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Procedure to investigate radio reception interference from the operation of the radio transmission apparatus of broadband mobile radio communication networks

(Methodical Procedure)

Published in connection with the Tender for the award of the rights
to use radio frequencies for providing a public communications network
in the 800 MHz, 1800 MHz and 2600 MHz bands

1 INTRODUCTION

This document describes the procedure used in addressing complaints concerning radio reception interference from the operation of the radio transmission stations of the newly built private corporate networks for broadband data transmission.

Taking into account the networks' operating frequency bands (800, 1800 and 2600 MHz), the greatest problems can be expected with interference to the reception of TV signals on TV band V (i.e. up to 790 MHz) from the operation of the base stations (BS) of mobile networks in the 791-862 MHz band. Interference of the signals of radio transmission apparatus using higher frequency bands cannot be entirely eliminated, but it will certainly be much less frequent, the interference mechanism being the same.

As suggested by experience with similar issues (including, in particular, TV reception interference caused by CDMA and GSM base transceiver stations' signals), a substantial majority of interference cases can be assumed to be due to the high level of the mobile network radio transmission apparatus signals entering the receiver (interference caused by failure to maintain the EMC-related parameters of the radio transmission apparatus is very exceptional at present – in fact it only occurs when there is a fault). This document therefore describes only the procedure of interference investigation in cases of interference from a strong radio transmission apparatus signal, interfering with television or radio signals on the receiving side due to:

A low C/I separation – in this case the required protection ratio between the useful and interfering signal has not been respected.

Receivers´ blocking – due to a high level of the interfering signal the receiver´s sensitivity is reduced and a cross-modulation created.

Intermodulation products which are generated due to a high level of the interfering signal. According to the frequency position of interfering signal(s) (blocks A1.1 and A2.1 – A2.5) and useful signals (DVB-T), any DVB-T channel may be interfered with these products.

In practice, it might be supposed that there might be cumulated occurrence of all the mentioned types of interference of DVB-T signals.

2 GENERAL PRINCIPLES

a) Limit values of the protection ratios (PR), overloading threshold (Oth) and other parameters, as indicated below, apply to networks.
   - DVB-T useful signal in variant C2 or C3,
   - LTE interference signal (LTE: long-term evolution).

b) Where other systems are used, the parameters will be determined in accordance with their respective specifications.

c) Submissions complaining about radio reception interference from a LTE signal are addressed by the Office, mainly through its regional branch offices, which decides how to proceed further in accordance with the Act. The operator of the interfering apparatus may work independently on removing the interference in cooperation with the submitters or with the local authorities. If a DVB-T transmitter is installed later on the costs of the protective measures are paid for by its operator.

d) The Office will inform at its Internet sites about the construction plan of radio mobile networks transmitting equipment.

3 PROCEDURE TO INVESTIGATE INDIVIDUAL RADIO AND TV RECEPTION INTERFERENCE

3.1 General investigation procedures

a) Subjective evaluation is performed on the complaint submitter's reception equipment (in accordance with Regulation No. 163/2008) to see if there is any interference. If no interference occurs, measurements under clause b) below will only be made for later investigation, if any.
b) The level of the useful signal (TV signal) and interference signal (LTE) is measured on the receiving apparatus.
c) The level of the useful signal is evaluated according to the ČSN EN 60728-1 Standard; in simple distribution systems, a minimum DVB-T signal level of 40 dBμV can be admitted at receiver input which is a sufficient reserve with respect to the receivers´ sensitivity based on the required sensitivity of DVB-T receivers (-7,4 dBm = 31,4 dBμV@75Ω for the variant C2 and -75,8 dBm = 33,0dBμV@75Ω for the variant C3 according to the standard ČSN EN 62216).
d) In the case of a LTE signal, the total power in the entire LTE block (or more than one block) is measured at the maximum BS load (maximum BS load will be provided by the operator if so required by the Office).
e) If necessary, the intensity of both signals' electromagnetic field is measured (using a horizontal polarisation measuring antenna) in the area near the reception antenna of the equipment exposed to interference, as far as possible.
f) When there is suspicion of interference due to failure to respect the technical parameters (EIRP, BEM) BS LTE (eNodeB), tentative measurement is performed in measuring vehicle and, depending on the results, further measurements are made directly at the output of the radio transmission apparatus.
g) The minimum intensity of the electromagnetic field of the useful signal (R, DVB-T) is defined by Regulations No. 163/2008 (TV) and No. 22/201 (FM, T-DAB).
h) The reception equipment is evaluated, for:
    - suitability of the selected solution to television and radio reception (the use of antennas, boosters and passive elements in the distribution of television and radio signals),
    - the levels of the useful and interfering signal at the individual points of the system,
    - suitability of using the selected elements (including, in particular, boosters and their gain); conformity statement in respect of the active elements.

