

TECHNICAL REPORT

**CLC/TR 50427**

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

December 2004

---

ICS 13.230; 33.060.20

English version

**Assessment of inadvertent ignition of flammable atmospheres  
by radio-frequency radiation –  
Guide**

Evaluation des risques d'inflammation  
des atmosphères inflammables  
par des rayonnements de  
radiofréquence –  
Guide

Leitfaden zur Verhinderung  
der unbeabsichtigten Zündung  
explosionsfähiger Atmosphären  
durch hochfrequente Strahlung

This Technical Report was approved by CENELEC on 2004-08-28.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

**CENELEC**

European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

**Central Secretariat: rue de Stassart 35, B - 1050 Brussels**

---

## Foreword

This Technical Report was prepared by the Technical Committee CENELEC TC 31, Electrical apparatus for explosive atmospheres - General requirements.

The text of the draft was submitted to the formal vote and was approved by CENELEC as CLC/TR 50427 on 2004-08-28.

---

This document is a preview generated by EVS

## Contents

Introduction .....	6
<b>1 Scope.....</b>	<b>7</b>
<b>2 Normative references.....</b>	<b>7</b>
<b>3 Terms and definitions .....</b>	<b>7</b>
<b>4 Symbols and abbreviations .....</b>	<b>9</b>
4.1 Modulation codes .....	9
4.2 Polarization codes.....	10
<b>5 General considerations .....</b>	<b>10</b>
5.1 Radio-frequency hazard.....	10
5.2 Philosophy of systematic method of approach .....	11
5.3 Responsibility for making the hazard assessment.....	11
<b>6 Transmitters and transmitter output parameters .....</b>	<b>12</b>
6.1 Types of transmitter .....	12
6.2 Frequency range .....	12
6.3 Transmitter output power .....	12
6.4 Antenna gain .....	12
6.5 Modulation factors.....	12
6.5.1 General.....	12
6.5.2 Frequency modulation (FM).....	13
6.5.3 Amplitude modulation (AM).....	13
6.5.4 Single sideband (SSB) operation.....	13
6.5.5 Pulsed radar.....	13
<b>7 Structures and spark-making mechanisms .....</b>	<b>14</b>
7.1 Structures.....	14
7.2 Loop-type structures .....	14
7.3 Vertical structures .....	16
7.4 Spark-making mechanisms.....	17
<b>8 Ignition of flammable atmospheres.....</b>	<b>17</b>
8.1 Flammable atmospheres .....	17
8.2 Ignition by radio-frequency discharges .....	17
8.3 Criteria for ignition .....	18
8.3.1 Effectively continuous transmissions .....	18
8.3.2 Radar transmissions .....	18
<b>9 Practical measurements and tests .....</b>	<b>19</b>
9.1 Measurement of electromagnetic fields .....	19
9.2 Measurement of extractable power.....	19
9.3 Test transmissions .....	20
9.4 Incendivity tests.....	20

<b>10</b>	<b>Methods of assessment for determining potential RF ignition hazards on a plant containing hazardous areas</b> .....	<b>21</b>
10.1	General .....	21
10.2	Basis of the theoretical assessments .....	21
10.2.1	General.....	21
10.2.2	Initial assessment.....	22
10.2.3	Full assessment .....	22
10.3	Initial assessments.....	32
10.3.1	Initial assessment of the risk from a particular transmitter site .....	32
10.3.2	Initial assessment for a particular plant.....	33
10.4	Full assessment procedure.....	34
10.4.1	Procedure.....	34
10.4.2	Information to be obtained .....	35
10.4.3	Calculation of effective field strengths .....	35
10.4.4	Calculation of extractable power or energy.....	41
10.4.5	Comparison of the total extractable power or energy from the structure with the threshold values detailed in Clause 8 .....	43
10.5	Practical on-site tests.....	46
10.5.1	Procedure.....	46
10.5.2	Plant and transmitter both in existence (Case 1 of Figure 3).....	46
10.5.3	Existing plant and proposed transmitter (Case 2 of Figure 3) .....	47
10.5.4	Existing transmitter and proposed plant (Case 3 of Figure 3) .....	48
<b>11</b>	<b>Plant safety measures</b> .....	<b>49</b>
11.1	General .....	49
11.2	Bonding .....	49
11.3	Insulation.....	50
11.4	Reducing the structure efficiency.....	50
11.5	De-tuning of structures.....	50
<b>12</b>	<b>Special cases</b> .....	<b>51</b>
12.1	Cranes.....	51
12.2	Mobile and portable transmitters.....	51
12.3	Ships .....	51
12.3.1	General.....	51
12.3.2	Ships in harbour areas .....	52
12.3.3	Ships at sea .....	52
12.4	Offshore oil and gas installations .....	53
12.4.1	General.....	53
12.4.2	Structures on offshore installations .....	53
12.4.3	Assessment procedures.....	53
12.4.4	Radio frequency transmitters and vulnerable zones.....	54
12.4.5	Safety measures and recommendation .....	55

