,2,3}$ (corrected) = $N_{1,2,3}$ - correction term

Table H3 — Correction Terms

Frequency Difference Between NAV Signal and Intermodulation Product (kHz)	Correction Term (dB)
0	0
± 50	2
± 100	8
± 150	16
± 200	26

For frequency differences beyond ± 200 kHz, type B_1 interference does not need to be considered. For COM receivers, the Venn diagram method shall be used.

H1.4 Type B2 Interference

Table H4 contains maximum permitted levels of broadcasting signals at the input to the airborne ILS or VOR receiver.

Table H4 — Maximum Permitted Levels of Broadcasting Signals

Frequency of Broadcasting Signal (MHz)	Level (dBm)
107.9	-20
106	-5
102	5
≤100	10

For intermediate values, the maximum permitted level is determined by linear interpolation. For COM receivers, the level of any FM signal should not exceed -10 dBm.

H2. Selection of Aeronautical Test Points

For a test point height of:

- 2450 m above sea level (ASL) for ILS; and
- 12200 m ASL for VOR;

Table H5 lists separation distances between a broadcasting station with a given ERP and frequency, and the test point of an aeronautical radionavigation station beyond which it is considered unlikely that the

service of the aeronautical station would be affected. The more critical requirements are those for types A_1 and B_1 interference; the higher of the two separation distances is shown in Table H5.

In general, broadcasting stations which are:

- more than 500 km from a VOR/COM test point;
- more than 255 km from an ILS test point; or
- beyond the radio line-of-sight from a VOR or ILS test point;

are considered as being unlikely to affect the service of that aeronautical radionavigation station.

Table H5 — Separation distance (km) Between a Test Point of an Aeronautical Radionavigation Station and an FM Broadcasting Station Beyond Which the Aeronautical Service Is Unlikely to be Affected

Effective Radiated Power of Broadcasting Station		Broadcasting Station Frequency (MHz)						
		≤ 100	102	104	105	106	107	107.9
(dBW)	(kW)	Distance (km)						
55	300	125	210	400	500	500	500	500
50	100	75	120	230	340	500	500	500
45	30	40	65	125	190	310	500	500
40	10	25	40	70	105	180	380	500
35	3	20	20	40	60	95	210	500
30	1	20	20	25	35	55	120	370
25	0.3	20	20	20	20	30	65	200
20	0.1	20	20	20	20	20	40	115
≤ 15	≤ 0.030	20	20	20	20	20	20	65

H3. Compatibility Assessments

For the purpose of compatibility assessment, an interference prediction model, based on the compatibility criteria given in Section H1 of this annex, is used.