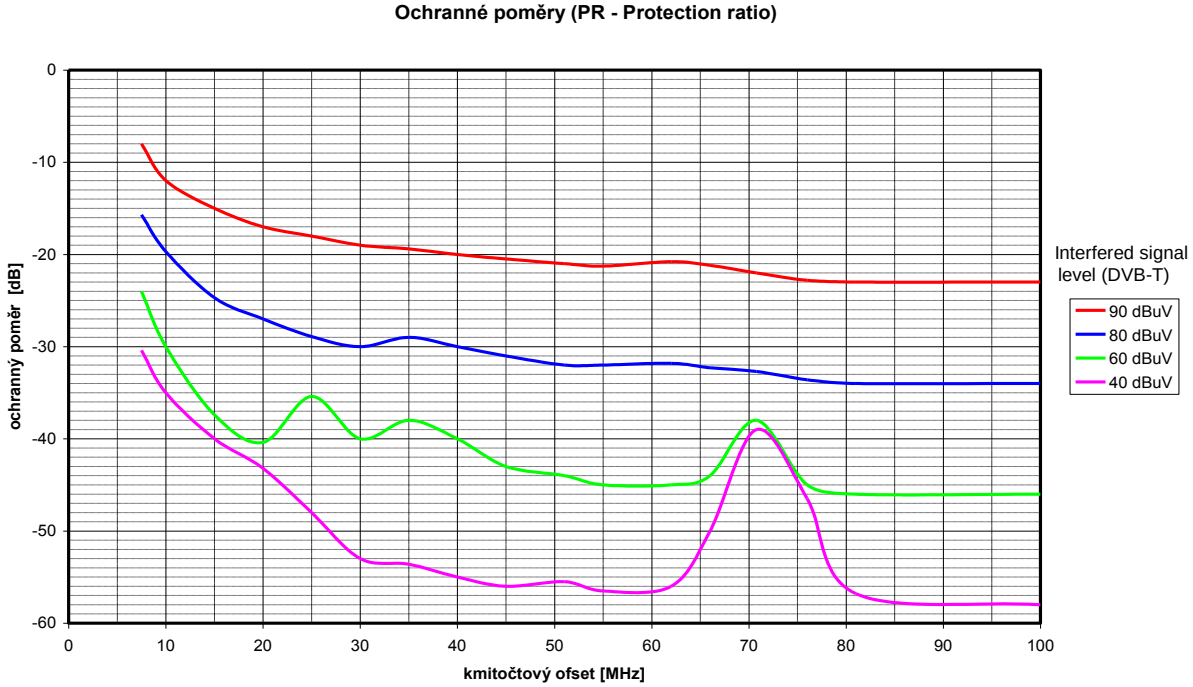
3.2 The Office will reject a complaint

a) In the case of faults in the reception equipment, or its unsuitable solution.
b) In a situation where the intensity of the useful signal's electromagnetic field is lower than the value necessary for good-quality reception (in accordance with the Regulations referred to above and the RRC06 conclusions).
c) If the interference by the LTE signal occurs at the receiver´s input and the value of the protection ratio (PR) or overloading threshold (Oth) is not exceeded according to the chart 1.
d) If the interference occurs and the input level of the LTE interfering signals does not exceed the value of the overloading threshold (Oth) according to the chart 2.
e) In the case that an active reception antenna is used inside a building.
f) If the intensity of the electromagnetic field of the interfering LTE signal measured at the site of interfered reception is $\leq$ 125 dBμV/m, provided that the interfering signal enters the reception equipment outside the antenna lead-in conductors, i.e. straight into the receiver or other active elements.

