CISPR TR 16-4-6

Edition 1.0 2024-10

TECHNICAL REPORT

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

Specification for radio disturbance and immunity measuring apparatus and methods –
Part 4-6: Uncertainties, statistics and limit modelling – Statistics on radio frequency interference (RFI) and verification by measurements in the field

CISPR TR 16-4-6:2024-10(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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CONTENTS

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SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 4-6: Uncertainties, statistics and limit modelling – Statistics on radio frequency interference (RFI) and verification by measurements in the field

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CISPR 16-4-6 has been prepared by CISPR subcommittee H: Limits for the protection of radio services. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
CIS/H/504/DTR	CIS/H/513/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the CISPR 16 series, published under the general title *Specification for radio disturbance and immunity measuring apparatus and methods* , can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

In 2018, work started in CISPR/H to undertake a fundamental review of CISPR TR 16-4-4:2007, CISPR TR 16-4-4/AMD1:2017 and CISPR TR 16-4-4/AMD2:2020 [1][1]. As a result of this review, it was decided to transfer the content on statistics of complaints in Clause 4 to a new publication, as the content of this clause was quite disconnected from the limit modelling part of CISPR TR 16-4-4 [1]. A cross-reference list of CISPR TR 16-4-4 [1] and this document is given in Annex E. Note that with reorganization of CISPR 16 in 2003, the recommendations on statistics of interference complaints were moved from CISPR TR 16-3:2002 (first edition) to Clause 4 of CISPR TR 16-4-4:2003 (first edition).

In the past interference on analogue radio reception, for example television, was easy to detect. With the shift to newer technologies the recognition of interference is more difficult. Nevertheless, submission of statistical data on complaints is still considered an important instrument to verify the suitability of CISPR publications, as they are widely adopted in various regions and countries for market access of equipment.

The recommendations for reports on statistics of complaints in CISPR TR 16-4-4 were found also to be outdated and not suitable to analyse and interpret the interference complaints that are often reported within CISPR and its subcommittees. Therefore, it was decided also to add additional recommendations in this new CISPR publication to enable proper analysis of these complaints and subsequently to implement appropriate changes in the CISPR publication concerned. With these additions, this CISPR publication on statistics of radio frequency interference serves as a more meaningful feedback loop on how effective the limits and test methods in CISPR publications are.

This CISPR publication is intended for any party having an interest in aggregation and subsequent submission of statistical data to CISPR, either as a CISPR liaison, or via the respective National Committee. It addresses radio frequency interference incidences and reported cases which could be traced back to having been caused by use as intended in the given category of electromagnetic environment, of any kind of electric/electronic equipment, system or installation being conformant with the provisions of CISPR standards.

This document provides a methodology for the systematic collation, aggregation and verification of interference in the given environment, or in general any investigations into reported radio frequency interference cases.

The latter more administrative activity incorporates the aggregation of statistical data on interference complaints. These could be traced back to having been caused by operation and use of any kind of closely co-located and well-maintained or also defective electric/electronic equipment, systems or installations and radio receivers in the field or also by other shortcomings in the local conditions of use of such equipment, radio receivers, or by lack of service coverage or other reasons. This document can be used to prepare reports on the statistics of interference complaints in line with the provisions set out in Chapter IV, Article 15, Section VI of the ITU Radio Regulations 2020 [2], see also Appendix 10 of these ITU Radio Regulations [2].

[1] Numbers in square brackets refer to the Bibliography.

SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 4-6: Uncertainties, statistics and limit modelling – Statistics on radio frequency interference (RFI) and verification by measurements in the field

1 Scope

This part of CISPR 16, which is a Technical Report, applies to the acquisition, processing and preparation of statistical data of radio interference cases to facilitate the evaluation of the effectiveness of CISPR standards with respect to their potential to prevent radio frequency interference (RFI).

This document also provides a method for the analysis and evaluation of the residual risk of occurrence of the incidence of RFI in the electromagnetic environment.

This document also provides guidance for how an interested party can verify the root cause of RFI. This can be applied to either a reported RFI case or a case otherwise suspected of constituting an “RFI scenario”, by inspection and field strength measurements at the local site in the given electromagnetic environment.

Acquisition of statistical data according to this document only encompasses RFI incidences which affect radio reception by radio receivers or respective receiver components.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
complaint
report containing information on radio frequency interference (RFI) observed on radio receiving equipment

EXAMPLE Report received by a national RFI investigation service from a citizen containing information on an RFI incident including or not including a request for assistance.

3.1.2
RFI investigation service
entity investigating reported cases of radio frequency interference (RFI)

EXAMPLE Examples of institutions include regulatory authorities and special interest groups.

3.1.3
source
any electric or electronic equipment, system, or (part of an) installation generating electromagnetic emissions in the radio frequency (RF) range which can cause radio frequency interference to radio receiving equipment

Note 1 to entry: Electric and electronic equipment can be a source of electromagnetic energy when they contain active components or modules, such as switched mode power supplies, power electronic components, electric motors and thermostats.

3.1.4
electromagnetic disturbance
any electromagnetic phenomenon that can degrade the performance of a device, equipment or system, or adversely affect living or inert matter

Note 1 to entry: An electromagnetic disturbance can be an electromagnetic noise, an unwanted signal, or a change in the propagation medium itself.

Note 2 to entry: In this document, the phrase “propagation medium” is taken as the propagation mechanism or means, an example being leakage from a coaxial cable or by mode conversion in a balanced pair cable.

[SOURCE: IEC 60050-161:2018, 161-01-05, modified – Notes 2 and 3 have been removed and a new Note 2 has been added.]

3.1.5
radio frequency disturbance
RF disturbance
RF interference
RFI
electromagnetic disturbance having components in the radio frequency range

Note 1 to entry: In accordance with IEV 701-02-12, the radio frequency range comprises by convention all frequencies which are lower than 3 000 GHz.

Note 2 to entry: The disturbance can also present the accumulation of disturbance components from more than one, i.e., from multiple disturbance sources.

Note 3 to entry: The English words "interference" and "disturbance" are often used indiscriminately.

Note 4 to entry: The word interference is used short term for radio frequency interference in this document.

[SOURCE: IEC 60050-161:2018, 161-01-13, modified – In the terms, “radio disturbance” has been removed, RF interference is no longer a deprecated term, and “RFI” has been added; in addition, the original Note 2 has been renumbered as Note 1 and Notes 2 and 3 have been added. A Note 4 for clarification of the short term use has been added.]

