CENELEC/ETSI JOINT WORKING GROUP ON
EMC OF CONDUCTED TRANSMISSION NETWORKS

16th MEETING TO BE HELD ON 21 & 22 February 2006 at ETSI, SOPHIA ANTIPOLIS

Source: **Federal Ministry for Transport, Innovation and Technology (Austria)**

Date: **16 February 2006**

Title: **PLC interference;**
Report about measurements concerning power line communication systems (PLC), and harmful interference caused by PLC in the HF bands 2000 – 30000 kHz.

Background

In Austria, broadband services via PLC are being provided in some regions. Since the first trials of PLC technology in Austria, which commenced in 2001, radio amateurs, and various public safety organizations using radio services in bands below 30 MHz, periodically reported harmful interference in these frequency bands, which were, according to the opinion of these spectrum users, caused by PLC operation in the concerned region.

In order to verify the complaints of these various users of HF systems, the Austrian Telecommunication authority carried out relevant investigations in the region Linz (Upper Austria) in May 2004, April 2005 and November 2005, where a PLC system is operated on a commercial basis. It turned out that the measured emission of PLC installations in the region of Linz is much higher (approximately 42 dB) than the relevant limit according to CEPT ECC/REC(05)04 which reflects the state-of-the-art in Austria.

Results of these measurements are presented in the Annexes.
Annex 1 contains measurement results of emissions in the HF spectrum from a PLC repeater mounted on an open-wire power grid (first part), measurement results of emissions in the HF spectrum of PLC signals from a transformer and from a terminal box (second part), and emissions of mercury vapour lamps induced by a PLC signal (third part). It should be noted that

- Emissions from PLC modems installed inside of buildings (e.g. within a flat) are quite the same as emission from PLC repeaters mounted on an open-wire power grid (see first part of Annex 1).
- Mercury vapour lamps (which are in many cases used for street lighting) obviously emit signals in the frequency band below 30 MHz up to at least 3 GHz which are induced by PLC signals carried on the power grid. This effect was detected quite recently and is still under investigation. At present, it is supposed that the plasma of mercury vapour lamps, is triggered by high-frequency PLC pulses. Obviously, the mercury vapour plasma, being an element with a non-linear characteristic, spreads the PLC signal into a very large bandwidth, and amplifies/radiates this signal as broadband radio emissions with rather high field strength (see Annex 1 part 3). It was not yet possible to investigate whether these broadband radio emissions cause harmful interference to radio stations using the subject frequency bands in the vicinity of such mercury vapour lamp street lighting installations. Other administrations are encouraged to also investigate this effect and to exchange relevant results.

The characteristics of measured PLC signals are available in Annex 2 of this document.

Proposal:

This report is intended to inform the "CENELEC/ETSI JOINT WORKING GROUP ON EMC OF CONDUCTED TRANSMISSION NETWORKS" about measurements concerning power line communication systems (PLC) and harmful interference caused by PLC in the HF bands 2000 – 30000 kHz and to trigger a discussion to adopt the ECC/REC/(05)04 as the document describing the state-of-the-art for wire-line telecommunication networks such as PLC networks within Europe.

Annex 1

Measurement results

Measurement on	Location	Measurement date	Frequency of Field strength maximum	Measured field strength (Peak) in 3 m distance	Permissible field strength (Peak) according to ECC/REC/(05)04	Ppermissible field strength is exceeded by
Part 1						
PLC repeater mounted on an open-wire power grid	Ansfelden, Neubaustraße (Traunuferstraße)	23.11.2005	**8 000,0 kHz**	78,5 dBµV/m	32,1 dBµV/m	**46 dB**
	Pregarten, Mitterfeld	24.11.2005	**5 141,0 kHz**	80,9 dBµV/m	33,7 dBµV/m	**47 dB**
	Linz, Plesching	22.11.2005	**8 747,0 kHz**	82,2 dBµV/m	31,7 dBµV/m	**50 dB**
Part 2						
PLC repeater in transformer-station	Linz, Im Schlantenfeld	22.11.2005	**4 738,0 kHz**	54,7 dBµV/m	34,1 dBµV/m	**21 dB**
	Luftenberg, Statzingerstraße	22.11.2005	**21 842,0 kHz**	51,8 dBµV/m	28,2 dBµV/m	**24 dB**
	Pregarten, Trafo Heimstätte	24.11.2005	**8 002,0 kHz**	68,2 dBµV/m	32,1 dBµV/m	**36 dB**
	Steyregg, Bergsiedlung	29.11.2005	**4 753,0 kHz**	73,0 dBµV/m	34,0 dBµV/m	**39 dB**
PLC repeater in terminal box	Linz, Galvanistraße	22.11.2005	**4 648,0 kHz**	66,9 dBµV/m	34,1 dBµV/m	**33 dB**
	Linz, Im Schlantenfeld/Pulvermühlstraße	24.11.2005	**4 349,0 kHz**	69,1 dBµV/m	34,4 dBµV/m	**35 dB**
	Linz Dornach, Glaserstraße	24.11.2005	**6 460,0 kHz**	65,9 dBµV/m	32,9 dBµV/m	**33 dB**
	Luftenberg, Statzingerstraße	25.11.2005	**21 549,0 kHz**	56,3 dBµV/m	28,3 dBµV/m	**28 dB**
	Neumarkt, Feldstraße	30.11.2005	**6 858,0 kHz**	69,3 dBµV/m	32,6 dBµV/m	**37 dB**
Part 3						
Mercury vapour lamp used for street lighting	Linz, Karl Renner Straße	22.11.2005	**8 946,0 kHz**	87,4 dBµV/m	31,6 dBµV/m	**56 dB**

