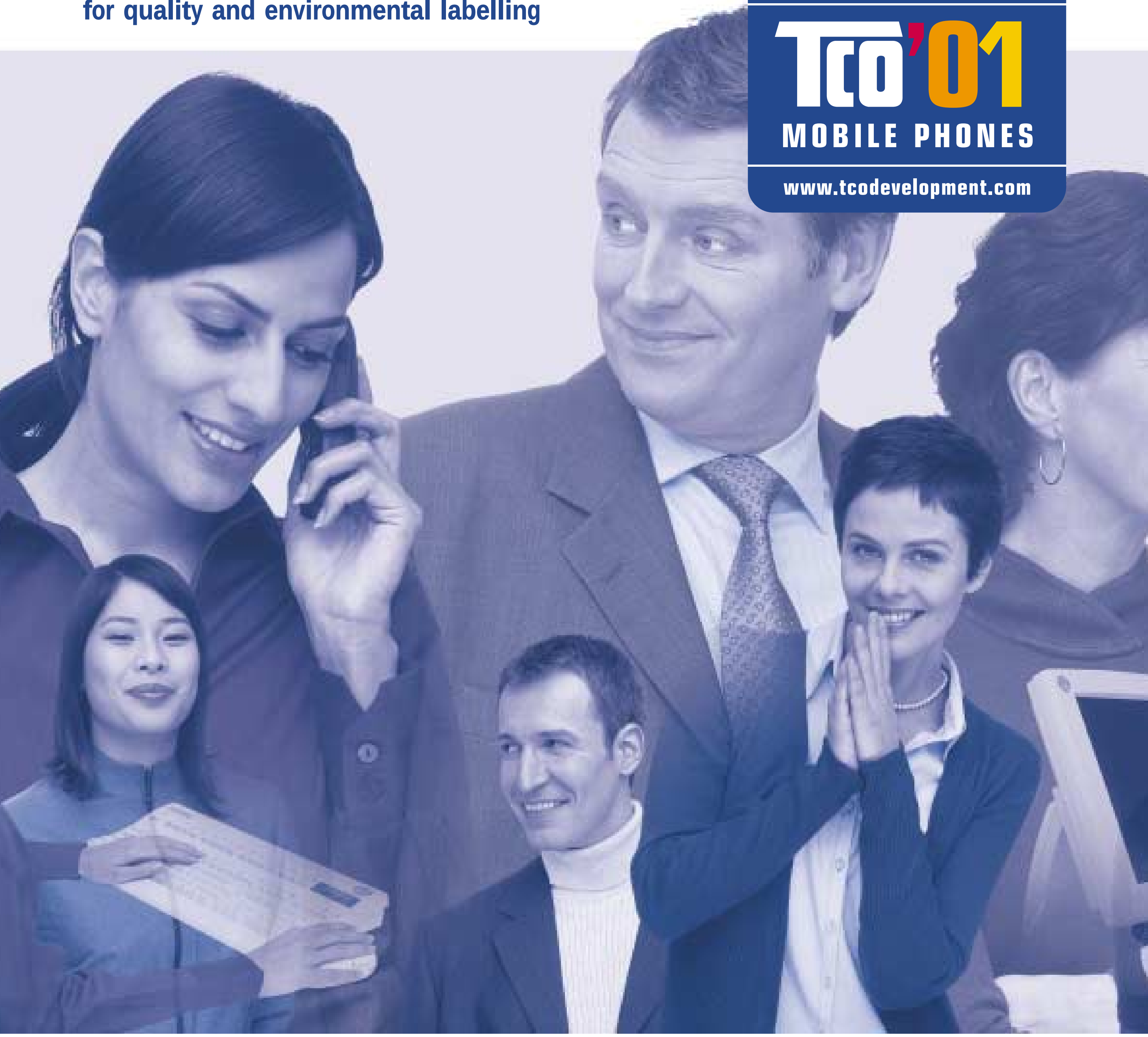
Requirements and test methods for quality and environmental labelling

TCO Development

TCO'01 MOBILE PHONES

www.tcodevelopment.com



TCO'01 Certification

of Mobile Phones

TCO Development

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A Introduction

Mobile phones have today become an important work tool for many professionals the world over. TCO Development wants, by defining this group of requirements and criteria for the quality and environmental labelling of mobile phones, to contribute to the emergence on to the market of telephones with good user characteristics. We begin with the premise that the manufacturers are willing to develop good products on the basis of the knowledge and experience held by large groups of users in their working life. At the same time, users want to work with high quality products, in order to increase their competence and strengthen their professional standing.

The term “mobile phone” is defined in this standard as a portable, battery-driven product that is principally used for telephonic communication and to send and receive short messages. In this case “mobile phone” does not include PDA (Personal Digital Assistant) or similar equipment that includes a telephony function but does not have a traditional keypad.

Due to the limitations of the measuring methods for TCP as included in this first version of the standard, it is only possible to certify mobile phones designed to the GSM standard.

The levels of radio frequency (RF) electromagnetic fields have in recent years caused concern. TCO Development, whilst accepting that this is an important question, wants however to widen the perspective to encompass ergonomics and ecological considerations. The rapid technological developments leading to wireless communication and third generation mobile telephony, which involve the handling and management of immense amounts of data, will set new demands on equipment from an ergonomic point of view.

The criteria in this document have been developed in conjunction with user representatives, researchers and experts in various areas. Before the requirements were finalised, a draft version open for comments was made available. This procedure has resulted in changes in the draft version.

The aspects we have included cover Emissions, Ecology and Ergonomics. In this first version of the standard we have decided to focus on emissions, and the requirements concerning radiation from the telephones are quite severe, being a vital part of our ambition to push advances forward in this respect when it comes to the development of new mobile phones. The ergonomics and ecology requirements are included because it is important to maintain an overall view, and we have chosen to remain at a base level in these areas.

Our long experience of quality and environmental labelling of computer displays is the foundation of this work, something we began in the early 1980s and which resulted in the launch in 1992 of our first labelling scheme, TCO ’92. This has since been followed by TCO ’95 and TCO ’99.

Existing standards and measurement techniques have been used to test telephones against the requirements that have been formulated by TCO Development. However, new methods and definitions have been added where necessary. We consider it of vital importance that the requirements can be verified in tests or assessments by independent organisations.

An important complement to quality and environmental labelling is advice on the use of mobile phones. TCO Development provides such advice on its web page, **www.tcodevelopment.com**. It deals with such matters as what you should look for when buying a telephone, which are the important characteristics of the telephone and what to do if you want, for safety's sake, to minimise your exposure to electromagnetic fields while using the telephone.

Plans for updating TCO labelling – future requirements

During our work we have taken into consideration a large number of possible requirements in the areas of Emissions, Ergonomics and Ecology, but in addition within Energy, which is the fourth area included in our existing quality and environmental labelling schemes. Requirements in the Ergonomics and Ecology areas will in future versions be tightened up considerably in pace with the expected increasing need for user-adapted and environmentally-friendly mobile phones. In the foreword for each respective section we review important requirements that were considered but not included. This was done to indicate that future labelling updates may bring these requirements into the specification.

The rapid pace of development within the area of mobile telephony means that we anticipate a need to update the requirements and criteria at frequent intervals. There are strong indications that these updates will occur at shorter intervals than those for displays and computers, which undergo revision about every third year.