3.1.6
root cause of RFI
local conditions and circumstances in the electromagnetic environment causing a radio frequency interference case

Note 1 to entry: Such conditions and circumstances can relate to phenomena in the electromagnetic environment (e.g., very high ambient noise), to the equipment with the radio receiving function incorporated (e.g. insufficient immunity), or to the equipment producing the unwanted radio frequency energy (e.g. via a special coupling mechanism).

3.1.7
interference incidence
event, detected as degradation in the quality of radio reception, that drops below the necessary quality of service or quality of experience

Note 1 to entry: The quality of experience can be defined in ITU documents.

Note 2 to entry: The probability of an interference incident is binary either there is or there is not an interference incidence.

Note 3 to entry: Interference incidence does not by itself state the severity of the incidence.

3.1.8
incidence distance
shortest distance between the particular disturbance source and the antenna of the disturbed radio receiver

Note 1 to entry: If a machine or installation causing interference is in a dedicated building/premises, the distance can be measured from the boundary of that premises/building.

3.1.9
protection distance
distance between the source of a radiated disturbance and the victim receiver at the edge-of-service area used for the derivation of a specific CISPR limit for radiated disturbance

Note 1 to entry: The edge-of-service area is defined by the minimum value of the wanted field strength of a radio service or application derived from ITU-R specifications.

Note 2 to entry: This definition can vary in other publications, when conducted disturbances are concerned.

Note 3 to entry: Every limit has an associated protection distance; the protection distance can vary with frequency.

[SOURCE: CISPR 16-2-3:2016/AMD1:2019 [19], 3.1.34]

3.1.10
target
figure, value, ratio or the like of a given parameter recommended by CISPR as criterion for the assessment as to whether or not a detected RFI incidence can be considered a case of harmful interference

Note 1 to entry: Target figures are recommended by CISPR for use as reference, guideline and measure for the overall evaluation of reported RFI cases or results of survey measurements aiming at data gathering for indication of the residual risk of radio frequency interference, in the electromagnetic environment.

3.1.11
residual risk
remaining risk of an interference incidence when the requirements of the applicable CISPR standards are met

3.1.12
harmful interference
Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations

[SOURCE: ITU Radio Regulations:2020 [2], 1.169]

3.1.13
radio function
function that provides either a radiocommunication interface, or a radiodetermination interface, or both

3.1.14
radio appliance
appliance in which the radio function is incorporated in a fixed and permanent way

3.2 Abbreviated terms

EE Electromagnetic environment

EMC Electromagnetic compatibility

E_u minimum level of usable field strength

ISM Industrial, scientific and medical (electrical equipment, system or installation)

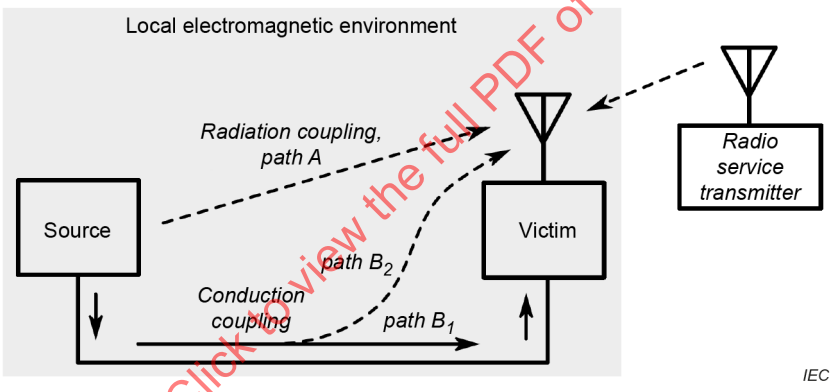
RF Radio frequency

RFI Radio frequency interference

4 Acquisition and organization of data on RFI incidences

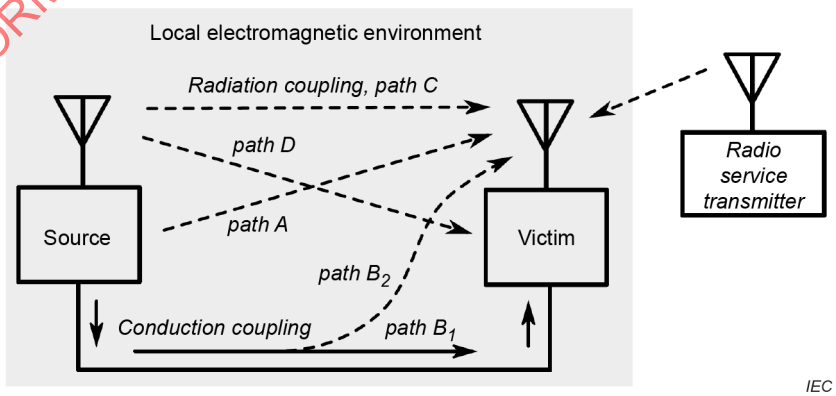
4.1 Basic interference model and conditions for undisturbed radio reception

RFI relates to the disturbance source, coupling path and victim as shown in Figure 1 and Figure 2. In addition, the wanted RF radio signal at the antenna of the radio receiver is provided with at least the minimum level of usable field strength E_u.



NOTE The conducted cable is not necessarily connected to the victim as for example in telecommunication lines, where only the radiation coupling (path B2) exists.

Figure 1 – Basic RFI model for source without radio module



NOTE The conducted cable is not necessarily connected to the victim as for example in telecommunication lines, where only the radiation coupling (path B2) exists.

Figure 2 – Basic RFI model for source with radio module

The following gives information on the conditions required to ensure that there is compatibility between disturbance source, system or installation operated in the field and radio receivers in the neighbourhood of these sources.

a) Source related:

   1) Emissions from the source in Figure 1 or Figure 2, along path A or paths B1/B2 do not exceed limits specified in the EMC standard applicable for that type of source.

   2) In addition to 1) if the source has a radio component, intentional, out-of-band and spurious emissions from the source comply with the relevant radio performance specifications, i.e. with RF spectrum-related and associated supplementary EMC requirements (coupling path C);

NOTE 1 Radio requirements are typically not considered by CISPR.

b) Victim related:

   1) The victim (i.e. the antenna of the radio receiver) is in a position where it could receive sufficient signal.

   2) The victim radio equipment has sufficient immunity to unwanted emissions from the source arriving through paths A/B in Figure 1 and Figure 2.

   3) In addition to 2), the victim has sufficient immunity to any intentional, out-of-band and spurious emissions from the source's radio transmitter/transceiver component (if any), arriving through radiation coupling paths C/D.