Annex 2

Figure 1: PLC signal injected from PLC modem into artificial grid according to EN55022

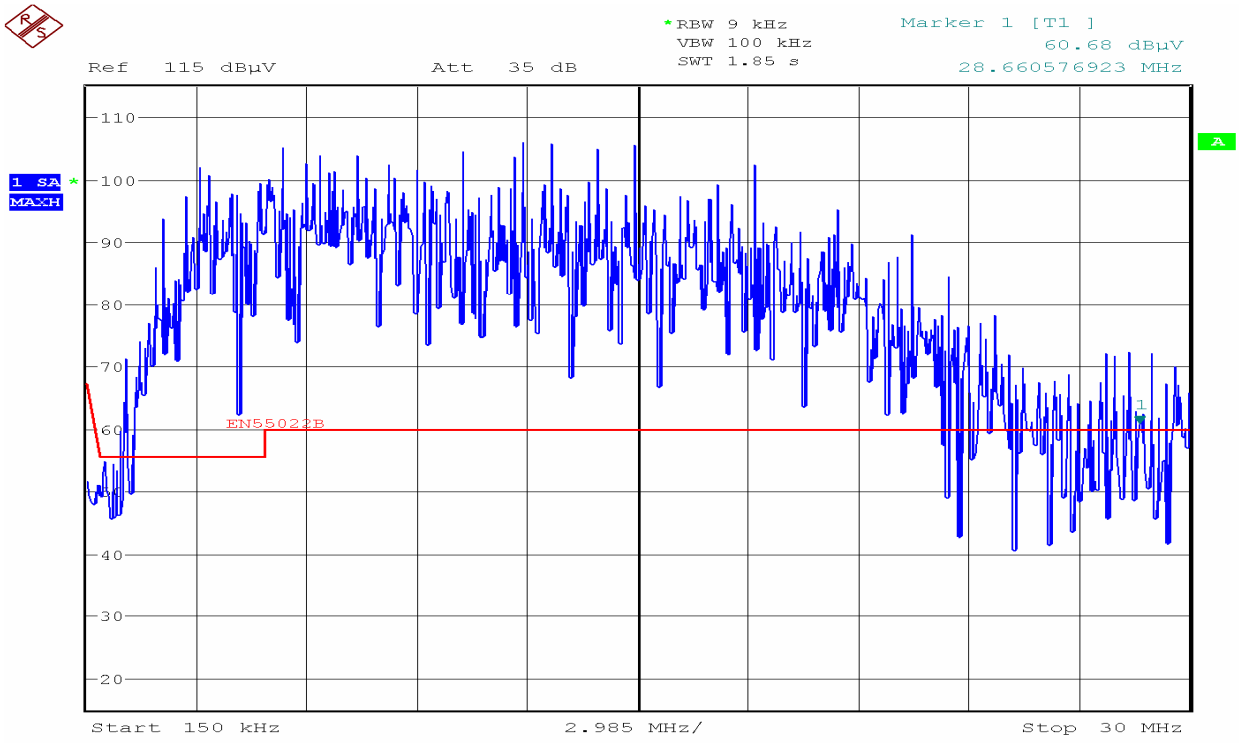
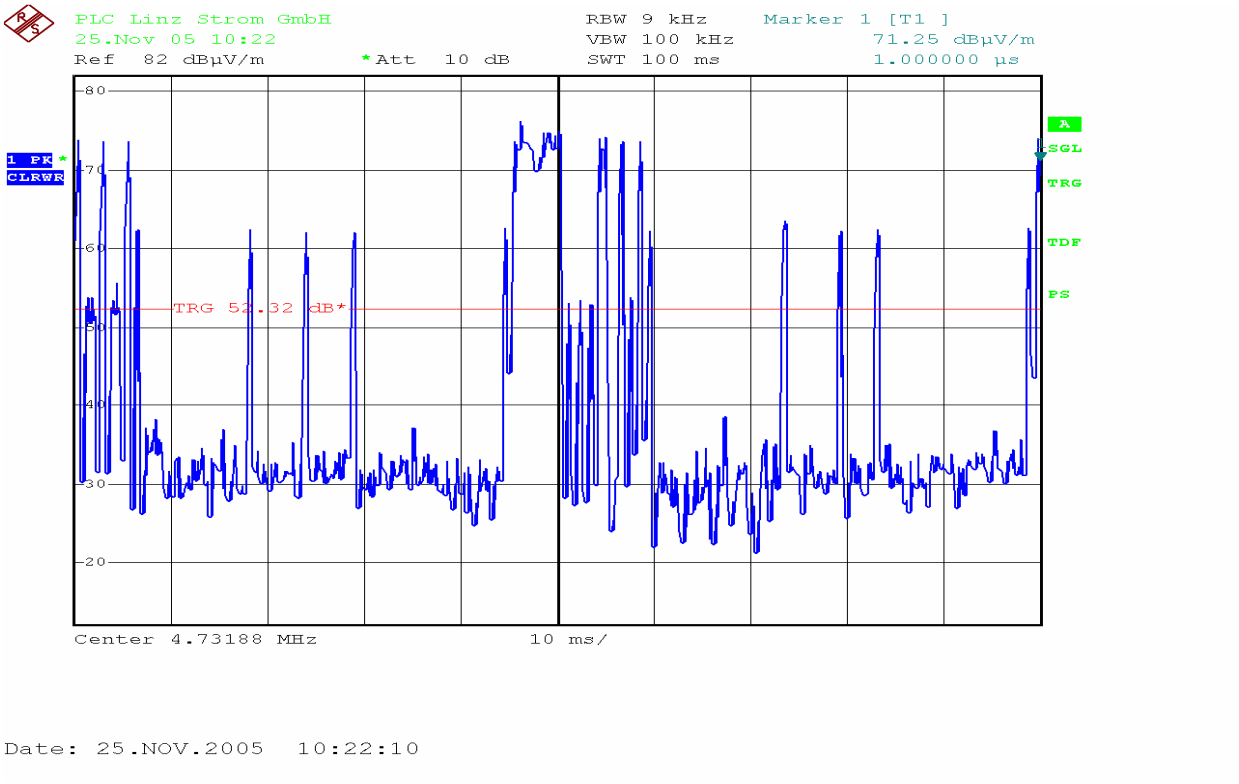