This particular quality and environmental labelling scheme only covers mobile phones and is mainly concerned with their use as telephones that transmit speech. Because of the measuring methods used, labelling is also limited to telephones that meet the GSM technological standard. At short notice TCO may in the future broaden the labelling base to also include other currently widespread mobile telephone technological standards.

The rapid development of portable equipment for wireless transmission of written and visual information (third generation mobile telephony) reinforces the need for creating special criteria for these categories at a later date. The question of whether wireless telephones for short distance communication also need special criteria is left open just now.

Mobile phones have a number of accessories, such as battery chargers and head-sets. We have decided, in this first round of labelling, to limit their requirements to the extent that the manufacturer will have to state the model definition for certain specified accessories. Specific requirements may be set for accessories in later updates.

TCO Development welcomes comments on these requirements and suggestions for future updates.

Stockholm November 12th 2001

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Date

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Company

A.2 Emissions

Emitted Electric and Magnetic Fields in the Work Environment

International research has not been able to prove that the electromagnetic fields emitted during normal use of mobile phones carry any risk of serious health problems. However there are several research reports that show biological, non-thermal effects. Among other things this includes studies which reveal changes in human reaction times, effects on cell cultures, breaks in DNA strands and changes in transmission through the blood-brain barrier. At the present level of research it cannot be said which of these effects indisputably exist and what they mean. The on-going extensive research will eventually increase the fund of knowledge about health risks associated with mobile phone use.

There are also scientific papers that report subjective complaints such as headaches, fatigue and uncomfortable warmth, which are associated with the duration of calls and the frequency of mobile phone use. Individual users have also complained of similar problems.

In addition many mobile phone users are worried about possible effects, which can in itself contribute to poor health and reduced quality of life.

Against the background of this scientific knowledge and the fact that mobile telephony has only existed for a few years, there is good reason to apply the precautionary principle and try to minimise the exposure to RF fields from mobile phones. This exposure applies to both the characteristics of the telephones and the way they are used. It is important for users to be able to identify those telephones on the market that have good emission characteristics.

By measuring the electromagnetic fields that are absorbed in the head while using a mobile phone, one can calculate the Specific Absorption Rate (SAR) distribution and the maximum average value of SAR for a given volume of biological tissue. One difficulty is that Europe and the USA define SAR values for different volumes of biological tissue, and there are also differences in the numerical limit values. This is confusing, and it is also very difficult to compare measurements carried out using the two different systems for individual telephones.

It is however clear that the limit values applied in the USA are much more stringent than those in Europe. TCO Development wants its labelling scheme to have international application, and therefore decided to use the US limit values as a starting point when preparing the SAR value standard.

The requirement we have defined for the SAR value is by no means a limit where we can state for certain that a telephone that meets the requirement is completely free of risk from a health point of view, and conversely it does not mean that a telephone with an SAR value above the requirement is automatically posing a risk to the user.

Measurement of the SAR value is carried out with the mobile phone transmitting at maximum power. The SAR value will not therefore be representative for a typical user, since mobile phones often transmit at a much lower power level than their maximum. The amount of power transmitted depends on the strength of the signal reaching the base station. If the signal level is high, the telephone can reduce its power, in the best case to less than one per cent of the maximum. This means that the electromagnetic fields absorbed by the user are reduced proportionally. It is not certain that a low SAR value means that the telephone has good transmitting characteristics.

As a complement to the SAR value we have chosen a new method that measures the maximum power the telephone can utilise for communication. A good telephone uses a large part of its power for communication and very little power is lost by the absorption of electromagnetic fields in the user's head and other parts of the body.

We denote this measurement "Telephone Communication Power", TCP, expressed in watts (W). The higher the value of TCP normally the greater the signal strength reaching the base station, which permits a greater reduction in the power of the telephone transmitter and consequently a lower exposure to the user is achieved.

Both the SAR value and the TCP value are thus important elements in characterising the emission characteristics of a mobile phone. Our investigations have revealed that there are distinct differences in TCP values between different telephone models and frequency bands. TCO Development has prepared its TCP requirements on the basis of this research. These requirements initially apply to telephones that are operating in accordance with the GSM standard, but there are plans to also produce requirements in respect of other telephony standards.

Plans for updating TCO labelling – future requirements within emissions

It is today impossible to predict what could be included in an update of the standards within the area of emissions. Much depends on our knowledge of the risks involved with mobile telephony. Measuring methods and standards must reflect these risks and contribute to the furtherance of telephones with improved emission characteristics. We also need to know more about the results of measuring SAR and TCP values.

It is also known that magnetic fields from mobile phones in the 217 Hz range can cause much interference, for example to IT equipment and hearing aids. A standard and associated measuring method may well be introduced.

A.2.1 SAR measurement

Background

SAR measurements are currently the only internationally accepted and utilised methods for measuring the absorbed radiation energy in unit volumes of brain tissue.
The EU applies a SAR value of maximum 2.0 W/kg measured in any cube of 10 gram of biological tissue. The USA (FCC) applies a limit value of 1.6 W/kg measured in any cube of 1.0 gram of biological tissue.

TCO Development has the ambition to further reduce the radiation energy taken up by the user and has therefore chosen a SAR value of 0.8 W/kg, measured in any cube of 10 gram of biological tissue in accordance with EN 50361. The value chosen by TCO is set so that a mobile phone achieving this limit is also very likely to meet the requirement set by the FCC.

Applicability

All mobile phones.

References

- EN 50360. Product standard to demonstrate the compliance of mobile telephones with the basic restrictions related to human exposure to electromagnetic fields (300 MHz – 3 GHz).
- EN 50361. Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz – 3 GHz).

Mandate:

The SAR value shall be equal to or less than 0.8 W/kg for any cube of 10 g phantom tissue.

The following information shall be submitted:

A copy of a test report from a test laboratory accredited for EN 50361 by an EA (European co-operation for Accreditation) recognised accreditation body. The test report shall fulfil the requirements in EN 50361. The distribution of the SAR, where the largest value is measured, shall be shown in the test results including an outline of the mobile phone under test.

The mobile phones tested must in all aspects be representative of those delivered to the customers. If the same phones are not used for the SAR and the TCP tests, the manufacturer must show that the output power and other relevant characteristics of the tested phones are equal.

We hereby guarantee that the above mandatory requirement is fulfilled and the appended information is correct.

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Signature	Name and title in block capitals
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A.2.2 Telephone Communication Power (TCP)

Background

The purpose of introducing TCP measurements is explained in detail in the introduction to section A2.

Telephone Communication Power, TCP, is measured as the utilised power when the telephone is operating at its maximum rated power output and is placed next to the phantom head in the four positions described in EN 50361. The TCP value for a specific frequency band is defined as the mean value of the four positions of the telephone.

The measurements are performed in all the frequency bands for which the telephone is designed, and the TCP values are taken separately for each frequency band.

Applicability

All mobile phones operating in accordance with the GSM-standard for frequencies 900 MHz and 1800/1900 MHz. TCO Development may within the scope of this standard later specify TCP values for telephones operating in accordance with other standards than GSM.

References

See Test Methods, C.2.2.

Mandate:

The average TCP (averaged over the four telephone positions) for each band/mode/antenna of the phone, shall be equal or greater than 0.3 W for GSM phones.

The following information shall be submitted:

A copy of a test report from a test laboratory accepted by TCO Development.

The mobile phones tested must in all aspects be representative of those delivered to the customers. If the same phone(s) are not used for the SAR and the TCP tests, the manufacturer must show that the output power and other relevant characteristics of the tested phones are equal.

We hereby guarantee that the above mandatory requirement is fulfilled and the appended information is correct.

