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# TCO Projectors 1.1



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# Introduction

Projected images – you see them everywhere – in both public and professional settings for advertising, information to large audiences as well as home cinema for entertainment or replacing the TV. Projectors are made in a variety of sizes ranging from light portable equipment to large projectors suitable for creating image sizes for larger halls.

Projector users demand high image quality and top performance. With this in mind, TCO Development has created a certification, *TCO Projectors*. The aim with the certification is to make it easier to choose projectors designed for both usability and environment. The TCO environmental impact criteria set limitations on hazardous substances and energy consumption as well as requirements for recycling. The usability criteria aim to give the user high image quality and low noise. Today image quality is related to light flux measured in Ansi lumen and contrast ratio. Most users have difficulties in relating image quality to these abstract values but they know which picture size they want to have a high picture quality with. TCO Development has developed a requirement aiming to provide a good picture on a maximum projected screen size, the **TCO Image Size**. It is possible to certify front screen projectors with fixed resolution according to TCO Projectors. Since projectors are developed for different lighting conditions, depending on usage purpose, TCO Development has developed two sets of requirement levels based on the ambient lighting conditions; office, enlightened room, and for video, dark room. In the requirements it is clearly stated if requirements apply only to a certain category or if they apply to both types of projectors.

We believe that the TCO certification for projectors will be a useful tool for users to choose a projector that meets their performance needs and environmental goals

*TCO Projectors* is the first TCO certification for projectors but the 5<sup>th</sup> product category ICT products since the first TCO certification for displays was launched in 1992. The TCO certification system is now internationally recognised and products bearing the TCO label can be found throughout the world. More information about the TCO certification can be found on [www.tcodevelopment.com](http://www.tcodevelopment.com).

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# A Criteria

## A.1 General information

This document contains requirements, test methods and references for front screen projectors with fixed resolution, herein referred to as “projectors” throughout.

### **Definition**

Projectors are devices that focus an image onto a screen by projected light. The image from a light reflecting screen is viewed from the projector side of the screen (so-called front screen projection with fixed resolution).

The aim of this criteria document is to provide relevant test methods and criteria for the actual use of the product. Since projectors are developed for different purposes and viewing conditions as well as for use in different ambient lighting conditions. We have identified that it is necessary to have two different requirement levels for some of the criteria in this document. We have chosen to group the projectors in the following two categories:

1. Requirement levels for Office projectors
2. Requirement levels for Video projectors.

The two projector categories will most likely be used in different ambient conditions and are designed to present either static or moving image content. Because of this, for some criteria, they will be tested in different ways and have different accepted limit values. If a projector is designed for both applications it is possible to apply all of the criteria in this document.

The requirement levels for Office projectors are for projectors that are aimed to produce a static image in a highly illuminated room.

The requirement levels for Video projectors are for projectors that are aimed to produce a moving image in darker or sparsely illuminated rooms, such as in the home environment, where it is possible to switch off the light. (References 1 and 2)

Compliance to the mandates in this criteria document can be achieved in one of two ways; by a test report or by a verification report.

1. A test report is defined as a report based on:
  - Testing conducted by the laboratory issuing the test report on the product identified in the report.
2. A verification report is defined as a report based on:
  - A test report issued by a different laboratory.
  - Declarations from the Company applying for the certificate.

The alternatives accepted by TCO Development for each criterion can be found under each mandate respectively.

## A.1.1 TCO Document

### Background

It is desirable that the purchaser of a product that has been certified in accordance with TCO Projectors should receive information concerning the quality, features and capabilities of the product. This information is based on the viewpoint from the user's perspective that TCO Development represents.

### Applicability

All front screen projectors with fixed resolution.

### References

The contract between TCO Development and the applicant company.

### Mandate:

A TCO Document written in English shall accompany the product, describing why these particular requirements have been chosen for the products within the program of TCO Projectors and what is expected to be achieved by them. The document may be provided as an electronic file. The text can be obtained from TCO Development.