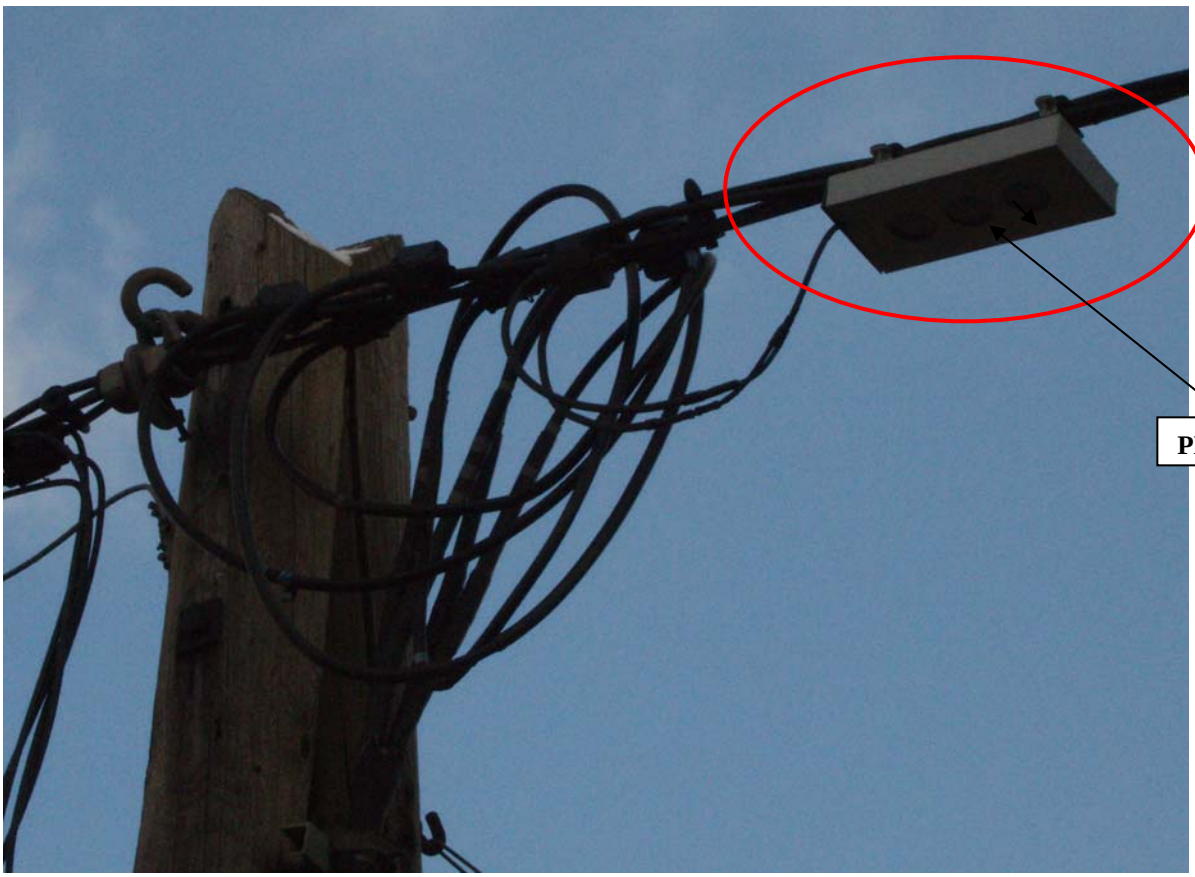
Figure 2: Radio spectrum emitted by PLC installation (measured in open area in a distance of 3 m from open-wire power grid line carrying PLC signals. Spikes are intended radio signals emitted by licensed radio transmitters. The line on the bottom presents the limit according to CEPT ECC/REC/(05)04).