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Signature Name and title in block capitals

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Date Company

A.3 Ergonomics

There is a steadily increasing use of mobile phones as tools in offices and among professionals. Almost all occupations now include the requirement to use a mobile phone in some part of the task. This means that telephones must be designed in such a way that people in different circumstances and with a variety of needs must be able to use the telephone efficiently in a wide range of situations and places.

Users are in this case defined as men and women, working in an office environment and with a variety of physical characteristics. Between 30% and 40% of office workers will, once or more during their working life, suffer from a temporary or even permanently reduced working capability with a consequent limitation on the ability to use a mobile phone.

A telephone with good ergonomic design shall be easy to use even with one hand, and the number of errors made in using the telephone shall be low. It shall be easy to assimilate as a new tool, and sensible in both physical design and its logical construction. It is important that the shape, tactile feedback, labelling, colour and functions of the buttons are integrated, so as to make the telephone as easy to use as possible for the maximum number of users.

Today mobile phones already have a wide range of applications, that will broaden further in the future and that will demand new characteristics in the telephones themselves. A well-written and clear instruction manual is important. Having a copy of the manual on the manufacturer's home page makes it easier for users with limited vision to see it enlarged.

Mobile phones give off heat. In the course of a long call with the phone being tightly held it becomes warm and damp, which means that people with low thresholds to allergic reactions will meet a new problem in their work environment. In addition the telephone must be held in exactly the right place for it to work well during a call, which increases the risk of static physical strain, particularly if long duration calls are made. The use of hands-free accessories, either a headset or an earpiece, with a connected microphone, is recommended.

Plans for updating TCO labelling – future requirements within ergonomics
It is important that the telephone display is of good quality in respect of contrast and lighting. Reflections from the protective surface covering the display can also cause a lot of problems when using a mobile phone in some working environments. These requirements are not present in this version of the requirements and criteria, but shall be obligatory requirements in the next version.

User tests of telephone menu program ergonomics will also be included in the next version. The structure of the program, its logical layout, where the user is located in the program, how easy it is to use, etc. are characteristics that will be tested by user panels. A number of ergonomic characteristics for key functions and display legibility other than those in this version will be included in future updates.

A requirement for the user's instruction manual to be available in the official language or languages for the country in which is to be sold is also an important future question.

A.3.1 Physical Ease of Use

A.3.1.1 Key shape, layout, text and legibility

Background
The massive impact of IT on working life puts a focus on the usability aspects of office equipment. Mobile phones must therefore include such characteristics as accessibility and usability for the intended user population, that also includes people with permanent or temporary disabilities.

Applicability
All mobile phones.

References

- Nordic Guidelines for Computer Accessibility, Second Edition, 1998. Nordic Co-operation on Disability. Editor: Clas Thorén.
- Guidelines-Booklet on Mobile Phones. A COST 219bis Guidebook. 2000. Editor: Patrick Roe.
- CCITT Rec. E.161.
- ETSI Standard ES 201 381.
- Human Factors in Product Design, Elsevier 1991.

Mandate:

1. **The *keys*[1] shall be elevated above the *keypad*[1] surface and be distinctly recognised by perception of touch.**
2. **The surface of the keys shall be made of material that is distinctly different, by means of colour coding and perception of touch, from the surrounding surface.**
3. **The numeric keypad layout shall comply with the international standard for numerical keypad layout (1-9, 0, *, #).**
4. **The function keys shall be clearly separated, by colour and form or by form from the numeric keys**
5. **The keypad shall have lighting that illuminates the characters and symbols on the keys, thereby showing the position of each button.**

The following information shall be submitted:

A written guarantee that the controls have the required characteristics. The guarantee shall be signed by the person responsible at the applicant company.

([1] *See Chapter B Clarifications and Definitions)*

We hereby guarantee that the above mandatory requirements are fulfilled.

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Signature Name and title in block capitals

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Date Company

A.3.1.2 Key depression force, activation and feedback

Background

Keys shall be activated by depression. Too high a depression force requirement strains the fine control muscles. Too low a depression force requirement carries the risk of incorrect button selection and uncertainty as to whether buttons have registered the executed depressions or not. Touch buttons are not accepted.

Applicability

All mobile phones.

References

- Nordic Guidelines for Computer Accessibility, Second Edition, 1998. Nordic Co-operation on Disability. Editor: Clas Thorén.
- Guidelines-Booklet on Mobile Phones. A COST 219bis Guidebook. 2000. Editor: Patrick Roe.
- ISO 9241:4, 1998.
- PrEN 1005-1 and 2.
- Human Factors in Product Design, Elsevier 1991.

Mandate:

Actuation of a *key*[1] shall need a *depression force*[1] and be accompanied by feedback. The indication upon key activation shall be given in both a *tactile*[1] and *audible*[1] manner.

The following information shall be submitted:

A written guarantee that the keys have the required characteristics. The guarantee shall be signed by the responsible person at the applicant company.

([1] *See Chapter B Clarifications and Definitions*)

We hereby guarantee that the above mandatory requirements are fulfilled.

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Signature	Name and title in block capitals
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Date	Company

A.3.2 Material Characteristics

Background
Since an increasing number of people are becoming allergic and sensitised to chemical substances, strict requirements must be set for the materials used in the casing and keypad.

Applicability
All mobile phones.

References
- Nordic Guidelines for Computer Accessibility, Second Edition, 1998. Nordic Co-operation on Disability. Editor: Clas Thorén.
- Biological evaluation of medical devices – Part 1: Evaluation and testing. ISO 10993-1:1997.

Mandate:

The outside surfaces of the housing, battery pack and buttons shall not contain nickel or chromium, neither in the material used nor as a surface treatment.

The following information shall be submitted:

A written guarantee that the material have the required characteristics.
The guarantee shall be signed by the responsible person at the applicant company.

We hereby guarantee that the above mandatory requirement is fulfilled.

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Signature	Name and title in block capitals
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Date	Company

A.3.3 Visual Ergonomics

Background
Status information on displays should enable the user to perform perceptual tasks effectively, efficiently and with satisfaction, independent of external light conditions. The size and contrast of the displayed characters and symbols are important in determining legibility and the ability to distinguish one from another.

Applicability
All mobile phones.

References
- Nordic Guidelines for Computer Accessibility, Second Edition, 1998. Nordic Co-operation on Disability. Editor: Clas Thorén.
- Guidelines-Booklet on Mobile Phones. A COST 219bis Guidebook. 2000. Editor: Patrick Roe.
- CCITT Rec. E.161.
- ETSI Standard ES 201 381.

Mandate:

The *symbol height*[1] shall be equal to or larger than 3.0 mm for capital letters that are used to show telephone numbers and to show incoming and outgoing messages.

The following information shall be submitted:

A written guarantee that the measured symbol size is equal to or larger than 3.0 mm.
The guarantee shall be signed by the responsible person at the applicant company

(*[1] See Chapter B Clarifications and Definitions*)

We hereby guarantee that the above mandatory requirements are fulfilled.

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Signature Name and title in block capitals

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Date Company

A.3.4 Accessories

Background

Mobile phones are used in many different work situations and their users have different requirements for their telephone characteristics. To make the telephone easy to handle, certain specialised applications for a limited range of users may be separately obtainable as accessories.

Applicability

All mobile phones.