   4) The radio receiver or radio communication equipment being the victim complies with the relevant radio performance specifications, i.e. with RF-spectrum-related requirements (coupling path C).

c) Coupling-path-related:

   1) The distance between source and victim is sufficient.

NOTE 2 Conditions a)1) through c)1) are used to determine the root cause of RFI incidents in 4.4.

4.2 Occurrence of interference

If one of the conditions above is not met, interference is likely. And even if all of the above conditions are met, interference can occur, as follows:

– any specified emission limits as well as immunity levels in CISPR and IEC standards are derived on a statistical basis enabling EMC to prevail for a very large number of configurations and installations operated in the given electromagnetic environment, but not preventing interference in all configurations;

– specified coverage and reliability figures for radio services in national planning standards are based on statistical assumptions for the tolerable probability of instantaneous interference caused by unfavourable local coverage conditions;

– the current emissions/immunity requirements fail to provide adequate protection for radio and need review.

That means that compliance of products with requirements in EMC or radio performance standards, or both, does not prevent the appearance of occasional interference cases, but where they appear, although all conditions listed in 4.1, a)1 through c)1) are met, then they will be included in the total number of observed interference incidences too. Due to the first two reasons mentioned above, there remains a residual (and to a certain extent tolerable) risk of interference anyway, and it is one of the purposes of this document to provide guidelines for evaluation of whether the number of reported or otherwise observed RFI incidences is still below the residual risk of RFI. If statistics indicate that this is not the case anymore, then this can induce a review of the CISPR limits and standards with regards to their ability to fulfil the target of the CISPR scope of protection of radio reception.

RFI can occur if either the source or victim is defective (e.g., due to component failure, damage, ageing, end of life, etc.) or in case of abused use of products or illegal product modifications. If this is the case, then the radio or EMC performance of either the source or victim can be jeopardized. In practice this can also be a rather obvious cause of RFI, even though the conditions listed in 4.1 are apparently met.

4.3 Accumulation of statistical data on interference and preparation for reporting to CISPR

4.3.1 General

The number of reported or otherwise observed RFI incidences is part of the statistical data of interest to CISPR. This data can also be expressed as a relative figure for the same environment category of representative and well defined reference size.

A percentage of the overall number of RFI incidences (scenarios) detected locally in a given electromagnetic environment can be used for comparison with a tolerable residual risk of interference (which can be set during the limit derivation process using the alpha factor, see [1]).

For further more detailed analysis, any registered RFI incidence needs to be attributed either to the subset of cases covering conditions that do not necessarily indicate insufficiencies in CISPR standards or to subsets that do.

4.3.2 First data set – RFI incidences not necessarily indicating insufficiencies in CISPR standards

This subset consists of cases where any of the conditions a)2), b)1), b)2), b)3) or b)4) of 4.1 are not met.

The number of reported or otherwise observed interferences in the first set, attributed individually (and separately) to one of the conditions a)2), b)1), b)2), b)3) or b)4) represents the traditional way of reporting to CISPR and indicates among other things, up to which extent the involved sources and victim radio equipment comply with the provisions of the relevant EMC standards or radio performance specifications, or both.

It can be seen that statistical information derived from data in the first set has less direct relevance for CISPR. However, this data can be an important indicator for many interested stakeholders. This could include for instance certain parties such as administrations, countries with special national conditions, or manufacturers of products with specific needs who might decide on the non-applicability of a standard to their situation.

4.3.3 Second data set – RFI incidences possibly indicating insufficiencies in CISPR standards

The number of RFI incidences in the second set provides information of much more substantial interest for CISPR, in respect of possibly pending needs for maintenance of CISPR standards and review of CISPR limits as well.

In respect of reporting statistical data on the frequency of occurrence of RFI incidences or otherwise seemingly RFI scenarios, only data accumulated for condition a)1) to c)1) in 4.1 carry content of interest which is related to the residual risk of RFI and which accompanies the “use-as-intended” of any electric/electronic equipment (inclusive radio equipment) in the local electromagnetic environment.

4.4 Accumulation of data on interference and preparation for reporting to CISPR

4.4.1 General

Not meeting a condition in 4.1 is a possible root cause of an RFI incident. Therefore information on all conditions is gathered.

Guidance for collation of statistical data on interference complaints and preparation of reports to CISPR are set out in Annex A of this document.

Annex B gives general information on the value of statistics on radio frequency interference observed in the electromagnetic environment.

Annex C gives guidance on field strength measurements in the electromagnetic environment.

4.4.2 Data to be collected

Upon reception of an RFI complaint, it is convenient to collect and pre-process as much as possible of the following information for subsequent reporting. The letters in front define classification codes.

1) General information
   a) an index number or reference;
   b) state in which country the RFI case occurred.
2) Source-related:
   a) short description of the product (e.g. toaster);
   b) state which EMC standard was applied to demonstrate compliance of the product;
   c) state if the source was individually tested for compliance with the relevant standard and its outcome: not tested, compliant, not compliant.

      NOTE 1 Whilst it is better if the source can be individually tested to assess compliance with the relevant standards it is recognised that this is not always possible and interference situations can still be included in statistics where further testing has not been possible.

   d) if c) was performed state the margin to the limit at the frequency relevant to the RFI incident;
   e) state whether the source equipment is predominantly moving or static;
   f) assessment as to whether the (type of) source is (predominantly) used with connection to the LV AC mains, to a DC (power) supply network or fed by batteries;
   g) report all ports of the source equipment with cables connected to them;
   h) state the length of every attached cable connected to the ports reported in g);
   i) assessment as to whether the received complaint belonged to an interference caused by a single RFI source or by multiple items of the same type, as e.g. found in an installation;
3) Source-related – supplement for sources with radio modules:
   a) state whether the interference was caused by intentional, out-of-band or spurious emissions of the radio module;

      NOTE 2 This can be verified by switching off the radio function of the source, if possible.

   b) state whether the radio module or part/component of the source was found to be compliant with the applicable radio standard(s) (noting 2)c) above).