Should the Office reject a complaint, the operator of the interfered equipment must bear the costs of the protection measures.

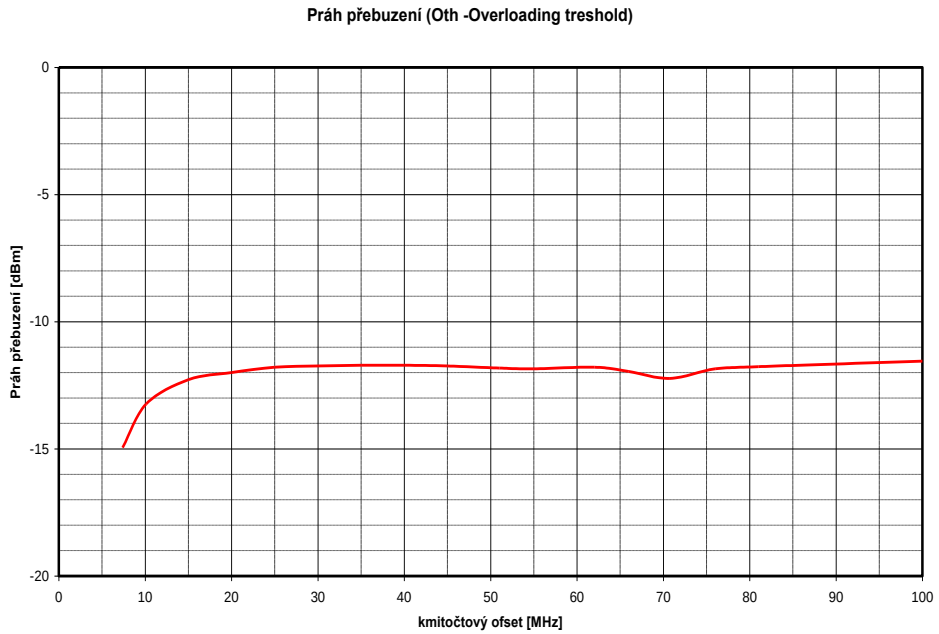
3.3 The costs of the protection measures must be borne by the operator of the interfering apparatus if

a) It is found that the conditions of the individual authorisation (IA) to use the frequency were not respected.
b) Other technical parameters of the equipment are not maintained.
c) The Office determines that the complaint is justified (See Point 3.2)



(1) The chart depicting the dependence between the protection ratio and the frequency offset (the difference between the center of the DVB-T channels and the LTE block).

The values in the chart are valid for the C2 variant, while for the C3 variant it is necessary to rectify the PR value by 2 dB, i.e. $PR_{C3} = PR_{C2} + 2dB$.



(2) The chart depicting the dependence of the overloading threshold on the frequency offset (the difference between the centre of the DVB-T channels and the LTE block).

Notes:

- *In the case of a LTE interfering signal, the total power of the signal(s) at the DVB-T receiver input at the maximum loading of the LTE BS is involved*
- *Graph 1 takes account of the undesired LTE BS radiation in the out-of-band transmission domain*
- *the overloading of the active elements of the receiving equipment is caused by the total power of the vf interfering signal, the difference for the variants C2 and C3 is not unequivocal and is not taken into account.*
- *The values shown in the graphs are based on the documents of the ITU-R, ECC and foreign sources, including the results of measurements made on a limited number of TV sets. We assume that they will be modified to reflect recent information (from relevant documents and from the results of the EMC LTE vs DVB-T experiment).*

Assessment of the EMC of the reception equipment must be differentiated according to its configuration.

3.3.1 Passive distribution of radio and TV signals

The operator of the interfering apparatus must bear the costs of the protection measures taken with respect to the distribution of the received signals without active elements:

a) If the value of the protection ratio (PR), as indicated in Graph 1, is not maintained due to the interfering signal.
b) If the interfering signal exceeds the value of the C – see Graph 2.
c) If the intensity of the electromagnetic signal of the interfering signal measured at the site of interfered reception (at the TV set) is $E \geq 125$ dBμV/m and the interfering signal enters the reception equipment outside the antenna lead-in conductors (ČSN EN 55020).
d) If the Office determines that the complaint is justified.