> **Mandate:**
>
> **The following accessories shall be made available for TCO-certified mobile phones:**
> **- battery charger**
> **- hands-free, either headset or earpiece, with a connected microphone**
> **- vibrator without or in combination with a battery pack.**
> **The manual shall specify the manufacturers, models and types of the accessories.**
>
> **The following information shall be submitted:**
>
> **A written guarantee that the above mandatory requirement is fulfilled, together with a list of the manufacturers, models and types for each of the mandatory accessories. The guarantee shall be signed by the responsible person at the applicant company.**

We hereby guarantee that the above mandatory requirements are fulfilled.

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Signature	Name and title in block capitals
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Date	Company

A.3.5 Instruction manual

Background

The range of mobile phone user applications is growing and the functions are becoming more complicated. In order to obtain good user quality at the work place, it must be possible to use telephones efficiently and to their full potential. This demands a good user's instruction manual that accompanies the mobile phone on delivery to the user.

Applicability

All mobile phones.

Mandate:

1. **A user's instruction manual shall accompany the mobile telephone on delivery to the user.**
2. **The user's instruction manual shall contain the following information:**
   - the internet address where it is possible to find the manual text
   - information concerning where to obtain assistance with problems encountered while using the mobile phone.
3. **The following accessories shall be declared in the user's instruction manual:**
   - battery charger
   – hands-free, either headphone or earpiece with connected microphone.
   - vibrator without or in combination with battery pack.
   The manual shall specify the manufacturers, models and types of the accessories.

The following information shall be submitted:

A written guarantee that the user's instruction manual for the telephone meets the specified requirements The document shall be signed by the responsible person at the applicant company.

We hereby guarantee that the above mandatory requirements are fulfilled.

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Signature	Name and title in block capitals
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Date	Company

A.4 Ecology

There is a dramatic increase in the use by the general public of mobile phones, which from an environmental perspective is increasing the risk of spreading environmentally harmful substances. The combination of widespread use and environmentally harmful contents puts mobile phones into a priority area in terms of achieving the goals of society for a non-toxic environment.

Over 10 years ago political agreement was reached within the framework of the North Sea conference. This conceived the precautionary principle, which states that protective measures must be taken before any damage is caused to health or the environment, even if the connection between the cause and effect may still be uncertain.

This principle has appeared in more and more international forums and documents. One of the more important is the international Esbjerg declaration of 1995. The same principle was later adopted by the Baltic States environmental ministries at the Visby conference in 1996. The precautionary principle is embodied in the EU treaty and, among others, in the Directive concerning the use of genetically modified organisms. In February 2000 the EU Commission adopted a Memorandum on the precautionary principle. This dealt with the principle in general terms.

Sweden has for a long time applied the precautionary principle in the area of chemicals, and it appears in environmental legislation (Chapter 2 §3).

The ecological requirements are founded on the basis of TCO Development's earlier experience of setting ecological requirements in the TCO '95 and TCO '99 environmental labelling schemes for computers and displays. These have since been adapted to suit the mobile phones product group.

TCO Development has deliberately chosen what may be considered as basic levels for the ecological requirements. There will be ample opportunity in future labelling scheme updates to tighten the requirements and thereby encourage to a wider extent the development of environmentally-adapted mobile phones.

Plans for updating TCO labelling – future requirements within ecology

A forthcoming requirement will be to tighten the demands concerning lead, which will add the prohibition of lead-based solder. Another area which will come under closer examination is the phasing out of flame retardants in the electronic components.

A.4.1 Environmental management system certification

Background

A certified environmental management system is proof that the company shows concern for the environment and has chosen to work in a systematic way with constant improvement of the environmental performance of the company and its products in focus.

Applicability

The company manufacturing the mobile phone.

References

- ISO 14001
- EMAS EU regulation no 1836/93 concerning the voluntary participation of industrial companies in the Union's environmental control and review structure.

Mandate:

The *manufacturing company*[1] must be certified in accordance with ISO 14001, or EMAS registered, no later than 12 months after the first product is certified in accordance with TCO. If the product is manufactured by a third party, it is this company that shall be certified.
The certification authority shall be accredited in accordance with ISO/IEC Guide 66, and shall meet the provisions of ISO/IEC Guide 61.

The following information shall be submitted:

1. **A written document giving the names of the manufacturers and describing where the manufacturing facility is located .**
2. **Copies of the ISO 14001 or EMAS certificates.**
3. **If the certificate is not yet available, a written document giving the time schedule for the certification process, along with a written environmental policy, signed by the manufacturing company's general director.**
4. **Information showing where and by whom the telephone was manufactured.**

([1] See Chapter B Clarifications and Definitions)

A.4.2 Environmental Hazards

A.4.2.1 Mercury (Hg) and Cadmium (Cd)

Background

The effects of mercury and cadmium on human health and the natural environment have been very thoroughly documented since the mid-1950s. In natural surroundings mercury forms the very dangerous compound methyl mercury which, like cadmium, is bio-cumulative with a long half-life, also being poisonous to aquatic life and warm-blooded animal species.

Cadmium accumulates in the kidneys, among other organs.

Within the EU the presence of mercury and cadmium in batteries is regulated by the Battery Directive (91/157/EEG).

In the EU production responsibility provisions for electrical and electronic products, embodied in the Waste from Electronic and Electrical Equipment (WEEE) draft Directive, it is proposed that both mercury and cadmium should be phased out, no later than by January 1st, 2007.

The UN/ECE Convention on Long-range Transboundary Air Pollution (CLRTAP) was extended in June 1998 by a Heavy Metals Protocol that included cadmium pollutants and products containing levels of mercury.

Applicability

All mobile phones.

References

- The EU 91/157/EEG Battery Directive
- Proposed EU Directive on limiting the use of certain harmful substances in electrical and electronic products, 2000/0159 (COD)
- CLRTAP; the UN/ECE Convention on Long-range Transboundary Air Pollution: "The 1998 Aarhus Protocol on Heavy Metals"

Mandate:

The telephone shall not contain *mercury or cadmium*[1] .

The following information shall be submitted:

A written guarantee that the telephone does not contain mercury or cadmium. The document shall be signed by the responsible person at the applicant company.

([1] *See Chapter B Clarifications and Definitions)*

We hereby guarantee that the above mandate is fulfilled

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Signature	Name and title in block capitals
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Date	Company

A.4.2.2 Lead (Pb)

Background

Exposure to lead can lead to a number of negative effects on health, such as damage to the kidneys, nervous system and foetuses. Lead accumulates in bone tissue with a long half-life. Lead is a basic element and cannot therefore be chemically decomposed, only turned into a compound. Lead is very widespread among society.

In the Waste from Electronic and Electrical Equipment (WEEE) draft EU Directive it is proposed that the industrial use of lead should be phased out by January 1st 2007. There are a number of initial exceptions, but its eventual elimination is clearly apparent.

The UN/ECE Convention on Long-range Transboundary Air Pollution (CLRTAP) was extended in June 1998 by a Heavy Metals Protocol that included lead. UNEP has defined lead as one of the substances that requires regulation on a global level with a binding convention.

The environmental ministers of the OECD countries issued in 1996 a declaration of risk-limiting measures in respect of lead.

Applicability

The batteries, paint, lacquer, cables and plastic components in the telephone.

References

- EU 91/157/EEG Battery Directive
- Proposed EU Directive on limiting the use of certain harmful substances in electrical and electronic products, 2000/0159 (COD)
- CLRTAP; the UN/ECE Convention on Long-range Transboundary Air Pollution: “The 1998 Aarhus Protocol on Heavy Metals”

Mandate:

The batteries, paint, lacquer, cables and *plastic components*[1] in the telephone shall not contain *lead*[1] .