4) Victim-related:
   a) short description of the product (e.g. toaster);
   b) state any EMC or radio standards, or both, applied to demonstrate compliance of the product;
   c) state if the victim was individually tested for compliance with the relevant standards and its outcome: not tested, compliant, not compliant;

   NOTE 3 Whilst it is better if the victim can be individually tested to assess compliance with the relevant standards it is recognised that this is not always possible and interference situations can still be included in statistics where further testing has not been possible.

   d) state whether the victim equipment was located in an environment with sufficient wanted field strength at the antenna;
   e) if possible provide measurement data on the wanted field strength at the location of the antenna;
   f) state whether the victim equipment is predominantly moving or static;
   g) report all ports of the victim equipment with cables connected to them;
   h) state the length of every attached cable connected to the ports reported in g);
   i) State the reason(s) for filing the complaint (e.g. audible or visible distortions, malfunction, damage, etc.);
   j) state how often and for how long the observed interference occurred (e.g. occurrences per day, per hour, permanently or repetitively, periodically, occasionally, etc.).
5) Coupling-path-related:
   a) state in which environment the source is located (i.e. residential, commercial, light industrial or industrial area);
   b) state in which environment the victim is located (i.e. residential, commercial, light industrial or industrial area);
   c) state the distance between the RFI victim and the source.
6) With relation to other causes:
   a) state whether the victim or source is defective (e. g. due to component failure, damage, aging, end of life);
   b) state whether the victim or source is not installed or used in accordance with the user manual or installation guideline, or used with illegal product modifications.

Annex A gives guidance on how to report to the CISPR.

5 Root-cause-analysis of the reported RFI incidences

In case of RFI incidences assigned to the second data set (as described in 4.3.3) the root cause of the incidence has to be investigated further.

The main possible root causes for second-data-set-RFI-incidences are:

– No applicable limit in the affected frequency range, for the affected port or the affected mode of operation exists.
– The disturbance field strength value of the source is in between the limit of the existing applicable EMC standard and the worst case CISPR limit resulting from derivation based on the parameters in the IEC Radio Services Database (RSD).
– Disturbance field strength exceeds the limit in the applicable EMC standard.
– Incidence distance falls short of the protection distance.
– Some of the systematic factors in the related derivation procedure based on CISPR TR 16-4-4 [1] were not chosen accurately (attenuation by obstacles, polarization decoupling) to reflect real situations.

– Summation effects by multiple sources.

Frequent and repeated observation of such incidents can be an indicator for insufficiencies in CISPR standards and therefore will be investigated carefully.

For more details on root-cause-analysis see Annex D.

6 Reporting

6.1 General

Any party with interest in collecting reliable information and statistical data on RFI is encouraged to provide this information to CISPR. Annex A can be followed for guidance on how to structure this information.

Reports intended for CISPR can be prepared, in line with the recommendations and advice in this document, either as results of case studies, other kinds of spectrum survey or monitoring measurements in the field (e.g. as results of measurement campaigns), or, preferably on an annual basis, as traditional reports on statistics of complaints (see 6.2).

Parties being liaisons to CISPR can submit their contributions and reports directly to CISPR or CISPR/H. For other interested parties such reports can be submitted to CISPR and the relevant CISPR subcommittee via the respective National Committee being a member of CISPR. Both paths of providing information to CISPR will ensure that the reports will find the appropriate attention in CISPR.

The reports cover any relevant statistical data, but preferably also other information of general interest, as regards possible needs for maintenance of CISPR standards and limits.

6.2 Indications on the reporting format for traditional statistics of complaints

RFI investigation services which would like to issue reports on statistics of radio-interference complaints can report as described in Annex A. For a possible classification of root causes guidance is given in Annex D. Use of classifications will facilitate comparison of RFI situations observed in different countries.

Data and statistics preferably cover a complete calendar year. They are whenever possible presented in XML format, without employing more detailed categories than those listed in Table A.2. It is however not intended to exclude further material, which can be submitted as separate documents in addition to the data in XML format.

Annex A
(informative)

Guidance for collation of statistical data on interference complaints and classification of interference sources

A.1 General

Interference reports come in many different shapes. For easy evaluation it is desirable to have a common data exchange format. The information from 4.4.2 has been encoded in an XML schema which will be available on the IEC EMC zone.

A.2 Example of how to use the XML input form

The data structure is in XML format. Each interference case can be a separate occurrence within a single XML message. Table A.1 shows how information on the reporting party is gathered, Table A.2 describes the data fields of one occurrence in line with 4.4.2.

Table A.1 – Information on reporting party

No	Heading	Datatype
1	Name of person or organization submitting report	string
2	Contact details	string (address, Email)

Table A.2 – Data fields of one occurrence

No	Description	Heading	Datatype	Note
1)	**General information**			
a)	An index number or reference	index	String	
b)	State in which country the RFI case occurred	Country	String	
2)	**Source-related**			
a)	Short description of the product	Source product	String	
b)	State which EMC standard was applied to demonstrate compliance of the product	Source standard	String	
c)	State if the source was individually tested for compliance with the relevant standard and its outcome	Source compliance status	Dropdown: not tested, compliant, not compliant	
d)	if c) was performed state the margin to the limit at the frequency relevant to the RFI incident	Margin to limit	Float (unit in dB)	Positive, if result is below the limit

No	Description	Heading	Datatype	Note
e)	State whether the source equipment is predominantly moving or static	Source mobility	Dropdown: static, moving, portable, nomadic	
f)	Assessment as to whether the (type of) source is (predominantly) used with connection to the LV AC mains or fed by batteries	Source power source	Dropdown: AC mains, battery, DC (power) supply network	
g)	Report all ports of the source equipment with cables connected to them	Source port	Dropdown: AC mains, wired network port, signal and control port, DC power supply port, DC power port, antenna port, tuner port, other	Non-exclusive selection When other is selected an additional string is expected with the other port type
h)	State the length of every attached cable connected to the ports reported in g)	Cable length to source port	Float (Unit: metre)	Associated with each occurrence of field g)
i)	Assessment as to whether the received complaint belonged to an interference caused by a single RFI source or by multiple items of the same type, as e. g. found in an installation	Source topology	Dropdown: single source, multiple sources of same type, multiple sources of different types, distributed source	
3)	**Source-related – supplement for sources with radio modules**			
a)	State whether the interference was caused by intentional, out-of-band or spurious emissions of the radio module	Source radio module disturbance type	Dropdown: intentional, out-of-band, spurious, not caused by radio module	
b)	State whether the radio module or part/component of the source was found to be compliant with the applicable radio standard(s) (noting 2)c) above)	Source radio module compliance	Dropdown: not tested, compliant, not compliant	
4)	**Victim-related**			
a)	Short description of the product	Victim product	String	
b)	State any EMC and/or radio standards applied to demonstrate compliance of the product	Victim standard	String	
c)	State if the victim was individually tested for compliance with the relevant standards and its outcome	Victim compliance status	Dropdown: not tested, compliant, not compliant	