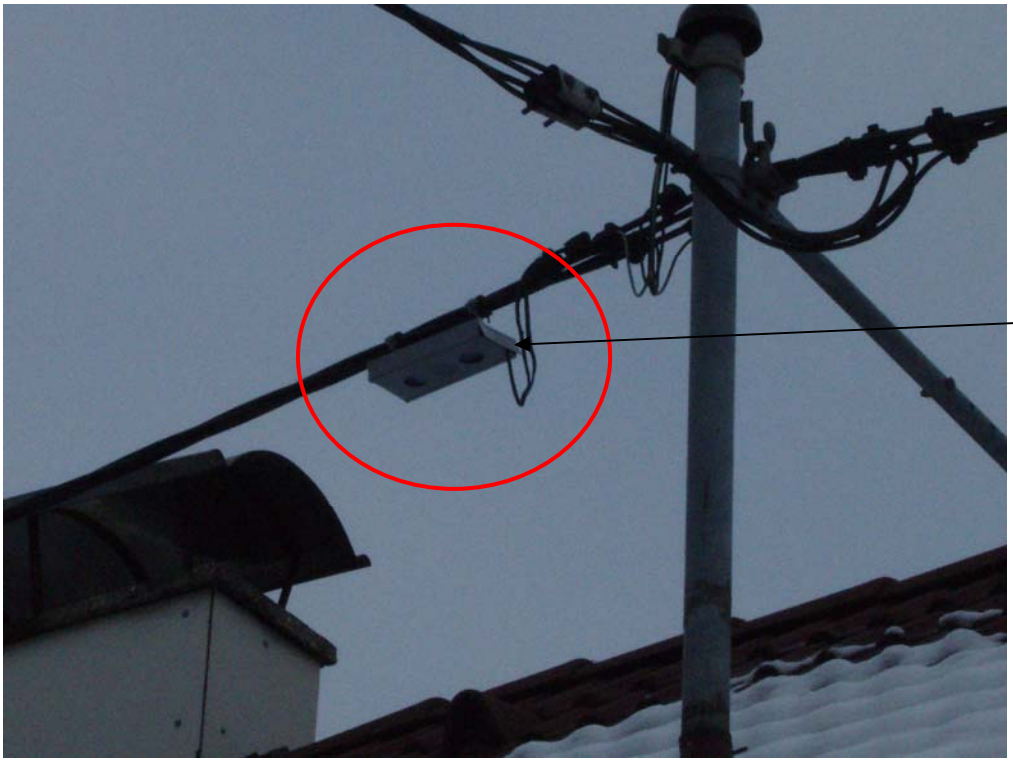
Figure 3: PLC emission on the frequency 4731.88 kHz in the time domain (sweep time 100 milliseconds).
In particular, this figure shows, as an example, the interfering signals (i.e. the spikes) caused by PLC emissions.