The following information shall be submitted:

A written guarantee that the above mandate is fulfilled. The document shall be signed by the responsible person at the applicant company.

([1] See Chapter B Clarifications and Definitions)

We hereby guarantee that the above mandate is fulfilled.

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Signature	Name and title in block capitals
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Date	Company

A.4.2.3 Flame retarding agents

Background

Brominated flame retardants are in chemical terms a group of about 250 different substances. The general requirements and discussion concerning bromine-free flame retardants and the phasing out of this group thus concern about 250 pollutants. Two families within the brominated flame retardants group have been identified in particular as environmentally harmful. These are PBB and PBDE. The presence of polybrominated biphenyls (PBB) in seals in the Arctic indicates a comprehensive geographical spread. PBDE and PBB show many similarities to the environmental poison PCB, and their background levels are increasing. The entire group is however highly persistent in the natural environment and difficult to degrade.

Within the EU certain brominated flame retardants are regulated by the limitations Directive (76/796/EEG). The use of PBB in textiles which are in contact with the skin is forbidden. Five brominated substances are included in the current risk evaluation in the EU programme for existing substances. These are five pollutants that belong to the PBDE family.

Since 1988 brominated flame retardants have been included in the OECD’s risk limitation programme. In the 1995 Esbjerg Declaration the environmental ministers united in an agreement that brominated flame retardants shall be replaced by less harmful substances where such alternatives are available.

The OECD has, together with organisations in the industry, managed to reach voluntary agreements to reduce the use of PBDE and PBB.

In Germany, the use of PBDE and PBB is limited through the dioxin regulations and industrial voluntary agreements. In Holland PBDE and PBB have been phased out by industrial consent. In Sweden the use of the whole group of brominated flame retardants is to be limited, and there shall be a rapid elimination of those substances within the group that are considered the most harmful (Parliamentary Proposition 90/91:90). The Swedish Chemicals Inspectorate defined PBDE and PBB as the most harmful substances in its 16/95 report. In Parliamentary Proposition 1997/98:145 the Swedish government repeated its assertion that the use of brominated flame retardants should be restricted.

Chlorinated hydrocarbons are persistent and can bio-accumulate in both fish and mussels. They are decidedly toxic to shellfish and have been detected in such mammals as seals and elk. If burnt, combustion products such as PCB and dioxins can be produced, that are also dangerous to human health and the environment.

A series of international elimination activities in respect of chlorinated hydrocarbons is currently in progress within the EU, OSPAR (the Commission for the Protection of the Marine Environment of the North-East Atlantic) and HELCOM (the Baltic Marine Environment Protection Commission). OSPAR took up in June 1995 a Swedish initiative to decide on phasing out chlorinated hydrocarbons in certain applications. Within the framework of the EU programme for existing substances (93/793/EEG) chlorinated hydrocarbons have been evaluated and binding measures discussed (similar to those within OSPAR).

[A.4.2.3 continues on next page]

[A.4.2.3 continued]

Applicability
Plastic components weighing more than 10 gram.

References
- EU Directive (76/796/EEG)
- Risk Reduction Monograph no. 3 (OECD Environment Monograph series no 102)
- Swedish Chemical Inspectorate Report 16/95
- Swedish government Parliamentary Proposition 1997/98:145
- HELCOM article 5, annex I
- OSPAR Strategy with regard to Hazardous Substances (1998-16)
- EU Directive 93/793/EEG
- Esbjerg declaration – 4th North Sea Conference 1995
- CAS (Chemical Abstracts Services) www.cas.org

Mandate:

***Plastic components*[1] weighing more than 10 g shall not contain flame retardants that contain *organically bound chlorine or bromine*[1] .**

The following information shall be submitted:

1. **A written guarantee that the above mandates are fulfilled.**
2. **A list of all plastic components weighing more than 10 g. The list shall include for each component its name, type of plastic used, plastic brand name, plastic labelling text, flame retardant type and flame retardant CAS no. This list is also used to verify compliance with requirements A.4.2.4 and A.4.3.1.**

The documents shall be signed by the responsible person at the applicant company.

([1] *See Chapter B Clarifications and Definitions)*

We hereby guarantee that the above mandates are fulfilled

....	....
Signature	Name and title in block capitals
....	....
Date	Company

[A.4.2.3 continues on next page]

[A.4.2.3 continued]

Component name	**Weight (grams)**	**Type of plastic**	**Plastic brand name**	**Flame retardant type**	**Flame retardant CAS number**	**Plastic labelling text (ISO 11469, 1043 series)**

....
Signature   Name and title in block capitals

....
Date   Company

A.4.2.4 Brominated and Chlorinated plastics

Background

By far the most common halogenated plastic is PVC. There are however other plastics that contain chlorine or bromine in the plastic itself, such as brominated polyethylene and polystyrene. As the requirement concerning permissible flame retardants tightens, the risk increases that halogenation of the polymers themselves will become more common.

PVC is a much-debated plastic that can pose environmental problems in most parts of its life cycle. Particular problems are chlorinated waste and releases during manufacture, generation of dioxins, environmentally harmful additives and more environmental problems due to the combustion of waste containing levels of PVC.

As a result of the energetic debate concerning PVC, the EU Commission produced in July 2000 a Green Book about PVC. So far there are no international agreements with respect to PVC. On the other hand, there are several national regulations concerning additives. Apart from the heavy metals lead and cadmium there are rules concerning softeners for children's toys.

In the EU Waste from Electronic and Electrical Equipment (WEEE) draft Directive, PVC is named as a material that harms the environment.

Applicability

Plastic components weighing more than 10 grams in the telephone.

References

- The EU Green Book "Environmental questions concerning PVC" KOM (2000) 469

Mandate:

***Plastic components*[1]** **that weigh more than 10 grams in the telephone shall not contain brominated or chlorinated plastics.**

The following information shall be submitted:

A written guarantee that the above mandate is fulfilled. The guarantee shall be signed by the responsible person at the applicant company.

([1] *See Chapter B Clarifications and Definitions*)

We hereby guarantee that the above mandate is fulfilled

....	....
Signature	Name and title in block capitals
....	....
Date	Company

A.4.2.5 Beryllium oxide (BeO)

Background

Beryllium is one of the most toxic metals to inhale, resulting in acute poisoning, and a chronic lung illness. Beryllium is a basic element and cannot therefore be chemically decomposed. The use of beryllium is controlled in many countries. Beryllium is according to its EU classification carcinogenic and is covered by an EU limitation Directive (76/769/EG).

Applicability

All mobile phones.

References

- EU Directive 76/769/EG

> **Mandate:**
>
> **The telephone shall not contain beryllium oxide.**
>
> **The following information shall be submitted:**
>
> **A written guarantee that the above mandate is fulfilled. The guarantee shall be signed by the responsible person at the applicant company.**

We hereby guarantee that the above mandate is fulfilled

....	....
Signature	Name and title in block capitals
....	....
Date	Company

A.4.3 Preparation for Recycling – Labelling of plastics

Background

Within both the EU and Sweden the problem of electronic waste has been a major issue for many years. The EU has now brought out a set of rules for dealing with environmental questions related to electronic items in waste. There are large volumes of mobile phones all over the world, and they have a relatively short life. Recycling and the handling of harmful substances is therefore an important environmental area.

Applicability

Plastic components weighing more than 10 g in the telephone.