No	Description	Heading	Datatype	Note
d)	State whether the victim equipment was located in an environment with sufficient wanted field strength at the antenna	Sufficient wanted field strength	Dropdown: yes, no, not measured	
e)	If possible provide measurement data on the wanted field strength at the location of the antenna	Wanted field strength	Float (unit: dB(µV/m))	
f)	State whether the victim equipment is predominantly moving or static	Victim mobility	Dropdown. static, moving, portable, nomadic	
g)	Report all ports of the victim equipment with cables connected to them	Victim port	Dropdown: AC mains, wired network port, signal and control port, DC power supply port, DC power port, antenna port, tuner port, other	Non-exclusive selection When other is selected an additional string is expected with the other port type
h)	State the length of every attached cable connected to the ports reported in g)	Cable length to victim port	Float (unit: metre)	Associated with each occurrence of field g)
i)	State the reason(s) for filing the complaint (e.g. audible or visible distortions, malfunction, damage, etc.)	Reason of complaint	String	
j)	State how often and for how long the observed interference occured (e.g. occurrences per day, per hour, permanently or repetitively, periodically, occasionally, etc.)	Repetition of occurrence	String	
		Length of disturbance	String	
5	**Coupling-path-related**			
a)	State in which environment the source is located (i.e residential, commercial, light industrial or industrial area)	Source environment	Dropdown: residential, commercial, light industrial or industrial area	
b)	State in which environment the victim is located (i.e residential, commercial, light industrial or industrial area)	Victim environment	Dropdown: residential, commercial, light industrial or industrial area	
c)	State the distance between the RFI victim and the source	Distance between victim and source	Float (unit: metre)	

No	Description	Heading	Datatype	Note
6	**With relation to other causes**			
a)	State whether the victim or source is defective (e. g. due to component failure, damage, aging, end of life)	Source or victim defective	Dropdown: source, victim, both, neither	
b)	State whether the victim or source is not installed or used in accordance with the user manual or installation guideline, or used with illegal product modifications	Source installed and used in accordance with manual	Dropdown: yes, no	
		Victim installed and used in accordance with manual	Dropdown: yes, no	

Annex B
(informative)

Value of statistics on radio frequency interference observed in the electromagnetic environment

B.1 Background and history

CISPR TR 16-4-4:2003 (first edition) contained, in its Clause 4, a complete reprint of CISPR Recommendation 2/3 [7] on statistics of complaints and sources of interference. However, due to modern technological evolution in radio systems directed towards introduction of digital radio services, and due to increasing use of mobile and portable radio appliances by the public, the traditional CISPR statistics of complaints on radio frequency interference experience decreasing significance as an indicator of the quality of standardization work for the protection of radio services and applications. That is why related information in the first edition of CISPR TR 16-4-4:2003 was meanwhile reduced to the necessary minimum allowing interested parties to continue their sole complaint-based collation of data on an annual basis. This condensed information is presently still found in Clause 4 of CISPR TR 16-4-4:2007 [1] and is also replicated, with slight updates and amendments, in Annex B of this document.

B.2 Towards the loss of a precious indicator: interference complaints

The evolutions detailed in Clause B.1 – generalization of mobile use of radio receivers and transition from analogue to digital radio services – will not reduce the number of interference situations, but continue to decrease the probability of getting significant numbers of interference complaints indicating a more general existing EMC problem. So, along with the growing development of portable digital radio devices, the usefulness of traditional interference complaints statistics to support the CISPR work will continue to diminish in importance.

However, considering that RFI investigation services will continue publication of statistics on interference complaints, it is useful to apply the information set out in Clause 4, Clause 5 and Clause 6 on the collection, organization, analysis, interpretation and reporting of data on radio interference complaints or otherwise detected “RFI scenarios”. Reports from RFI investigation services or other parties having a vested interest in providing profound statistical information on interference observed in the electromagnetic environment can then be presented in certain formats enabling comparison or aggregation of results. This avoids varied and ambiguous presentation of these statistics which often renders such comparisons or aggregations difficult.

Annex C
(informative)

Field strength measurements in the electromagnetic environment

C.1 General

Field strength measurements encompassed in this document are made for aggregation of data about the quantitative level of measurement results, for subsequent analysis, and primarily for verification of the suspected root cause of a reported RFI case or otherwise observed RFI scenario, by inspection and measurement at the location of the RFI incident or at other representative locations, in case of survey or other spectrum monitoring activities within the environment category of interest. Since verification of a given root cause out of a selection of possible root causes requires selection criteria, this annex also provides target levels and figures for evaluation of measured values during such inspections at local sites.

For further and more detailed advice for man-made noise measurements in electromagnetic environments, see also information in 5.7 – Radio noise measurements – of the ITU Handbook on Spectrum Monitoring (2011) [4], Recommendation ITU-R SM.1753 [5] and ITU-R SM 2093 [22]. CISPR 16 series also contains information on measurement instrumentation and methods.

C.2 Use of measurement frequencies

For investigation in RFI complaints where it is difficult to measure the interfered performance of a channel due to the interference occurring it can be possible to make appropriate measurements in an adjacent unused channel. As alternative it can be practical to wait for the user to stop using the channel and then measure the level of an interferer.

C.3 Measurement arrangement for field strength measurements in the local electromagnetic environment

Field strength measurements for verification of the root causes listed in Table D.1 can be made only at outdoor locations and preferably with measurement instrumentation according to CISPR 16-1-1 [21]. The CISPR detector as specified in CISPR 16-1-1 is chosen for the measurement frequency range. Measurements are made only for gathering of statistical data on generic RFI incidences and scenarios, it can also suffice to use other kinds of appropriate measuring instrumentation.

- Investigation in RFI complaints

For investigation of reported RFI incidences, the measurement distance between the location of the disturbance source and the antenna of the measuring instrumentation is often as close as possible to

a) 10 m, for locations in residential, commercial or light industrial environments, or

b) 30 m, for locations in industrial environments.

NOTE 1 In some countries, use of a measurement distance of 30 m can be more appropriate, for locations in commercial or light industrial environments, or both.

NOTE 2 If a measurement in the described distance is not possible, the result is converted from the measurement distance used, applying conversion factors used in CISPR publications.

Areas of the categories mentioned above can be found within many of the environmental categories encompassed in the planning standards for radio services. Such categories can be for example city, urban, sub-urban, rural or quiet-rural environments. Note that the measurement distance of 10 m is commonly also used in urban and city environments according to Table 5 in ITU-R Recommendation SM.1753-2:2012 [5].