Annex 3

Typical installation of a PLC repeater on an open-wire power grid





Measurement situation

Annex 5

Electronic Communication Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

ECC RECOMMENDATION (05)04

CRITERIA FOR THE ASSESSMENT OF RADIO INTERFERENCES CAUSED BY RADIATED DISTURBANCES FROM WIRE-LINE TELECOMMUNICATION NETWORKS

Recommendation adopted by the Working Group "Spectrum Engineering" (SE)

INTRODUCTION

In individual cases radiated disturbances from wire-line telecommunication networks can cause (harmful) interference[1] to radiocommunications applications even if the relevant part of the network meets all relevant EMC requirements. The elimination of such interference cases becomes particularly difficult if also the individual radiocommunications application meets the provisions of its harmonised EMC and functional standards and is operating within the coverage area of the relevant radiocommunications system.

In order to resolve such individual interference cases to the best interests of both parties involved, CEPT recommends that it is useful to have a set of common criteria to assess such cases of radio interference. CEPT administrations are encouraged to use these criteria as a guideline for eliminating individual interference cases.

It is considered appropriate that this Recommendation be reviewed every three years, in the light of changing technologies and regulatory requirements. This review should involve consultation with the relevant technical and working groups within CEPT, ETSI and CENELEC.

"The European conference of Postal and Telecommunications Administrations,

considering

a) that the radio frequency spectrum is a common resource and that it is essential to minimise unnecessary interference by making the best use of the most modern and cost-effective techniques;

b) that harmonised standards for radiocommunications equipment and other electrical/electronic apparatus are established in order that such products, systems and installations operate as intended in the majority of application cases and under normal operation conditions;

c) that meeting the requirements of harmonised EMC standards may not prevent an individual apparatus, system, installation or network from causing harmful radio interference under certain operation and environmental conditions;

d) that protection from radiated disturbances from telecommunications networks is specifically called for in ITU-R RR 15.12[2] and provided for in Council Directive 89/336/EEC[3];

[1] For ITU definitions on interference and harmful interference see RR articles 1.166 and 1.169

[2] ITU-R RR No. 15.12:"Administrations shall take all practicable and necessary steps to ensure that the operation of electrical apparatus or installations of any kind, including power and wire-line telecommunication networks, but excluding equipment used for industrial, scientific and medical applications, does not cause harmful interference to a radio communication service and, in particular, to a radio-navigation or any other safety service operating in accordance with the provisions of these Regulations"

[3] It is expected that the new version of the EMC Directive will be in force in 2007

e) that Article 6 (art 4.2 new EMC Directive, see note 3) of the Council Directive 89/336/EEC provides special measures with regard to the taking into service and use of apparatus taken for a specific site in order to overcome an existing or predicted electromagnetic compatibility problem;

f) an assessment of disturbances from wire-line telecommunication networks in accordance with the provisions of harmonised standards or other EMC specifications only is not sufficient to resolve in an appropriate manner individual cases of harmful radio interference;

g) that the ECC Report 24 "PLT, DSL, cable communications (including cable TV), LANs and their effect on radio services" addresses the compatibility between data communication systems and radiocommunications services. It also describes in detail the various radiocommunications services potentially affected by unwanted radiation from telecommunications networks and it describes the associated protection requirements. The ECC Report 24 also provides evaluation of radiation limit examples and examples of measurements.

h) that CEPT and ETSI have developed a Memorandum of Understanding describing the mutual responsibilities of the two bodies. The MoU text is available from ERO, further information available from ETSI[4];

i) that the R&TTE Directive 1999/05/EC, in force since 8th April 2000, has been implemented in EU Member States and also followed by most other CEPT member countries;

j) that further steps should be taken to harmonise the resolution of interference cases through a more formalised framework;

k) that the European Commission is preparing a Recommendation on broadband communications through Power-lines[5];

l) that the European Commission has issued the standardisation mandate M/313 under EMC Directive 89/336/EEC to CEN, CENELEC and ETSI to produce harmonised EMC standards for telecommunications networks. This mandate concerns the preparation of harmonised standards covering EMC aspects of wire-line telecommunication networks and their in-house extensions. These standards should cover the types of networks, which are currently operational or which are under development, including, but not limited to those using power lines, coaxial cables and classical telephone wires.