Examples of how the document can accompany the product are presented below:

- A separate printed document.
- As an electronic file or in the user manual.
- At the manufacturer's web site, together with the information about the product. A reference to the web site shall accompany the product

Additional information that shall appear on the document are:

- The diagonal length in inch for the TCO Image size for the native aspect ratio of the projector shall be declared in the TCO document (see A.2.1.1)

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.

The following information shall be submitted with the application to TCO Development:

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

We hereby guarantee that the above mandate is fulfilled.

.....

Product brand and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company

## A.2 Visual ergonomics

Good visual ergonomics and image quality are important aspects of projectors. Projectors are used for both static and moving images in both dim and illuminated rooms. In offices, projectors are used in highly illuminated rooms. This makes light flux more important than low black level to achieve a good contrast ratio. Video and home cinema projectors are used in dark or sparsely illuminated rooms. This makes a low black level more important than light flux to achieve good contrast ratio.

A projector can produce very large images by using zoom. When the image is enlarged by either zoom or changing the throw distance, many performance parameters like contrast ratio and image detail will change. This is because the limited light flux of the projector lamp is distributed evenly over the image and will be less intense when the image is enlarged. Because of this TCO evaluates and guarantees the image quality up to a maximum projected image size.

TCO's concept simplifies the process of buying a projector, since most users will already know the size screen they plan to use. The present practice of giving ANSI flux ratings and contrast ratios is not well suited to most users who have difficulties relating this information to an image size of suitable quality. The ANSI flux ratings and contrast ratios also have a different impact on projectors used in dark or well illuminated rooms.

### **Definition**

TCO Development has therefore devised a new approach by specifying the maximum projected image size (area m<sup>2</sup>) which is verified readable according to the TCO criteria, herein referred to as "**TCO Image size**" throughout.

All calculations correspond to a projector screen with gain=1.0.

TCO Development used three main ways to determine the suitable level for each requirement and the test methods for the visual ergonomics part of the TCO labelling scheme. One is based on acceptable visual levels determined by scientific research. The second is based on statistics from tests carried out in accordance with TCO, ISO, MPR regulations and from testing of projectors and other imaging devices. The third way is based on manufacturers' knowledge and experience, which is invaluable.

## A.2.1 Light flux characteristics

### A.2.1.1 Luminous flux

#### Background

It shall be possible to have a sufficiently high light flux with respect to the ambient lighting in order to present a comfortable viewing situation with sufficient luminance and luminance contrast. Poor light flux can affect legibility and colour discrimination of the presented image content, thus leading to misinterpretation and extended visual work load.

The light flux must be suitable for the viewing condition. In a dim lighting condition a too high light flux can be disturbingly high for human eyes adapted to the dim lighting, while a high light flux maybe necessary for an adequate image quality in very bright viewing conditions where the projected light must compete with the degrading ambient light.

#### Definition

$A_{max}$  is the maximum projected image size which is verified readable according to the TCO criteria, hereinafter named “**TCO Image size**”.  $A_{max}$  is measured in m<sup>2</sup>.

$$A_{max} \leq \frac{\Phi_{white/measured}}{L_{white} \times \pi + E_{amb}}$$

This is the largest “TCO Image size” that the certificate owner can declare. However, it may be necessary to declare a smaller “TCO Image size” in order to pass other criteria that depend on the “TCO Image size”, such as black level.

- $\Phi_{white/measured}$  is the measured light flux from the projector in lumens falling on a white screen. (In the calculations the screen is considered to have a Lambertian surface with gain=1).
- $L_{white}$  is the minimum required imaging luminance in cd/m<sup>2</sup> of white to achieve the “TCO Image Size”.
- $E_{amb}$  is the ambient illuminance in lux falling on the white screen.

Both  $L_{white}$  and  $E_{amb}$  illuminate the screen image, but  $L_{white}$  contributes to the image because it comes from the projector, while  $E_{amb}$  has no positive imaging affects and degrades the image from the projector. The  $E_{amb}$  and the  $L_{white}$  for the two viewing conditions used in this document are shown in the table below.

The following light values have been chosen to represent adequate standard viewing conditions for home video and office environment.