- Field strength survey or monitoring measurements in the field

For survey or similar monitoring field strength measurements in the electromagnetic environment, the median distance to any kind of unknown local disturbance source is likely not to fall short of the distance specified in a) or b) above, respectively.

Measurements are generally made at the lateral measurement distance indicated in a) or b), with the measuring antenna placed at 2 m height above ground, or for example, at 10 m height above ground, for measurement of the signal strength of the applicable broadcast signals. The latter height (10 m) will result in more reliable results, as it is the reference height for measurements of field strengths defined for coverage planning and monitoring (see also Figure C.1). This reference height is the same, regardless of the service being intended for provision of fixed or mobile mode radio reception (with outdoor receiving antennas), or for indoor radio reception with portable radio receivers.

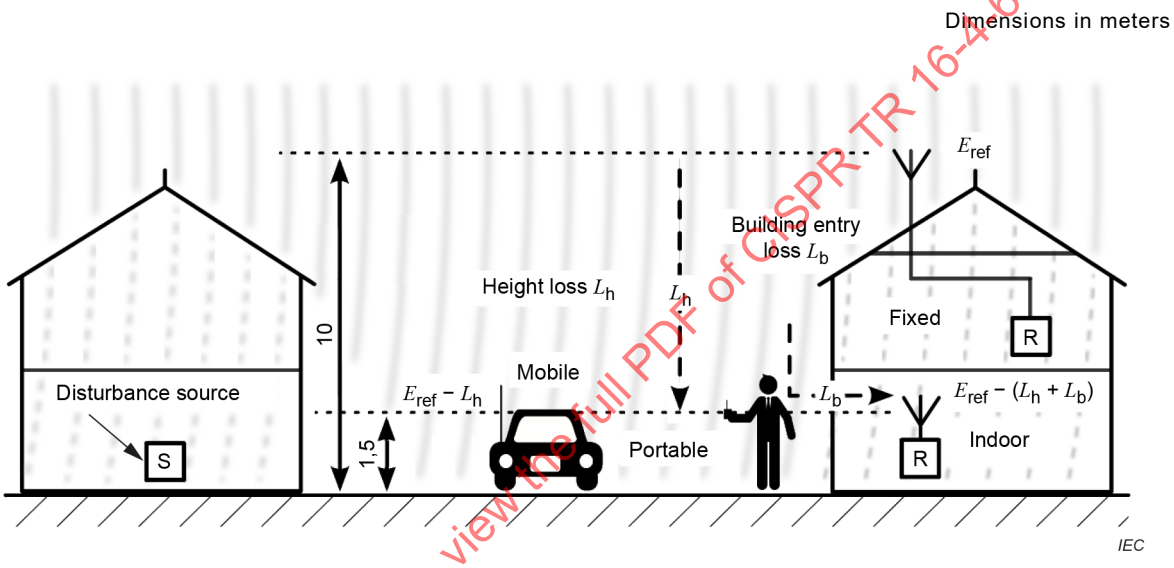


Figure C.1 – Conditions for coverage planning for different modes of radio reception

If, however, constraints in space, time or availability of suitable and safe measurement instrumentation at the local site do not allow for measurements at 10 m height, then it will suffice to perform these measurements with the measuring antenna placed at 2 m height above ground.

For most meaningful measurements results are gained when the wanted and the interfering signal are measured at the same physical location.

For regular measurements at 2 m height above ground, corrections can be made to the target level of the disturbance field strengths, which, except for ISM equipment, refer to a height of 10 m above ground, as a matter of course. Further advice on such corrections (compensation for height loss L_h) is found in the planning standards for radio services.

The measurement distance is normally taken from the outer circumference of equipment used outdoors, or, in case of indoor use, from the outer face of the exterior wall of the building in which the equipment is situated.

NOTE 3 More detailed advice on selection of the measurement distance for *in-situ* measurements on installations containing class A group 2 ISM equipment is found in 6.4 of CISPR 11:2024 [11]. They were chosen in line with No. 15.13 of the ITU Radio Regulations 2020 [2].

For verification purposes of root causes, the measurement distance is selected according to a) or b), regardless of the class or type, or both, of the disturbance source possibly involved in generation of interferences (see Table D.1).

C.4 Target levels for *in-situ* field strength measurements – Analysis of root causes (a) and (c) in D.2.2

Target levels for *in-situ* field strength measurements in close proximity to possible sources of RFI are specified in Table C.1. They were derived by CISPR for an adequate control of unwanted emissions in the radio frequency range. They indicate the threshold for disturbance component levels appearing in the radio frequency range which are deemed to be tolerable to CISPR and ITU-R with a residual risk of individual interference, in respect of radio reception with the required minimum reception quality determined by the reliability or grade of radio service and coverage in the respective service area. The target levels for the wanted radio signals are median estimates out of the given assortment of national standards for the planning of radio services.

As such, these target levels relate to worst case conditions of the use of sources and victims of RFI in any category of electromagnetic environment and the maximum tolerable figure for the probability (and related frequency) of occurrence of individual RFI cases. This figure has a value of 0,001 or 1 %, for narrowband-type disturbances, and 0,01 or 1 %, for any other broadband-type of disturbances. These probability figures were commonly established by CISPR and CCIR SG1, in 1988 and 1989, for the permissible rate (or frequency) of RFI cases being caused by operation and use in the electromagnetic environment as intended, of sources other than radio transmitters.

Table C.1 – Generic target levels for evaluation/analysis of the residual risk of occurrence of individual interference incidences

Frequency range in MHz	**Service to be protected**	**Frequency range in CISPR standards** in MHz	**Recommended target levels – QP detector** in dB(µV/m)		**References and remarks**
			Unwanted signal	**Wanted radio signal**	
0,1485 – 0,2835	LF BC	0,1485 – 3,95	47	77	CCIR Report 1104 [6]
0,525 – 1,605	MF BC		26	56	CCIR Report 1104 [6]
3,95 – 26,1	HF BC in several bands	3,95 – 30	24	54	
47/54 – 68/88	TV BC Band I	30 – 230	-2/10	48/60	CCIR Report 1104 [6]
41 – 68 87,5 – 108	FM BC		24	60	CCIR Report 1104 [6]
174 – 230	TV BC Band III		5	50	CCIR Report 1104 [6]
470 – 582	TV BC Band IV	230 – 1 000	14	64	CCIR Report 1104 [6]
582 – 960	TV BC Band V		20	70	CCIR Report 1104 [6]
NOTE Further target levels for the just still tolerable disturbance field strength from critical parts of wire-line (tele)communications networks are found in Recommendation ITU-T K.60 (2015-12) [23] and in ECC Recommendation (05)04 [3].					