3.3.2 Radio and TV signal distribution with active elements

Where active elements (boosters) are included in the reception route, the following procedure should be used to assess if the protection measures are to be funded by the operator of the intervening apparatus:

A) The booster has an input connector, normally available for measurement.

In such a case the levels of both the useful and interfering signals are measured – points 3.1(a) and (c) above. The measured values are compared with those indicated by the manufacturer (the max. output level, gain in the UHF band). Should the interfering signal overload the booster or (with the booster in a linear mode) cause the protection ratio at the receiver input to decrease under the limit value shown in Graph 1, the costs of the protection measures (filter at the booster input, attenuation at the booster input) must be borne by the LTE network operator.

B) The booster is located directly at the antenna (without an accessible input port)

In this case, the assessment must be based on the intensities of the electromagnetic fields of both signals (DVB-T and LTE) measured as close to the reception antenna as possible, and on the declared parameters of the antenna pre-booster (if known).

As pre-boosters with unknown parameters can be expected to be used frequently, it is necessary, for a basic assessment, to proceed from the average values of pre-booster parameters:

antenna gain:	12 dB	
booster gain:	15 dB	(sufficient to cover normal distribution attenuation with usual passive elements)
maximum output level:	105 dBµV	for the overloading threshold (IP_{1dB}) ≈ Oth
maximum input level:	90 dBµV	

The relevant intensity of the electromagnetic field of the interfering signal can be determined on the basis of the above values of antenna gain and maximum input level:

$E_{interfering}$ 105 dBµV/m (for 800 MHz frequency)

Should interference occur, an external booster (outside the antenna box) with a primary filter that eliminates the interfering signal should preferably be used.

The operator of the interfering apparatus should bear the costs of the protection measures:

a) Where the interfering signal exceeds the admissible maximum output booster level (indicated by the manufacturer).
b) Where the protection ratio value indicated in Graph 1 is not maintained at the booster output.
c) Where the intensity of the electromagnetic field of the interfering signal, measured by means of a horizontal polarisation antenna in the area of the reception antenna, is higher than 105 dBµV/m.
d) If the Office determines that the complaint is justified.

3.4 Assessment of the time course when interference occurs

When assessing the interference in respect of the time course at the beginning of the operation of the interfered or interfering equipment, the procedure will be in compliance with the section 100 of the ZEK Act, i.e. in the case of a later installed DVB-T transmitter the costs of the protection measures are paid by its operator.

4 PROCEDURE TO INVESTIGATE INTERFERENCE TO COMMUNITY ANTENNA TELEVISION AND CABLE TELEVISION DISTRIBUTION SYSTEMS

4.1 Crosstalk interference over the antenna

Interference to the electronic communication networks via the antenna and the cable (the community antenna television system and cable television distribution system) is addressed in a manner similar to that in the case of individual reception, account being taken of the specific features of these systems where professional installation may be supposed:

a) Measurements can be taken at different points of the system to consider the place where the interference arises.
b) During investigation in community antenna television systems and cable television distribution systems, the need to use pre-boosters must be considered carefully and their gain must be reduced to an essential minimum. In most cases, the interference can be removed by inserting selective elements before the first active element of the system.

The costs of the protection measures must be borne by the operator of the interfering apparatus in the event that the interfering signal causes the maximum admissible output level (indicated in the specifications of the elements used) to be exceeded in the pre-booster and in other active elements of the distribution system, or in the event that the required value of

protection ratio, as indicated in Graph 1, is not achieved in the subscriber outlets due to the effects of the interfering signal.

4.2 Crosstalk interference over the distribution system

The ČSN EN 50083-8 Standard can be used in the case of assessing crosstalk interference by mobile network radio transmission apparatus signals over the distribution system. This standard sets the system's external stability (electromagnetic compatibility, EMC, for the networks) at E = 106 dBμV/m in the 0,15 – 3000 MHz frequency band:

a) In the case of interference by LTE signals getting into the distribution system and direct interference to the signals of the same frequency being distributed, the necessary protection measures must be taken by the operator of the distribution system – the 690-862 MHz are determined, as a priority, for radio communication services.
b) Taking into account the large number of subscribers taking the signal from one master station of the cable television distribution system– for elimination of any problems with interference by the LTE signal for cable television distribution system operators – the Office will inform (about the planned commencement of the operation and location.
c) Selection of cable television network operators and their information about the commencement of the operation of their LTE BSs (through the web site of the Office.
d) If mobile networks operators consider it useful they may find who are the cable television distribution systems operators and ask for the information about the locations of the main stations of the cable television distribution systems at the web sites of the Rada pro rozhlasové a televizní vysílání /Council for radio and television broadcasting/ (www.rrtv.cz) – list of the broadcasting operators.