Lighting condition	Office projectors	Video projectors
Minimum luminance of white screen in a dark room	$L_{white/office} = 170$ cd/m <sup>2</sup>	$L_{white/video} = 85$ cd/m <sup>2</sup>
Ambient illuminance falling on the screen	$E_{amb/office} = 100$ lux	$E_{amb/video} = 20$ lux

**Applicability**

All front screen projectors with fixed resolution.

**Test procedure**

See B.2.1.1.

**References**

3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14.

**Mandate:**

The diagonal length in inch for the “TCO Image size” for the native aspect ratio of the projector shall be declared in the TCO document (see A.1.1).

The highest possible light output measured according to the test procedures in this document shall be declared in the test report.

**The following information shall be submitted with the application to TCO Development:**

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

### A.2.1.2 Black level and contrast ratio

#### Background

It is important that a projector can produce a black level dark enough to show shadow details in pictures at high and low white luminous flux levels. The black level is also important to achieve a good contrast ratio.

#### Definition

Black level is the capacity of the projector to maintain a good reproduction of black even when its luminance is high.

Office projectors shall be able to give a contrast ratio of 5:1 in normal “conference room” ambient illuminance (100 lux). To achieve this the luminous flux of black must not be higher than  $\Phi_{black/max/office}$

$$\Phi_{black / max / office} \leq \frac{\Phi_{white / measured} - 400 \times A_{max / office}}{5}$$

Video projectors shall be able to give a contrast ratio of 10:1 in normal “video room” ambient illuminance (20 lux). To achieve this the luminous flux of black must not be higher than  $\Phi_{black/max/video}$

$$\Phi_{black / max / video} \leq \frac{\Phi_{white / measured} - 180 \times A_{max / video}}{40}$$

- $\Phi_{white/measured}$  and  $A_{max}$  can be collected from A.2.1.1.

#### Applicability

All front screen projectors with fixed resolution.

#### Test procedure

See B.2.1.2

#### References

3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 30.

#### Mandate:

Office projectors shall be able to give a contrast ratio of 5:1 for the “TCO Image size” in normal “conference room” ambient illuminance (100 lux).

Video projectors shall be able to give a contrast ratio of 10:1 for the “TCO Image size” in normal “video room” ambient illuminance (20 lux).

The following information shall be submitted with the application to TCO Development:

A copy of a test report from a test laboratory approved by TCO development

### A.2.1.3 Light flux uniformity

#### Background

Image quality e.g. the identification of individual letters, could be badly affected by non-uniform image illuminance. When poor image illuminance uniformity is visible, it can locally affect the contrast and consequently the legibility of information on the projector. The areas of deviating image illuminance can have different sizes and cause varying edge sharpness.

#### Definition

Light flux uniformity is the capability of the projector to maintain the same illuminance level over the whole projected screen area. It is given as a ratio according to:

$$\frac{E_{\max}}{E_{\min}}$$

- $E_{\max}$  is the maximum illuminance of measuring location 1 to 9
- $E_{\min}$  is the minimum illuminance of measuring location 1 to 9

#### Applicability

All front screen projectors with fixed resolution.

#### Test procedure

See B.2.1.3.

#### References

3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14.

#### Mandate:

The ratio between the highest and lowest illuminance across the projected image shall be:

$$\frac{E_{\max}}{E_{\min}} \leq 1.55$$

The following information shall be submitted with the application to TCO Development:

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

## A.2.2 Image detail characteristics

### A.2.2.1 Native display resolution requirement

#### Background

Image quality is negatively affected by a low fill factor, visible “jaggies”, poor rendering of details, etc. All of these parameters are related to the native resolution of the projector. For resolution characteristics, it is important to take the viewing distance into account.

The necessary resolution to avoid a low fill factor resulting in jaggies poor rendering of details, etc is dependent on the viewing distance. If the viewing distance is larger, a lower fill factor (resolution) can be acceptable.

For most TCO Image sizes a viewing distance of 1.5 x the diagonal is defined for the first row of viewers.

However, for very small TCO Image Sizes (e.g. presented by pico projectors) it is likely that the first row of viewer is slightly further away than 1.5 x the diagonal. This means that a lower resolution can be accepted for small TCO Image sizes. Because of this, the viewing distance in this TCO criteria document is defined for three different TCO Image Size spans.