The target levels refer to an appropriate protection of radio broadcast reception in the edge of the service area, in the frequency ranges assigned to radio broadcast services by the ITU Radio Regulations. They can also be used as an indicator for the relative degree of protection of radio reception from other radio services operated in frequency ranges adjacent to these broadcast bands.

Note that the target levels for the unwanted signal are relevant in view of the compilation of statistical data regarding the residual risk of too frequent and hence not tolerable occurrence of “critical RFI scenarios” in the given environment. These target levels can therefore be used if the focal point and intention of the *in-situ* measurements is to compile reliable and comparable statistical data suitable for subsequent systematic analysis by CISPR.

The target levels for the unwanted signal are subject to maintenance by CISPR. They can be revised if tendencies in the number of recorded instantaneous RFI cases or otherwise detected RFI scenarios indicate that such action is necessary. It is hence important to submit related information to the attention of CISPR. One appropriate method to do so is the submission of reports on statistics but other forms of reporting such as reports of case studies, measurement campaigns or research results are equally valid methods to provide information on interference statistics.

C.5 Target levels for the field strength of the wanted radio signal – Analysis of root cause (c) in D.2.2

C.5.1 Use of national reference levels of the wanted signal field strength

Use of national reference levels for the wanted signal field strength is certainly useful for closer investigation in reported RFI cases. In contrast to the recommended target and reference level for the wanted radio signal in Table C.1 above it is useful to use the nationally specified field strength level that is just necessary for the provision of a specified quality of service for the particular delivery mode of this radio service.

In respect of reporting to CISPR, using these wanted field strength values will also allow an overall analysis by CISPR of statistical data on interference incidences and the residual risk of instantaneous RFI.

C.5.2 Use of target levels for the wanted signal field strength recommended by CISPR

For conduction of studies, measurement campaigns or other kinds of EMC survey measurements in the field it is useful to base evaluation of the observed residual risk of interference on the traditional minimum usable field strength levels for the wanted radio signal. These target levels are also listed in Table C.1.

Annex D
(informative)

Root-cause-analysis of the reported RFI incidences

D.1 General

The three main topics described in Clause 4 which are source, victim and coupling path can relate to the work to be done by the EMC committee if the root cause of the RFI incidence relates to

– disturbance field strength that exceeds the target level;
– incidence distance that falls short of the protection distance;
– wanted field strength that falls short of the target level for the minimum usable field strength for the electromagnetic environment (EE).

For further analysis and for determination of the root cause of a detected RFI scenario it is hence necessary to define these root causes based on the model in Figure 1 and Figure 2. In analysing the RFI scenario, one can then exclude successively any purely formal or apparent reasons coming along with observations at the local investigation site, in the electromagnetic environment, from the remainder of reasons, which actually covers then only the three possible root causes (a), (b) and (c) set out in D.2.2.

Preselection into formal or apparent reasons and more substantial reasons can be made by attributing respective observations either to group 1 in line with 4.3.2 (First data set – RFI incidences not necessarily indicating insufficiencies in CISPR standards), or to group 2 in line with 4.3.3 (Second data set – RFI incidences possibly indicating insufficiencies in CISPR standards). Having done this accurately, one can then concentrate on the data and information in group two which actually covers information for subsequent deduction on the root cause for the detected RFI scenario.

D.2 Matrix of root causes and identification procedure

D.2.1 General

The matrix of the possible root causes (a), (b) and (c) in D.2.2 and the eight cases one can actually observe at a given investigation site are shown in Table D.1, together with the associated root cause(s) of interference. A procedure for identification of the root cause for the observed RFI scenario is found below Table D.1.

Table D.1 – Matrix for root cause analysis of a detected interference scenario

Case	Observation at the location of a survey measurement or reported interference case in the electromagnetic environment (EE)			Associated root cause of interference (see D.2.2)
	Disturbance field strength exceeds the target level	Incidence distance falls short of the protection distance	Wanted field strength falls short of the target level for the minimum usable field strength for the EE	
	(a) (see D.2.2)	(b) (see D.2.2)	(c) (see D.2.2)	
1	yes	yes	yes	(a) AND (b)
2	yes	yes	no	(a) AND (b)
3	yes	no	yes	(a) AND (c)
4	yes	no	no	(a)
5	no	yes	yes	(b) AND (c)
6	no	yes	no	(b)
7	no	no	yes	(c)
8	no	no	no	(d)

D.2.2 Root causes of interest in maintenance of CISPR standards and limits

Field strength survey or monitoring measurements in the field:

Correct root causes analysis for interference scenarios detected in conjunction with survey or monitoring field strength measurements in local electromagnetic environments implies that the median distance to individual disturbances sources generally is a little bit larger than 10 m or 30 m, for measurements in residential or industrial environments. A root cause identified in the result of survey measurements can finally nearly miss any relation to a specific type of disturbance source, since root cause (b) – incidence distance that falls short of the protection distance – does not apply here. Furthermore, in case of survey measurements the term “victim’s receiving antenna” is meant as “antenna of the measuring receiver”. A possible root cause of RFI can be (a) or (c) only.

Combinations of root causes (see Table D.1) can be resolved into the obviously prevailing root cause by more detailed investigation in the actual reasons for existence of two obviously competing root cause indications, before sub-summing them into the pool of already compiled statistical data for the annual reports.

(a) The actual disturbance field strength at the position of the victim’s receiving antenna exceeds the target level recommended by CISPR.

Verification of that root cause is possible by measurement of the disturbance field strength at another nearby location which provides for a measurement distance which is close to or identical with 10 m or 30 m, respectively, for measurements in residential or industrial areas. If the measurement verifies that the target level is exceeded, then this fact consolidates this root cause of RFI.

Root cause (a) is an indicator that there could be deficiencies in the CISPR standard concerned, in the form of missing limits, in the frequency range within which the RFI actually does occur. Frequent and repeated observation of such root causes is the reason to cover this observation, together with reference to root cause (a), in the annual report to CISPR.

(b) The actual incidence distance between the source and the victim's receiving antenna falls short of the target protection distance.

Verification of that root cause is possible by measurement of the disturbance field strength at another nearby location which provides for a measurement distance which is close to or identical with 10 m or 30 m, respectively, for measurements in residential or industrial environments. Meeting of the target level at this location verifies that the shortage in the actual incidence distance is the root cause of this RFI case.