5 INTERFERENCE TO OTHER SERVICES

a) Cases of interference to the operation of other electronic communications services will be investigated in the standard manner, according to the Act.
b) With respect to the protection of the radio direction finders in the Office's automated system of frequency spectrum monitoring, the intensity of the LTE signal's electromagnetic field at the monitoring station sites indicated under point 7 below must not exceed 105 dBμV/m in the station's antenna space. A list of the stations is in Point 7 below (the table).

6 ACRONYMS

EIRP	Equivalent Isotropic Radiated Power
EMC	Electromagnetic compatibility
ECC	Electronic Communications Committee (a body of the European Conference of Postal and Telecommunications Administrations – CEPT)
BEM	Block edge mask for limitation of emissions into adjacent frequency block in the out-of-band transmission domain
BS	Base station – in the LTE system referred to as eNode B
C/I	separation between the interfering signal (LTE) and useful signal (DVB-T)
DVB-T	Digital video broadcasting – terrestrial – the C2 variant is being currently used in the Czech Republic (number of carriers OFDM 8k, modulation 64 QAM, code ratio 2/3) and the C3 variant (number of carriers OFDM 8k, modulation 64 QAM, code ratio 3/4)
ITU-R	International Telecommunication Union – Radio Communication Sector

IP_{1dB} Signal power causing signal compression by 1 dB – value used to determine the transition of an active element to non-linear state - corresponds approximately to the size of the overloading threshold (Oth)

LTE a cellular network as a next step in the GSM ⇒ EDGE ⇒ UMTS series, providing higher data speeds

Oth overloading threshold – maximum power (usually associated with the introduction of active elements), not causing nonlinearity manifestations (blocking, production of intermodulation products, cross modulation)

PR Protection ratio – the smallest difference between the power (level) of the useful and interfering signals (dB), which still does not cause perceptible interference; $PR = P_{usef} – P_{interf}$

RRC06 Regional Radio Communication Conference, 2006, Geneva

7 LIST OF MONITORING STATIONS FOR PROTECTION AS REFERRED TO UNDER POINT 5 B)

Type	Name (city)	Site	Geographical coordinates	
			LAT	LON
SNMS	České Budějovice	Lišov	49 N 01 09,91	14 E 34 57,88
SNMS	Plzeň	Doubravka	49 N 44 42,54	13 E 26 06,81
SNMS	Karlovy Vary	Horní Slavkov	50 N 08 15,12	12 E 43 45,11
SNMS	Ústí nad Labem	Osek	50 N 38 48,31	13 E 38 30,80
SNMS	Liberec	Rudolfov	50 N 47 20,30	15 E 06 21,50
SNMS	Hradec Králové	Poběžovice u Holic	50 N 06 07,10	15 E 59 46,00
SNMS	Jihlava	Větrný Jeníkov	49 N 27 46,00	15 E 30 26,90
SNMS	Brno	Diváky	48 N 58 17,50	16 E 46 29,40
SNMS	Ostrava	Prašivá	49 N 38 06,41	18 E 29 58,14
SNZS	Praha - město	Praha - Lysolaje	50 N 07 36,06	14 E 23 05,09
SOMS	Karlovice	Karlovice	49 N 23 02,00	17 E 30 58,00
SOMS	Tehov	Tehov	49 N 58 16,00	14 E 42 15,00
SOMS	Brno - město	Brno - Lesná	49 N 13 57,38	16 E 57 02,03

SNMS - fixed unattended monitoring station
SNZS - fixed unattended radio direction finding station
SOMS - fixed attended monitoring station

Ref.: ČTÚ-121 784/2012-620/II.vyř.
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