#### Example

To achieve 30 pixels/degree for a 4:3 aspect ratio image with a viewing distance of 1.5 times the diagonal it is necessary to have XGA native resolution. In the same way it is necessary to have SVGA native resolution if the viewing distance is increased to 1.8 times the diagonal and VGA native resolution is acceptable if the viewing distance is increased to 2.2 times the diagonal.

This means that if the intended use is to project 4:3 images of 0.5m<sup>2</sup> it is enough with VGA native resolution. If the intended use is to project larger images than 1.5m<sup>2</sup> it is necessary with XGA resolution.

For other aspect ratios the minimum accepted resolution must be calculated according to the formulas in B.2.2.1.

#### Definition

A pixel is the smallest addressable imaging element of the digital picture capable of reproducing a full range of luminance and colours.

The native resolution is the actual, true, physical resolution of the projector. The projector will never be able to display more actual pixels than it has on those panels or chips.

Viewing distance is the distance between the screen and first row of viewers.

#### Applicability

All front screen projectors with fixed resolution.

#### Test procedure

See B.2.2.1.

#### References

3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14.

**Mandate:**

The projected image shall have a *pixel* density  $\geq 30$  pixels/degree visual angle. To achieve this the necessary native resolution is dependent on the viewing distance.

For projectors with a declared TCO Image size  $\geq 1.5 \text{ m}^2$  ( $\approx 70''$  diagonal) the viewing distance is considered to be 1.5 x diagonal of the TCO Image Size. (This corresponds to at least XGA for 4:3).

For projectors with a declared TCO Image size  $< 1.5 \text{ m}^2$  ( $\approx 70''$  diagonal) the viewing distance is considered to be 1.8 x diagonal of the TCO Image Size. (This corresponds to at least SVGA for 4:3).

For projectors with a declared TCO Image size  $\leq 0.5 \text{ m}^2$  ( $\approx 40''$  diagonal) the viewing distance is considered to be 2.2 x diagonal of the TCO Image Size. (This corresponds to at least VGA for 4:3).

**The following information shall be submitted with the application to TCO Development:**

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

## A.2.3 Colour characteristics

### A.2.3.1 Correlated colour temperature, CCT variation

#### Background

If the Projector is equipped with pre-set correlated colour temperature settings the user has the right to expect that the colour hue of the measured correlated colour temperature setting is close to the one indicated by the pre-set. This makes it possible to more accurately evaluate the colour of an image on the Projector compared to real scenes or prints.

Physical measurements of colour stimuli can only give an indication of the colour appearance in a practical situation. The colour of a frame, the spectral composition of the lighting, the colour of various areas in the visual field, and the complexity of brightness variations in the visual field all influence the colour appearance of a projector image.

The colour rendering of the projected image is very dependent on the screen used.

Normal daylight has a correlated colour temperature in the range 5000 – 10000 K. As an example, the daylight on a cloudy day at midday is about 6500K.

#### Definition

The correlated colour temperature CCT is the temperature of the Planckian radiator whose perceived colour most closely resembles that of a given (whitish) stimulus at the same brightness and under specified viewing conditions.

#### Applicability

All front screen projectors with fixed resolution.

#### Test procedure

See B.2.3.1.

#### References

5, 8, 10, 11, 13, 14, 15, 16, 17, 18, 9, 29, 21, 22, 23, 24, 25, 26 and 27.

#### Mandate:

The correlated colour temperature of the projected bright white image shall be in the range of 5000K to 10000K.

Each pre-set correlated colour temperature shall have a colour difference  $\Delta u'v' \leq 0.015$  when compared to CIE  $u'$  and  $v'$  chromaticity co-ordinates for corresponding correlated colour temperatures.

The following information shall be submitted with the application to TCO Development:

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

### A.2.3.2 Colour uniformity

#### Background

The human visual system is very sensitive to changes in colour hue in white and grey areas. Since the white or grey colour hues are the background on which most colours are judged, the white or grey areas are the reference colours of the image.

