
Spectrum Management

Broadcasting Circular

Television Ghosting Interference Analysis

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Table of Contents

	Page
1. Introduction	1
2. Purpose	1
3. Prediction	2
3.1 Tower Reflection	2
3.2 Echo Delay	2
4. Procedure	2
4.1 Applications for New Television Broadcasting Undertakings	2
4.2 New Radio Towers or other Large Structures near a Television Transmitting Site	3
4.3 Analysis	3
4.4 Local Ghost	3
5. Limitation	3

1. Introduction

In television, a ghost image is a duplicate of the original image shifted slightly to the right of the original picture on the television screen. Ghost images appear when the same signal arrives at the viewer's location, having travelled through two or more different paths. Ghosting interference can be widespread or local. When the signal radiated by the television transmitting antenna is reflected by a high-rise building, a telecommunication tower or some other large structure adjacent to the television transmitting site, it creates ghosting interference that usually affects a large area within the service contour. By contrast, local ghosting interference is caused by reflections around the reception site. This type of interference is usually produced by an isolated structure remote from the transmitter. The affected area is normally confined to the surrounding region of the reflecting structure. In either case, the ghosting interference may produce impairment levels ranging from just perceptible to unusable.

Future NTSC or advanced television sets will be able to erase ghost images. Ghosting interference will be eliminated through the use of Ghost Cancelling Reference (GCR) signals on line 19 of the vertical blanking interval. Presently, only a handful of television undertakings in Canada are using GCR encoders. So, until such time as this technology is fully implemented by the industry and the majority of receivers are equipped with appropriate decoding devices, ghosting interference has to be monitored and regulated by Industry Canada.

2. Purpose

The role of Industry Canada in analyzing and ensuring the remedy of potential television ghosting problems is within the framework of its spectrum management responsibilities. The procedure described in this circular to predict ghosting interference which may be caused by the proposed undertaking to existing undertakings or to the proposed undertaking by existing undertakings reflects this responsibility.

Identifying the potential for ghosting interference in the initial stages of planning the implementation of a television undertaking or the construction of a structure near an existing television transmitting site is very important. District and regional offices which are physically close to sites under consideration are in the best position to detect potential problems and to propose practical remedial measures.

- (a) In the case of a proposed television undertaking, Industry Canada must assess the potential for ghosting. If predictions indicate a picture quality of less than the required grade (refer to Section 3), the applicant should be advised of the potential problem.
- (b) In the case of proposed construction of new radiocommunications structures or substantial changes to existing structures, Industry Canada must assess the potential for ghosting that may be caused to existing television undertakings by the proposal. Industry Canada must also require modifications to the proposal

in order to remedy possible ghosting problems. Remedial measures undertaken by the applicant should be verified by subjective image assessments.

3. Prediction

The method normally employed for predicting television ghosting interference is TVG1 software. The software is described in the report entitled "*Report on Predicting Television Ghosting Interference and Picture Quality*" (BTRB-6).

As mentioned above, the evaluation of picture quality is hinged on the calculation of two essential components: the magnitude of ghost signals, or tower reflection, and the calculation of ghost delay. Once these components are calculated with acceptable accuracy, one can then estimate the resulting picture quality.

3.1 Tower Reflection

The magnitude of the reflected field from a nearby tower can be analyzed by treating the tower as a source of radiation. For horizontally polarized RF fields, the magnitude of reflection is a function of the tower width. The reflection coefficient can be calculated by assuming the tower to be an infinitely tall "equivalent" cylinder. The horizontal pattern of the field scattered from this mast, of relatively small cross-section with respect to the wavelength, is considered as non-directional.

3.2 Echo Delay

The delay of the echo signal depends on the location of the viewer, the transmitting tower and reflecting structure. To simplify the evaluation of the delay, it is assumed that the distance between the transmitter tower and the viewer is much greater than the distance between the transmitter tower and the reflecting tower.

4. Procedure

4.1 Applications for New Television Broadcasting Undertakings

All antenna towers and other metallic structures, situated within a radius of 500 metres from the proposed transmitter site, should be considered for ghosting interference analysis. It is also recommended to consider structures which are beyond 500 metres but higher than the centre of radiation of the proposed antenna.

In general, the proposed undertaking should provide the required grade of service [refer to Broadcasting Procedures and Rules (BPR) Part IV, Section C-7.6] in all directions where there are populated areas, including areas where there may be imminent urban development.

4.2 New Radio Towers or other Large Structures near a Television Transmitting Site

All television transmitting sites within a radius of 500 metres from the proposed structure should be considered for ghosting interference analysis. If the height of the proposed structure exceeds 150 metres, it is recommended that all television transmitting sites within a radius of 1500 metres from the proposed structure be considered.

The proposed undertaking shall maintain the required grade of service (refer to BPR Part IV, Section C-7.6) of all television undertakings in the vicinity, in all directions where there are populated areas, including areas where there may be imminent urban development.

4.3 Analysis

The analysis may be simplified considerably if the television antenna is non-directional. In this case, most offending reflectors are the ones located directly in line with the principal service area and behind the television antenna tower. Thus, locations for ghost analysis should be selected in this direction, starting at a distance of five to ten times the separation distance between the transmitting and reflecting towers to few multiples of the initial distance. When investigating ghosting interference for a proposed television transmitter, the above procedure should be repeated for all reflecting towers in the area. The results for each reflecting tower should be analyzed individually, pending the development of subjective data on the relationship between ghost delay, ghost level and picture impairment grade for multiple ghost situations.

Note: It is difficult to predict the picture impairment for separation distances of less than 75 metres (refer to Section 5). For such cases, subjective assessment of the image quality has to be conducted periodically during the construction phase of various towers.

4.4 Local Ghost

As the title indicates, a local ghost is an isolated interference situation which is limited in its extent. Since this kind of condition doesn't affect a large viewing area inside the service contour, neither the broadcaster nor the owner of the offending structure is directly responsible for remedial measures. In such cases, changing the location of the receiving antenna or using an antenna with higher gain (highly directional) will solve the problem.

5. Limitation

The 500 metre separation distance designated above is only a guideline. This distance may have to be expanded depending on the actual situation.

The subjective effect of a very short delay echo in the range of 0 to 500 nanoseconds, which translates into separation distances between towers of less than 75 metres, may be more severe than the extrapolation of the impairment curves (BPR Part IV, Appendix 7) would indicate. Theoretical calculations demonstrate that significant colour saturation and hue changes can be anticipated where the echo delay is approximately one half period, plus an integer number of periods of the colour sub-carrier frequency. This aspect of echo impairment is beyond the scope of the TVG1 program.