recommends

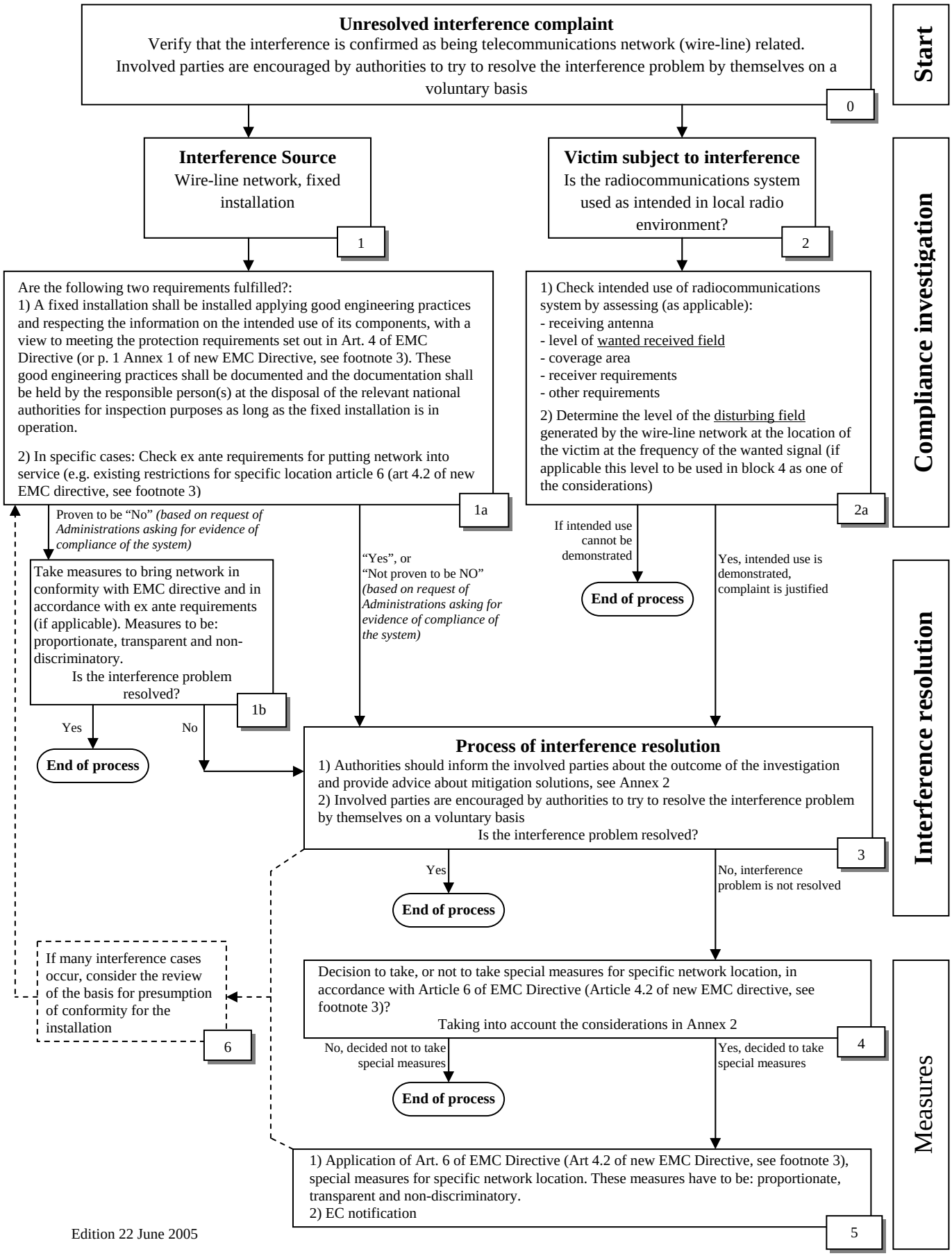
1. that when examining cases of interference complaints, caused by radiated disturbances of wire-line telecommunications networks, CEPT Administrations or National Authorities consider the use of the framework described in Annex 1 as a guideline for the process of resolving these interference cases in a transparent, proportionate and non-discriminatory way;

2. that the set of criteria for the assessment of interference, which includes reference field strength limits, as given in the Annex 2, should be used in order to investigate the case and to address all necessary measures to resolve the interference in a proportionate, non-discriminatory and transparent manner."