Patches of colour variation on an active white or grey image could reduce the contrast locally, be disturbing and affect the legibility, colour rendering and colour differentiation.

The colour rendering of the projected image is very dependent on the screen used.

#### Definition

The colour uniformity of a projector is the capability to maintain the same colour in any part of the projected image area.

#### Applicability

All front screen projectors with fixed resolution.

#### Test procedure

See B.2.3.2.

#### References

5, 8, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 27, 30 and 31.

**Mandate:**

$\Delta u'v' \leq 0.015$  for the maximum colour deviation between measured active areas on the TCO Image Size that is intended to maintain the same colour.

**The following information shall be submitted with the application to TCO Development:**

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

### A.2.3.3 Colour gamut

#### Background

Accurate colour rendering is important when realistic colour images or colour presentations are to be presented using the projector. Poor colour rendering can lead to poor legibility and misinterpretation. The  $u'$  and  $v'$  chromaticity co-ordinates of the primary colours red (R), green (G) and blue (B) of the projected image shall aim at values given in international IEC, EBU and ITU standards. The  $u'$  and  $v'$  chromaticity co-ordinates of the primary colours R, G and B form a triangle in the CIE 1976 uniform chromaticity scale diagram. The larger the area of the triangle, the wider the range of colours the projector is capable of presenting.

The colour rendering of the projected image is very dependent on the screen used.

#### Definition

The colour characteristics of a projector are based on the visual appearance of the Projector primary colour stimuli, the R, G, B-stimuli.

#### Applicability

All front screen projectors with fixed resolution.

#### Test procedure

See B.2.3.3.

#### References

5, 10, 13, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28 and 29.

<b>Mandate:</b>						
The minimum colour triangle shall have the following coordinates at factory default setting:						
	Red		Green		Blue	
Co-ordinate	$u'$	$v'$	$u'$	$v'$	$u'$	$v'$
Requirement	$\geq 0.400$	$\geq 0.510$	$\leq 0.160$	$\geq 0.550$	$\geq 0.145$	$\leq 0.210$
<b>The following information shall be submitted with the application to TCO Development:</b>						
A copy of a test report from a test laboratory approved by TCO Development.						

### A.2.3.4 Colour greyscale linearity

#### Background

A well-tuned colour greyscale is the basis for good colour rendering of any imaging device. This is measured via steps in a greyscale in the test image. Each greyscale step shall have similar colour hues in order to simplify colour interpretation and to avoid confusion for the user. Only the luminance shall vary (within acceptable limits).

The colour rendering of the projected image is very dependent on the screen used

#### Definition

Colour greyscale linearity is the capability of the imaging device to maintain the same  $u'$ ,  $v'$  coordinates of a greyscale pattern at all tested greyscale levels, i.e. only the luminance shall change from one greyscale step to the next.

#### Applicability

All front screen projectors with fixed resolution.

#### Test procedure

See B.2.3.4.

#### References

5, 14, 15, 18, 20, 21, 24, 25 and 31.

Mandate:								
Greyscale	Maximum $\Delta u'v'$ difference							
	255	225	195	165	135	105	75	45
255	0							
225	0,015	0						
195	0,015	0,015	0					
165	0,020	0,020	0,020	0				
135	0,025	0,025	0,020	0,020	0			
105	0,025	0,025	0,025	0,025	0,020	0		
75	0,035	0,035	0,035	0,035	0,035	0,025	0	
45	0,035	0,035	0,035	0,035	0,035	0,035	0,035	0

The  $\Delta u'v' \leq$  the maximum allowed difference for each step according to table 2.3.4  
**The following information shall be submitted with the application to TCO Development:**  
 A copy of a test report from a test laboratory approved by TCO Development.

## A.2.4 Compatibility characteristics

### A.2.4.1 Video- and computer interfaces

#### Background

It has become more common for projectors to be used to show both video and computer signals. In the case of these projectors, it is important that suitable interfaces are available for the most common video- and computer signals, e.g. s-video, component, VGA, DVI and HDMI.

#### Definition

An *interface* is a system of standardised regulations for devices to handle electrical signals and physical connections. They are different for video and computer purposes.