Annex A (informative) Sources of information and addresses of some advisory bodies .....59

Annex B (informative) Electromagnetic radiated fields and examples of radiating antenna and unintended receiving antenna characteristics .....61

Annex C (informative) Subdivision of group II flammable gases and vapours.....69

Annex D (normative) Measurement of electromagnetic fields .....74

Annex E (normative) Methods of measurement on structures (on-site tests).....78

Annex F (informative) Derivation of vulnerable zone distances for Table 5, Table 6 and Table 10 .....84

Annex G (informative) Worked examples of full assessment procedure .....85

Annex H (informative) Ground-wave propagation (vertical polarization) -  
Calculation of field strength .....94

Bibliography .....96

This document is a preview generated by EVS

## Introduction

Electromagnetic waves produced by radio-frequency (RF) transmitters (e.g. radio, television and radar) will induce electric currents and voltages in any conducting structure on which they impinge. The magnitude of the induced current and voltages depends upon the shape and size of the structure relative to the wavelength of the transmitted signal and on the strength of the electromagnetic field. When parts of the structure normally in contact are caused to break or separate momentarily (e.g. during maintenance or as a result of vibration) a spark may occur if the induced voltage and current is sufficiently large. If this happens in a location where a potentially flammable atmosphere may be present a hazardous situation can occur. However, the possibility of ignition will depend on many factors including whether the spark can deliver sufficient energy to ignite a particular flammable atmosphere.

This European Technical Report provides a systematic approach to assist transmitter operators, plant managers and all others concerned with a logical method for the assessment and elimination of RF induced ignition hazards.

The assessment procedures recommended in this European Technical Report are based on measurements of the powers and energy that can be extracted from typical structures, including cranes, and measurements of the minimum powers and energy that are required to ignite various flammable atmosphere gas groups.

The assessment procedures for probability of ignition recommended in this European Technical Report are based on the assumption that worst case conditions apply at all times. The critical features are the coincidence of the structure in resonance and the presence of the gas/air mixture in the optimum proportions for RF spark ignition. Deviation from these optimum conditions will result in significantly higher powers being required for ignition.

NOTE 1 Several studies have been performed which indicate that the power could be twice as great for an assumed risk as detailed in reference [1], if due allowance is taken for probabilistic effects. In order to achieve a probability of ignition comparable with other risks, it would be necessary for effective extractable power calculated to be twice the values determined according to this European Technical Report. The probabilistic elements could be taken into consideration following further research work and practical experience.

NOTE 2 If allowances for probabilities are to be applied then expert advice should be sought.

generated by EVS

## 1 Scope

This European Technical Report provides guidance on assessing the potential ignition hazard from the inadvertent extraction of energy from electromagnetic fields, propagated from communication, radar or other transmitting antennas to plant where a potentially flammable atmosphere may be present. The frequency range covered by this European Technical Report is 9 kHz to 60 GHz. This European Technical Report does not apply to similar hazards arising from electromagnetic fields generated by other means, such as electric storms, electricity generating installations or other radiating electrical equipment, nor does it apply to any hazard arising within telecommunication or other electronic equipment.

NOTE 1 The methods of assessment from 9 GHz to 60 GHz are based on extrapolation of data for frequencies below 9 GHz.

NOTE 2 The ignition of dust is not covered in this European Technical Report. This European Technical Report also provides advice on how to mitigate the hazard in cases where the assessment indicates that a hazard may exist. This European Technical Report does not cover the hazards associated with the use of electro-explosive devices (EED) (see CLC/TR 50426), or the biological hazards of exposure to RF fields.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>
EN 60079-0		<i>Electrical apparatus for explosive gas atmospheres — Part 0: General requirements (IEC 60079-0)</i>
EN 50020		<i>Electrical apparatus for potentially explosive atmospheres — Intrinsic safety “i”</i>
EN 60079-10		<i>Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas (IEC 60079-10)</i>

## 3 Terms and definitions

For the purposes of this European Technical Report the following terms and definitions apply.

### 3.1

#### **circuit factor, $Q_k$**

performance parameter for a structure acting as a receiving antenna (see [2])

NOTE Assuming the structure to be tuned to the transmission frequency  $f_i$ ,  $Q_k$  is the ratio of  $f_i$  to  $\Delta f$ , where  $\Delta f$  is the difference between those frequencies, one above and one below  $f_i$ , at which the structure resonates when it is re-tuned so that the open circuit voltage at  $f_i$  has fallen by 3 dB.  $Q_k$  is closely related to the Q factor of a tuned circuit.

### 3.2

#### **extractable power, $P_{\max}$**

power dissipated in a resistive load connected across a discontinuity in a structure acting as a receiving antenna

NOTE The extractable power reaches its maximum when the structure is tuned to the frequency of the transmitter (under these conditions the impedance of the structure presents a resistive value only, with no reactive components), and the load resistance is a value equal to that of the structure.

### 3.3

#### **modulus match power, $P_{\text{mm}}$**

maximum value of extractable power that can be achieved with a resistive load at a frequency to which the structure is not tuned (see [2])