References

- ISO 11469
- ISO 1043-1, -2, -3, -4
- Proposed EU Directive concerning limitation of the use of certain harmful substances in electrical and electronic products, 2000/0159 (COD)

Mandate:

Plastic components[1] **that weigh more than 10 grams shall be labelled in accordance with ISO 11469, ISO 1043-1, -2, -3, -4.**

The following information shall be submitted:

A written guarantee that the above mandate is fulfilled. The guarantee shall be signed by the responsible person at the applicant company.

([1] See Chapter B Clarifications and Definitions)

We hereby guarantee that the above mandate is fulfilled

....	....
Signature	Name in block capitals
....	....
Date	Company

B Clarifications and Definitions

B.3 Ergonomics

B.3.1.1 Key shape, layout, text and legibility

Definitions

The word *key* embraces the On/off control, function keys and numeric keys.

The *keypad* consists of the On/off control, function keys and numeric keys.

B.3.1.2 Key depression force, activation and feedback

Definitions

Key Depression force No measured value is specified

Tactile feedback Feedback to the finger tips when pressing the key

Audible feedback Feedback that can be heard, in this version no measured value is specified

Touch button Button touched by finger tip without depression force

B.3.1.3 Visual Ergonomics

Symbol height For capital letters that are used to show telephone numbers and to show incoming and outgoing messages.

B.4 Ecology

B.4.1 Environmental management system certification

Definitions

The *manufacturing company* is the company or companies involved in the final assembly of the telephone.

B.4.2.1 Mercury (Hg) and cadmium (Cd)

Definitions

Levels of *mercury* of less than 2 ppm and *cadmium* of less than 5 ppm are permitted.

B.4.2.2 Lead (Pb)

Definitions

Levels of *lead* of less than 10 ppm are permitted.

Plastic components are components made mainly of plastic, e.g. the housing. Components containing other materials in any significant amount, e.g. cables or printed wiring board laminates, are not defined as *plastic components.*

B.4.2.3 Flame retardant agents

Definitions

Levels of *brominates* or *chlorinates* of less than 0.05% are permitted.

CAS (Chemical Abstracts Services) refers to a unique identification of the chemical that is used. Refer to www.cas.org for more information.

C Test Methods

C.2.2 Procedure for Measuring TCP (Telephone Communication Power) from GSM system Mobile Phones

This section describes the procedure for measuring TCP in a reverberation chamber. TCP can be measured in different possible ways. Described below is a method, using a reverberation chamber, which has in practical tests been shown to give reliable results.

Definition of TCP

The TCP is the power leaving a closed surface, which surrounds the phone and the head phantom when these are located far from other objects. It is the maximum available power, which can be provided by the phone if the antenna on the phone were ideally matched to the output impedance of the phone, **minus** the power which is reflected due to an actual mismatch at the antenna port, **minus** the power which is dissipated in the antenna, **minus** the power which is absorbed in the head phantom.

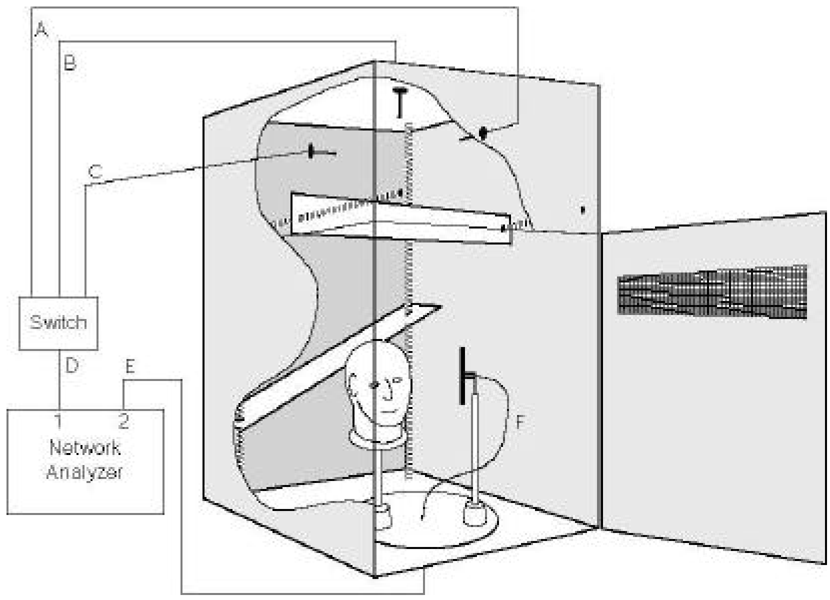
The TCP is the figure of merit of a mobile phone, when it is transmitting. The higher the TCP, the better the phone will work in the transmit mode. On the other hand, the possible radiation hazards are characterized in terms of a Specific Absorption Rate (SAR) distribution that should be as low as possible or at least below some standardized limits. Both the TCP and the SAR are proportional to the maximum power that can be radiated by the phone. Therefore, a high quality phone must provide a good compromise between high TCP and low SAR. This is possible by directing the radiation from the phone away from the head.

The TCP is proportional to the radiation efficiency of the antenna on the phone, measured with the head phantom present.

C.2.2.1 Requirements of the measurement setups

Reverberation chamber

The measurement setups both for the chamber calibration and the TCP measurement are illustrated in Figure 1. Both setups are composed of the reverberation chamber with mechanical stirrers and three receiving antennae (also referred to as the fixed antennae) for polarization stirring, and two head phantoms (one for use at 900 MHz and another for 1800 MHz). If the chamber is small it must additionally be provided with a rotatable platform stirrer to provide sufficient accuracy, as shown in Figure 1. The three receiving antennae must be orthogonal linearly polarized over the frequency ranges of the measurements. The three orthogonal polarized receiving antennae may be monopoles connected orthogonally to three different and orthogonal walls (including roof/floor) of the chamber. The three receiving antennae are connected to an electronic coaxial switch by means of three coaxial cables A, B and C.



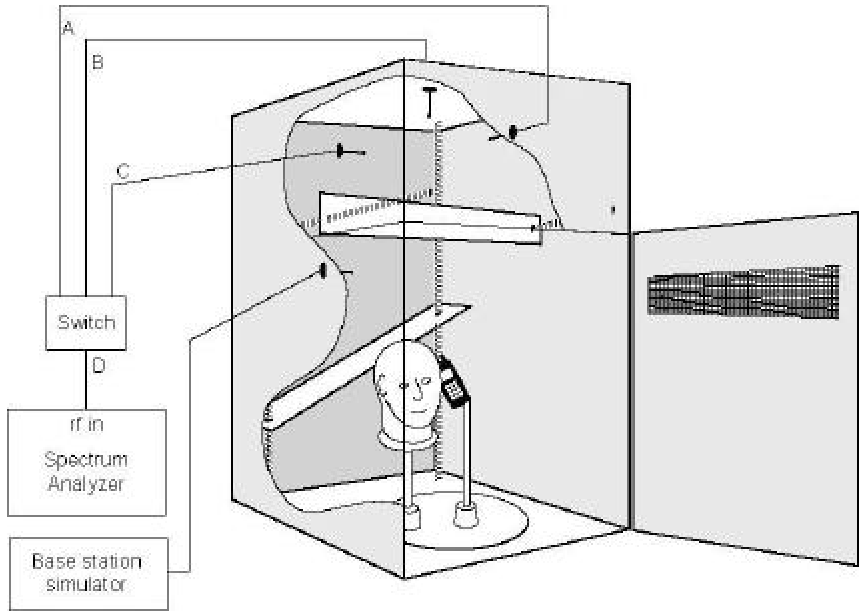


Figure 1. Illustration of measurement setup in a small reverberation chamber for calibration (upper) and TCP measurement (lower). The network analyzer, the spectrum analyzer, the polarization switch, the two mechanical stirrers, and the rotatable platform can be controlled from a PC.