#### Applicability

All front screen projectors with fixed resolution.

#### Test procedure

See B.2.4.1

#### References

10, 12 and 19.

#### Mandate:

A projector shall have at least one *interface* for video signals and one interface for computer signals following common standards.

**The following information shall be submitted with the application to TCO Development:**

A copy of a verification report from a test laboratory approved by TCO development

## A.4 Emissions

The amount of electrical equipment in our homes and workplaces is increasing tremendously, with a concomitant increase in the presence of electrical and magnetic fields. Users of IT equipment now have several nearby field sources placed on work surfaces that are constantly in use. The degree of exposure of users working with this equipment is increasing. The permanent relationship of the body to certain field sources, such as distance from projectors, displays, mobile telephone location next to the ear and the proximity of task-specific lighting are realities that exacerbate this trend.

When the first TCO label was introduced in 1992 one of the main interests was the requirements for electrical and magnetic fields. To this day scientists and experts are divided on the question if these fields pose health risks to humans.

The amount of fields surrounding us is increasing, so TCO is convinced that the criteria in our requirements are still highly relevant. TCO emission criteria are created to ensure that a TCO certified product's emissions are at technically achievable low levels and will not raise normal background levels at home or workplaces when the product is placed in these environments.

The product may be placed there persons, other than the user, are working in close proximity. This is why TCO criteria cover emissions around the product.

Many people find acoustic noise from projectors annoying and especially noise with high tones. To prevent annoyance TCO Development sets requirements that a declaration of the product's noise level shall accompany the product.

## A.4.1 Alternating electrical fields

### Background

Electrical alternating fields are created between objects that have different levels of electrical potential which change over time. When the potential changes in a periodic manner, an electrical alternating field is set up, with field strength and a frequency. A projector contains many sources of electrical alternating fields. The field characteristics depend on the actual electrical potential difference and the distance from the Projector.

Electrical device users are often concerned about a possible health risk arising from electrical alternating fields generated by equipment. Quite a large number of users also report various kinds of symptoms that cannot completely be attributed to the influence of other factors in their environment or to medical reasons.

The mandatory requirements are based on the ambition to reduce the electrical alternating fields to such a low level so as not to burden the work and home environment with unnecessary factors. The mandatory requirements shall not be regarded as hygienic limit values.

### Applicability

All front screen projectors with fixed resolution.

### Test procedure

See B.4.1.

**Mandate:**

**Band II: 2 kHz to 400 kHz,  $\leq 1.0$  V/m measured at 1 m around and topside of the projector.**

**The following information shall be submitted with the application to TCO Development:**

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

## A.4.2 Alternating magnetic fields

### Background

Magnetic alternating fields are created when an electrical alternating electrical current flows through a conductor. Like other electrical equipment, projectors are surrounded by magnetic alternating fields. These magnetic alternating fields are generated by different parts of the projector, e.g. power supply unit, voltage inverters and other electrical circuits. The field strength depends on the actual electric current and on the distance from the projector.

Electrical device users are often concerned about a possible health risk arising from electrical alternating fields generated by equipment. Quite a large number of users also report various kinds of symptoms that cannot completely be attributed to the influence of other factors in their environment or to medical reasons.

The mandatory requirements are based on the ambition to reduce the magnetic alternating fields to such a low level so as not to burden the work and home environment with unnecessary factors. The mandatory requirements shall not be regarded as hygienic limit values.

### Applicability

All front screen projectors with fixed resolution.

### Test procedure

See B.4.2.

**Mandate:**

**Band I: 5 Hz to 2 kHz,  $\leq 200$  nT, measured at 1 m around and topside of the Projector.**

**Band II: 2 kHz to 400 kHz,  $\leq 25$  nT measured at 1 m around and topside of the Projector.**

**The following information shall be submitted:**

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

## A.4.3 Acoustic noise

### Background

Acoustic noise from fans can be disturbing. To prevent such disturbance projectors shall cause a minimum of noise during usage. In this requirement the sound power level is required since this includes the total noise emitted from the projector and describes the noise characteristics of the projector in the most reliable way. Sound power level is the only value that can be used to compare different products.