Root cause (b) is an indicator that there can be deficiencies in the limits in the CISPR standard concerned. The inadequacy of the limits is caused by the fact that the protection distances assumed to be adequate for the specified use cases some time back in history when the CISPR limit was derived, are not applicable to the more modern use cases for the same kind of products involved in the RFI case and hence needed to be replaced by more modern protection distances. These can be defined by CISPR and ITU-R, for the operation and use of state-of-the-art products. Whether revision of the respective CISPR limits is necessary depends among other things on the frequency of observation of such root causes. Frequent and repeated observation of such root causes is the reason to cover this observation, together with reference to root cause (b), in the report to CISPR.

(c) The actual field strength level of the wanted radio signal at the position of the victim's receiving antenna falls short of the necessary minimum usable field strength for the given mode (fixed, mobile, portable, etc.) of radio reception.

Verification of that root cause is possible by measurement of the wanted signal field strength at another nearby outdoor location which provides for a measurement distance which is larger than 10 m or 30 m for the residential or industrial environment. These measurements will be made at the respective reference height above ground of 1,5 m or for example, 10 m, for radio services intended for mobile, or for fixed mode radio (broadcast) reception. If the actual wanted signal field strength falls short of the given national target level(s) for the minimum usable field strength, then this fact consolidates this root cause of RFI.

Root cause (c) is an indicator that there can be a latent or permanent problem with intended local coverage for the radio service and corresponding reliability of service provision with the required minimum mean quality of radio reception which can have to be resolved sooner or later by the respective service provider himself.

(d) Cause concerning the "tolerable RFI case" [2] for occasional occurrence of interference used as the threshold for determination of the limits specified in CISPR standards and for determination of the provisions for planning of coverage and reliability of radio reception from the respective radio service, in the given category of environment encompassed in CISPR and IEC standards and in ITU-R Treaties and Recommendations for the planning of radio services.

It concerns the totally random nature of all possible worst-case conditions in the electromagnetic environment at the individual location of the victim's receiving antenna. These factors were not, or only in part, considered or just disregarded when deriving CISPR limits for the respective types of disturbance sources, and when deriving minimum mean coverage and reliability provisions for radio reception from the respective radio services. The efficient and effective use of the available radio frequency spectrum in conjunction with questions of feasibility of economic production and provision of radio and other electric/electronic products to the world-wide market without barriers to trade, for subsequent promotion, sales to and use by any customers, require these factors to be considered.

Root cause (d) is an indicator that there can be a latent or permanent problem with the figure for the necessary RF protection ratio R_p or signal-to-interference (S/I) ratio chosen for derivation of the respective CISPR limit. These are derived from the planning standard for the respective radio service, but without further adjustment to the characteristic RFI properties of the waveform of the disturbance. Frequent and repeated observation of such root causes is the reason to cover this observation, together with reference to root cause (d), in the annual report to CISPR.

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2 In the ITU Radio Regulations 2020 [2] for administrative use denoted as "accepted interference", see RR 1.168.

The frequency of RFI cases related to root cause (d) is of course always worth reporting to CISPR, since it would immediately indicate whether the once commonly agreed upon and established upper threshold for the tolerable probability [3] of occurrence of instantaneous RFI cases (CCIR SG1) is still met, or exceeded. The latter would happen due to changes in the conditions of use of respective products in the field.

D.3 Accumulation of statistical data on root causes

Investigation in RFI complaints:

Statistical data (i.e. observed numbers/frequencies of detected interference incidences) relating to root causes (a), (b) and (d) in D.2.2 are recorded separately in these annual reports, with reference to the related root cause. Reports to CISPR can also include the total of the summed-up RFI incidences attributed to (a), (b) and (d) in D.2.2, preferably in relative figures in percent or per million. Taken as the right basis for normalization, the latter figures allow for direct and immediate comparison with the tolerable residual risk of interference established into by CISPR and CCIR SG1 (nowadays ITU-R SG1) back in 1988 and 1989, having a threshold of $P(I) \leq 1‰$. The report can of course also cover statistics on root cause (c), but such information is not of direct relevance for CISPR.

NOTE That changes in radio technology such as transition from analogue to digital radio services and transmission can impact the threshold for the "just still tolerable probability of interference $P(I)$" and this can be taken into account when comparing with the classical threshold $P(I) \leq 1‰$ established into by CISPR and CCIR back in 1988 and 1989.

In case of doubt which base to choose in order to normalize absolute numbers of registered RFI incidences into their relative equivalent figures, the absolute numbers of registered RFI incidences can be reported to CISPR, just indicating to which base they actually belong to.

Field strength survey or monitoring measurements in the field:

A report to CISPR includes statistical data (i.e. observed numbers/frequencies of detected interference scenarios) relating to root cause (a) in D.2.2. The report can of course also cover statistics on root cause (c) in D.2.2, but such information is not of direct relevance for CISPR. Statistical data in relative figures in percent or per million are the preferred form of reporting, but with clear reference to the base of normalization of the data concerned.

D.4 Instructions for normalization of the absolute number/frequency of observed interference incidences/scenarios into representative relative figures

The basic concept behind relative figures (i.e. percentages) for evaluation of the residual risk of RFI in a given electromagnetic environment is the same as is used for evaluation of the efficiency E_{FS} of use in the frequency spectrum for radio communications and broadcasting. The metrics for such evaluation denote this efficiency as a product of "frequency-bandwidth" B_{TR} times "space occupied" A_{SA} and hence denied to radio reception from other radio transmitters. For a variety of several transmitters of a given radio service servicing simultaneously the same service area, the frequency-bandwidth is identical with the width of the frequency band assigned to the respective radio service by the ITU Radio Regulations (or the tuning range (TR), of a radio receiver for that service), and the occupied space is translated as having the size A_{SA} of the respective service area, in the given electromagnetic environment.

[3] This upper threshold for the tolerable "complex statistical probability *P*" according to CISPR TR 16-4-4 [1] for RFI caused by operation of electric/electronic equipment, systems or installations in the field has a value of 1‰ (or – 30 dB) for interferences caused by narrowband disturbance, and 1 % (or – 20 dB) for broadband disturbances. The CISPR model uses these values as adequate "allowance" of + 30 dB or + 20 dB in the worst case CISPR limit for the test site, in compensation for the mere occurrence of such RFI cases in the field. This way the worst case CISPR limits were adjusted to normal case conditions of use of respective products in the electromagnetic environment.