[4] http://portal.etsi.org/erm/kta/emc/clc_agree_emc.asp
[5] This recommendation was in draft form as of August 2004

Annex 1

GUIDELINES FOR THE ASSESSMENT OF RADIO INTERFERENCE CASES CAUSED BY DISTURBING RADIATIONS GENERATED BY WIRE-LINE TELECOMMUNICATIONS NETWORKS



Addendum

Explanation of flowchart in Annex 1

<table>
<tr><td>0</td><td colspan="2">Starting point

The process starts with an unresolved interference case complaint involving a radiocommunications system and a wire-line network. Involved parties are encouraged by authorities to try to resolve the interference problem by themselves on a voluntary basis</td></tr>
<tr><td>1</td><td colspan="2">Gathering information about the interference source
• Determine if the wire-line telecommunications network causes the interference
• Request evidence of presumption of conformity of the network. Wire-line telecommunications networks are considered to be fixed installations and can only be put into service if they comply with the essential requirements of the EMC Directive</td></tr>
<tr><td rowspan="2"></td><td>1a</td><td>The following requirements have to be assessed by the national authority:
• A fixed installation shall be established applying good engineering practices and respecting the information on the intended use of its components, with a view to meeting the protection requirements set out in Art. 4 of EMC Directive (P. 1 of Annex 1 of new EMC Directive, see footnote 3). Those good engineering practices shall be documented and the documentation shall be held by the responsible person(s) at the disposal of the relevant national authorities for inspection purposes as long as the fixed installation is in operation.
• In addition, ex ante requirements might be applicable for a specific location, e.g. if prior EMC Directive’s Art. 6 procedure (Art. 4.2 of new EMC Directive, see footnote 3) was used to forbid the putting into service or use of a wire-line network in an certain area in order to overcome an existing or predicted EMC problem in that area.</td></tr>
<tr><td>1b</td><td>If network is NOT in conformity with EMC directive:
• Wire-line communications networks are considered to be fixed installations and can only be put into service if they comply with the essential requirements of the EMC Directive. So the network must be brought in conformity with the EMC Directive. Measures should be:
- proportionate;
- transparent;
- non-discriminatory.</td></tr>
<tr><td>2</td><td colspan="2">Gathering information about the radiocommunications system which suffers interference
Is the radiocommunications system used as intended in local radio environment?:
• Investigate the radiocommunications system
• Obtain information and evidence of compliance of the radiocommunications system with the relevant requirements.</td></tr>
<tr><td></td><td>2a</td><td>1) Check intended use of radiocommunications system by assessing (as applicable):
• Receiving antenna
• Receiver requirements
• Coverage area
• Level of <u>wanted received field</u>
• <u>Distance between the source and victim</u>
• Does the victim radiocommunications system suffer from a structural defect or other inner malfunction?
• Are the operating conditions in accordance with the specification?
• Do the operating conditions (such as location and type of antenna) fulfil the minimum relevant requirements for reliable signal reception?
• Other requirements that are applicable

2) Determine the level of the disturbing field generated by the wire-line network at the location of the victim at the frequency of the wanted signal (if applicable this level to be used in block 5 as one of the considerations)</td></tr>
</table>

3	**Process of interference resolution** - Authorities should inform the involved parties about the outcome of the investigation and provide advice about mitigation solutions, Annex 2 refers - Involved parties are encouraged by authorities to try to resolve the interference problem by themselves on a voluntary basis
4	Process of taking a decision to take or not to take special measures for this specific location of the network (in accordance with Art. 6 of EMC Directive, Art. 4 of new EMC Directive), taking into account the considerations given in Annex 2 like: - the importance of the radiocommunications service - the importance of the network - technical aspects - economic aspects and other aspects
5	Taking specific measures on the basis of Art. 6 of EMC Directive, Art. 4 of new EMC Directive (see footnote 3). Special measures for a specific location of a network have to be: - proportionate; - transparent; - non-discriminatory. Special measures should be notified to the European Commission. Those that have been recognized as justified must be contained in an appropriate notice made by the Commission in the *Official Journal of the European Union.*
6	If many interference cases occur, administrations are urged to consider the review of the basis for the presumption of network conformity.