The reverberation chamber can have an inner volume as small as a minimum of 1.25 m^3 if platform stirring is implemented, but must be larger than 8 m^3 if there is no such stirring facility.

Linearly polarized dipole antennae are used for calibration of the chamber, one for each band. These shall have a reflection coefficient better than -10 dB over the frequency band used, when measured at their input connectors.

The reference level of the chamber is different at different frequencies. It shall be measured as described in Section C.2.2.2 in each band used. The reference level shall be measured both when the calibration antenna is oriented for vertical polarization and when it is oriented for horizontal polarization. These two values shall differ by less than the specification in Table 1. In order to obtain values for comparison with the results in the table, the reference levels shall be measured for both orientations of the calibration dipole at 8 different positions of the dipole inside the chamber. The average of the difference, standard deviation and maximum difference shall be evaluated by comparing results for both polarizations over the whole set of 8 measurements. Alternatively, the levels for the two polarizations of the calibration antenna at 1 MHz intervals between 800 MHz and 1 GHz for the GSM 900 band (and between 1600 MHz and 2000 MHz for the GSM 1800-1900 band) can be measured, and thereafter the average, standard deviation and maximum of the difference between the two sets of values over this frequency range are calculated.

Table 1. Specifications of differences of measured reference levels in each frequency band between using vertically and horizontally polarized calibration dipoles.

Average	Standard deviation	Maximum
0.2 dB	0.5 dB	1.0 dB

Head phantoms

The phantoms used in the tests should fulfill the requirements in Section 5.2 of EN 50361 on SAR measurements. It is admissible to use two phantoms, one for the GSM 900 MHz band and another for the GSM 1800-1900 MHz band. They shall be filled with the brain-equivalent liquids specified in Section 5.2 of EN 50361.

Environmental conditions

The tests shall be performed in an indoor laboratory where the ambient temperature shall be in the range 15 °C – 30 °C and the variation shall not exceed ± 2 °C during the tests.

Instrumentation and data acquisition

The two different measurement setups make use of a network analyzer, a spectrum analyzer (or a power meter or a measurement receiver) and a base station simulator. A PC controls the network analyzer, the spectrum analyzer, the base station simulator and the coaxial switch, as well as the step motors for the mechanical stirrers and the platform stirrer (if used).

Mobile phone holder

The mobile phone must be fixed to a mobile phone holder that satisfies the requirements given in Section 5.5 of EN 50361.

C.2.2.2 Measuring the reference level (Calibrating the chamber)

The calibration setup is shown in the upper part of Figure 1.

First calibrate the network analyzer at its ports 1 and 2.

Connect cable D to port 1 of the network analyzer and cable A to port 2. Measure the relative transmission factor *TA* of cable A plus the switch plus cable D. Make sure the switch is set to permit transmission between cables A and D. Measure, in the same way, the relative power transmission factors *TB* and *TC* of cables B and

C including the switch and the cable D. Note that *TA*, *TB* and *TC* are always smaller than 1.

Measure the attenuation *LdipdB* of the calibration dipole (in *dB*). This can be done by measuring the reflection coefficient *RdB*, at the input port of the dipole, when the feed gap between the dipole arms is short-circuited. Then, *LdipdB = RdB/2*, and the dipole transmission factor (smaller than 1) becomes

$$T_{dip} = 10^{-LdipdB/10}.$$

Connect the single output of the switch, via cable D, to port 1 of the network analyzer. Connect cables A, B and C between the switch and the connectors to each of the three receiving antennae.

Mount the calibration dipole on a holder inside the chamber. Connect cable F between the connector of the calibration dipole and a connector that makes a connection through the floor or wall (shown in the center of the rotatable plate in the example in Figure 1). On the other side of the wall (or floor) there shall be a cable E connecting this to port 2 of the network analyzer. If the chamber is provided with a rotatable plate stirrer, the calibration dipole shall be located on the plate, and the cable E shall be connected to cable F via a rotary joint.

Recalibrate the 0 dB level of the network analyzer three times, once for each cable A, B and C. This shall be done for cable A by connecting together the dipole end of cable F and the monopole end of cable A. Similarly for cables B and C. Store the three calibration sets A, B and C.

Connect cable F to the dipole again.

Locate the head phantom inside the chamber in such a way that it is not closer to any wall, ceiling or floor than 0.5 wavelengths λ. Make sure that this is the case at all positions of the rotatable platform (if such a platform is used). Use a phantom that is filled with the correct liquid for the band to be measured. For large reverberation chambers, it may be necessary to load the chamber with more absorbing material than the head phantom, otherwise some phones may not work properly inside the chamber. If this is needed, exactly the same material must be present inside the chamber when the phones are measured as when the reference level is measured.

Position the calibration dipole inside the chamber in such a way that all its parts are not closer to any wall, ceiling or floor than 0.5 λ and at least 0.7 λ away from the phantom. The phone shall be located outside the chamber, but the phone holder must be located inside the chamber. (See the second last paragraph of Section 2.2.3 about the calibration procedure.)

Measure the S-parameters, when the switch is in the position corresponding to cable A, for all the chosen positions of the mechanical stirrer and the platform stirrer (if used), and over the whole GSM transmit band plus 12 MHz on each side of it (for 25 MHz frequency stirring). The frequency interval shall be 1 MHz.

The measured reflection coefficient S_{11} has two additive contributions: One due to the reflection from the antenna port itself (deterministic) and the other due to the chamber (statistic). The same applies to S_{22}. Therefore, calculate the averages of the complex values of S_{11} and S_{22}, and average them further over a 5 MHz bandwidth. The remaining parts are the free space reflection coefficients $\overline{S}_{11}$ and $\overline{S}_{22}$ of the fixed receiving antenna A and the calibration dipole, respectively.

Take the measured values S_{21} and calculate

$$P = \frac{|S_{21}|^2}{\left(1-|\overline{S}_{11}|^2\right)\left(1-|\overline{S}_{22}|^2\right)}$$

For each of the selected frequencies f_i for measuring the phone (see Section C.2.2.3), calculate the average $P_A(f_i)$ of P, by averaging P over all stirrer positions and over a 25 MHz band centered around each f_i.

Calculate the reference transfer function of the chamber $P_{refA}(f_i)$ when using antenna A at each frequency f_i by using

$$P_{refA}(f_i) = \frac{P_A(f_i)\left(1-|\overline{S}_{11}|^2\right)}{TA \cdot T_{dip}}$$

Repeat the above for the other receiving antennae B and C by using the switch to obtain $P_{refB}(f_i)$ and $P_{refC}(f_i)$, respectively.

C.2.2.3 Measuring the TCP of a phone

The phone measurement setup is shown in the lower part of Figure 1.

Positioning the phone

Mount the mobile phone in the holder and position it at the desired position relative to the head phantom. The mobile phone shall be tested in 5 positions: “free space position”, which in the chamber means more than 0.7 wavelengths away from the phantom, “right and left cheek positions”, and “right and left tilted positions”. The cheek and tilted positions are the same as those defined in Sections 6.1.4 of EN 50361 on SAR measurements.

The mobile phone shall be turned on, and use its internal transmitter during the TCP measurements. The battery and accessories shall be those specified by the manufacturer. The battery shall be fully charged before each measurement.

Base station simulator

The base station simulator shall be located outside the chamber and connected to a fixed antenna inside the chamber, by means of a wall-mounted coaxial connector with a centre conductor going through the wall. This antenna can also be a monopole.

The base station simulator controls the output power and frequency (channel) of the mobile phone. The mobile phone shall transmit at its highest output peak power level allowed by the system.

The signal emitted by the base station simulator is several orders of magnitude lower than the output level of the phone and will therefore not cause any errors in the power measurements. If the transmitted power is measured by using a measurement receiver or a spectrum analyzer in the zero span mode (which means that it is measured at the transmit frequency of the phone and not at its receive frequency) the base station simulator could not cause errors, even if radiating at higher levels.

Measuring pulse power with a spectrum analyzer

The pulse power can, as mentioned above, be measured with different measurement instruments. This section describes how it can be done with a spectrum analyzer. Measurements with other instruments can be done in a similar way.

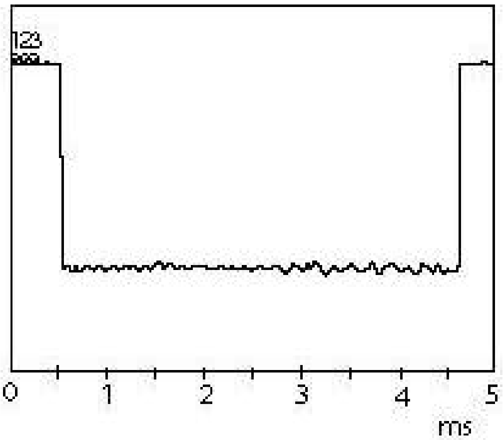


Figure 2. Illustration of GSM pulse, which is triggered at t_0 = 0 ms, as it would be seen on the screen of a spectrum analyzer in the zero span mode. The time positions for measuring the pulse level are at the three markers 1, 2 and 3, the first at t_1 = 50 ms, the second at t_2 = 150 ms, and the third at t_3 = 250 ms.

The phone transmits pulses at a certain pulse repetition rate. The spectrum analyzer shall be operating in a zero span pulse detection mode that triggers at the front of each pulse in the pulse train. It is thus possible to read the pulse level at the same position relative to the front of the pulse, at each measurement. Read the pulse power levels at three different time delays relative to the pulse front (choose 50, 150 and 250 µsec), as shown in Figure 2, and use the median value as the pulse power level in the calculations below.

The base station simulator shall control the phone to transmit at 5 frequencies or more (one at a time) distributed with equal spacing over the whole transmit band.

Set the switch to measure power from receiving antenna A. Measure and save pulse power levels for all the positions of the platform stirrer and mechanical stirrer and for all the frequency points used. Average the saved pulse power levels over all stirrer positions. The result of the averaging is $P_{avA}(f_i)$. Repeat this for receiving antennae B and C to get $P_{avB}(f_i)$ and $P_{avC}(f_i)$.

The TCP in W of the phone is finally obtained by

$$TCP = \frac{1}{N}\sum_{1}^{N}\frac{1}{3}\left(\frac{P_{avA}(f_i)}{P_{refA}(f_i)}+\frac{P_{avB}(f_i)}{P_{refB}(f_i)}+\frac{P_{avC}(f_i)}{P_{refC}(f_i)}\right)$$

where N is the number of frequency points.

Definition of measurement cases

The TCP tests shall be performed in the “free space position” of the phone as well as in all four positions of the phone relative to the phantom.

If the mobile phone has a retractable antenna, all of the tests described above shall be performed both with the antenna extended and with the antenna retracted. When considering multi-mode and multi-band mobile phones, all of the above tests shall be performed in each transmitting mode/band with the corresponding maximum peak power level.

Presentation of results

The measurement protocol shall contain all the five TCP values in W, i.e. for free space, right cheek, left cheek, right tilt and left tilt positions. They shall be given for each band/mode/antenna of the phone. In addition, the average TCP value of the four talk positions shall be calculated and given in W for each band/mode/antenna. The values shall be given with a maximum uncertainty of **2.0 *dB***.

Uncertainty estimate

Test laboratories must provide an uncertainty analysis of their facility at each measured frequency band. This analysis shall at least contain a breakdown of documented error contributions, such as the one shown in Table 2. It must be possible to verify each contribution in the table. The table below is from [1] where the different contributions are described in detail. A brief description is also given below.

Table 2. Uncertainty breakdown analysis of the chamber used when measuring TCP.

	GSM 900 MHz band	**GSM 1800 MHz**
Error sources	**Standard Uncertainty**	**Standard Uncertainty**
Chamber statistics		
Power meter level		
Network analyzer		
Chassis of phone		
Phone position		
Phantom type		
Permittivity & conductivity		
Expanded uncertainty		

The contribution due to chamber statistics has a theoretical lower limit. This contains both the uncertainty of the reference level and the pulse power level, and it depends on the mechanical stirring, platform stirring and polarization stirring. The estimate in the table shall be based on measuring at least 5 phones in two very different chambers. The same network analyzer, spectrum analyzer and head phantom may be used, as well as using the same person to operate the instruments. The different TCP values measured in each of the corresponding positions of the phone (free space, cheek right and left, and tilt right and left) shall be compared for the two chambers. This gives at least 25 independent TCP values. The standard deviation and maximum deviation of these two sets of values can be used to calculate this contribution of the standard uncertainty.

The pulse power meter (e.g. spectrum analyzer in zero span mode) has a limited accuracy. The error must be checked against specification and calibration. By calibrating the power meter in the actual frequency bands, the uncertainty can be reduced compared to the full band uncertainty.

The network analyzer accuracy can be found in its manual. Note that all measurements performed with the network analyzer are relative which reduces the uncertainty.

The calibration setup is somewhat simplified, in the sense that the effect of the chassis of the phone on the reference level has been neglected. The correct way would have been to place the phone inside the chamber and leave it on during the calibration while the reference level was measured by means of the calibration level and the network analyzer. The phone would be located at least 0.5 λ from the walls and the calibration dipole and the phantom. Similarly, the calibration dipole (with its port terminated in a 50 Ohm load) should be in position inside the chamber when measuring the pulse power from the phone by using the pulse power meter. However, this calibration procedure is laborious when many phones are being tested, so the error can instead be estimated by measuring for some large phones the difference in the reference level due to the chassis as follows: First, a second lossless antenna (which must be terminated ideally in 50 Ohms) is placed inside the chamber and the reference level measured. Then the second lossless antenna is removed and replaced by the phone (which must be ON). The difference between these two reference levels represents the error due to losses in the chassis of the phone.

The positioning of the phone in its cheek and tilt positions is also a source of error. Part of this error is included in the first ‘chamber statistics’ estimate. However, if the same operator is measuring in both chambers, the error may be very small. Still, it is believed to cause some of the larger uncertainties in [1] for some phones that are difficult to locate. The table should also include an estimate of positioning errors. This is done by repeating a few times with small changes in the physical positioning of the phones, using exactly the same setup in the chamber (i.e. exactly the same phantom position and stirrer position).

References

[1] Per-Simon Kildal and Charlie Carlsson, “TCP of 20 mobile phones measured in a reverberation chamber”, Bluetest report 2, Nov 2001 (available from Bluetest AB, Chalmers Teknikpark, 41288 Gothenburg, Sweden, or from E-mail: simon@kildal.se).

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