Annex 2

MITIGATION TECHNIQUES AND CONSIDERATIONS, INCLUDING LIMITS OF THE DISTURBANCE FIELD STRENGTH,

APPLICABLE TO BLOCKS 3 AND 4 OF FLOWCHART IN ANNEX 1

Mitigation techniques (Ref. Block 3, Annex 1)

Some examples of possible mitigation techniques are:

- Change of receiving antennas and/or their siting for the victim radiocommunications system
  Note: other antenna types or a better antenna siting could be an efficient mitigation technique. However this may not always be possible in a given location and could involve significant costs if the antenna site is high above the ground.
- Change in the geometrical structure of the wire-line network
- Frequency notching by the operator of wire-line network
  Note: the notching of specific frequencies may not be possible with some modulation schemes. Notching is an effective technique to mitigate specific cases of interference. If there are multiple cases of interference, multiple notches will seriously reduce the bandwidth available to the network operator.
- Use more repeaters in the wire-line network to reduce peak power
  Note: this will tend to increase the bandwidth used by a network operator in a locality as many repeaters employ a frequency-shift. A wire-line telecommunications network operator will wish to minimise the number of repeaters on economic grounds.
- For the case of Power Line Communication systems, other techniques such as the use of filters and signal terminations, differential mode signal injection, adaptive filtering and power control can be considered.

Criteria to decide whether special measures should be taken (Ref. Block 4, Annex 1)

These special measures refer to Art. 6 of the EMC directive (Art 4.2 of new EMC directive, see footnote 3) which are meant to overcome an existing or predicted electromagnetic compatibility problem at a specific site regardless of the fulfilment by the involved equipment (interference source and victim) of the requirements of the EMC Directive.

Criteria to decide whether special measure should be taken should contain the following aspects:

1. Technical aspects

- Level of the disturbance field strength generated by the network at the location of the victim at the frequency of the (disturbed) wanted signal. Examples of practical measurement procedures[6]: for each scenario and network different measurement methods should be used as appropriate, for example: in-situ measurements of the disturbance emission or conducted disturbance measurements.

- Recommended field strength level for assessing the level of the disturbance emission generated by the wire-line network at the location of the victim at the frequency of the (disturbed) wanted signal is stated in the following table:

[6] CENELEC TLC/prTS50271; RegTP 322 MV 05

Frequency f [MHz]	**Limit of the interfering electric field strength in dB(µV/m) (peak detector) at the location of the victim and at the distance of 3 meter from the source**	**Measurement Bandwidth**
0.009 to 0.15	40 - 20·$\log_{10}$(f/MHz)	200 Hz
0.15 to 1	40 - 20·$\log_{10}$(f/MHz)	9 kHz
Above 1 to 30	40 - 8.8·$\log_{10}$(f/MHz)	9 kHz
Above 30 to 1000	27 (1)	120 kHz
Above 1000 to 3000	40 (2)	1 MHz

(1) This corresponds to an effective radiated power of 20 dBpW.
(2) This corresponds to an effective radiated power of 33 dBpW.

- National Administrations could decide to take special measures regardless of the level of disturbing field if it is justified by the importance of the victim radiocommunications service, e.g. for safety and/or emergency services (see section 2 of this annex).

- Field strength measurements at the interference site will show if a decrease in the unwanted field strength might improve the interference scenario

2. Economic and political aspects

- Burden of costs to achieve compatibility for the victim and interferer (note: Administrations should have to take account of the proportionalities of the costs)

- Importance of the victim service (safety related services etc.)
  Setting more stringent parameters or limits for particular devices or frequency bands.
  Note: This is a political rather than an economic aspect. The need to protect special services (e.g. safety related services) should not be influenced by an economic argument.

- Alternative delivery of the service
  Note: This is a political decision. Freedom of access to existing sources may potentially be restricted if alternative delivery is by a non-radio medium. An alternative delivery of a service will also have an economic impact for the operator and the user of this service.

- Number of interference complaints
  Note: The number of interference complaints may be far below the number of interference events. A user subject to interference may not recognise the cause as interference from a wire-line network. As a result an interference complaint is not made to the Administration. Administrations are expected to intervene only when interference complaints are notified.

- Perspectives for the future
  - New radio technologies
  Note: New technologies may not improve the interference scenario. New technologies are usually introduced for economic reasons.

- New users to take account of existing users ("First come - first served" principle)
  Note: This principle provides a general protection of existing services. However Administrations have to assess if this general principle has to be maintained under all circumstances.

3. Regulatory aspects

- Responsibility
  Note: The responsibilities of the interferer and the victim have to be identified.
- Administrations may invoke coordination procedures between the affected parties to solve a case of interference.

4. Assessment of all criteria and circumstances

Administrations should assess all criteria in a balanced and proportional way. Especially in a “Conflict of Standards” case, Administrations are expected to avoid any unnecessary burden for the victim service.