### Definitions

*A-weighted sound power level* ( $L_{WA}$ ) in decibels: The sound power level of the projector, determined in accordance with ISO 7779:1999, with A weighting. The reference sound power is 1 pW.

*Declared A-weighted sound power level* ( $L_{WAd}$ ): in bels (B). Defined in accordance with ISO 9296:1988 3.2.5. NOTE: besides the unit bels (B) a declaration in decibels (dB) is common.

*Operating mode.* A condition in which the system and hard disk drive shall be operated in accordance with ISO 7779:1999 C.15.3.2 and C.9.3.2.

*Idling mode.* A condition in which the system shall be operated in accordance with ISO 7779:1999 C.15.3.1.

*Eco Mode.* A reduced power state that the projector enters on the user's initiative following the manufacturer's instructions. Eco mode is when the projector consumes less energy, the acoustic noise level is reduced and the possible life of lamp is increased than in on mode.

### Applicability

All front screen projectors with fixed resolution.

### Test procedure

See B.4.3.

### References

32, 33 and 34.

<b>Mandate:</b>		
<b>The declared <i>A-weighted sound power level</i> shall not exceed:</b>		
<b>TCO Image Size <math>A_{Max/office}</math></b>	<b><math>\leq 3 \text{ m}^2</math></b>	<b><math>\leq 6 \text{ m}^2</math></b>
<b>Declared sound power level <math>L_{WAd}</math></b>	<b><math>\leq 5.0 \text{ B(A)}</math></b>	<b><math>\leq 5.5 \text{ B(A)}</math></b>
<b>TCO Image Size <math>A_{Max/video}</math></b>	<b><math>\leq 6.6 \text{ m}^2</math></b>	<b><math>\leq 13.3 \text{ m}^2</math></b>
<b>Declared sound power level <math>L_{WAd}</math></b>	<b><math>\leq 5.0 \text{ B(A)}</math></b>	<b><math>\leq 5.5 \text{ B(A)}</math></b>
<p><b>The declared <i>A-weighted sound power level</i> (<math>L_{WAd}</math>) for eco mode according to ISO 7779:1999 shall be at least 0.2 B(A) lower than the declared <i>A-weighted sound power level</i> (<math>L_{WAd}</math>) for operating mode.</b></p> <p><b>TCO Development will present the declared <i>A-weighted sound power level</i> in the online database.</b></p> <p><b>The following information shall be submitted:</b></p> <p><b>A copy of a test report from a test laboratory approved by TCO Development.</b></p>		

We hereby guarantee that the above mandates are fulfilled.

.....  
 Product brand name and model/type

.....  
 Signature

.....  
 Name and title in block capitals

.....  
 Date

.....  
 Company

## A.5 Electrical safety

### A.5.1 Electrical safety

#### **Background**

Electrical safety concerns the electrical design of apparatus with respect to its electrical insulation and other arrangements that are intended to prevent accidents resulting from contact with live components, and the risk of fire or explosion as a result of electrical flash-over due to inadequate or faulty electrical insulation.

#### **Applicability**

All front screen projectors with fixed resolution.

#### **References**

35, 36 and 59.

#### **Mandate:**

**The Projector and the internal or external power supply/supplies shall be certified in accordance with EN/IEC 60 950-1, UL 60950 and/or EN/IEC 60065 (home usage).**

#### **The following information shall be submitted:**

**A copy of a CB or UL certificate or a national certificate from a CB member (NCB) shall be submitted.**

## A.6 Environmental requirements

The TCO Development label requirements combine a unique integrated balance of indoor and outdoor environmental issues. Achieving a good working environment should not be at the expense of the natural environment. This document details the environmental requirements of the TCO Certified label.

The Environmental requirements are divided into the following sections:

1. Organisation – requirements focusing on the production phase, environmental management and social responsibility.
2. Climate – energy consumption, the most important issue in the environmental impact of IT products.
3. Hazardous Substances – heavy metals, flame retardants, plastics.
4. Product Lifetime – factors to extend the life of the product.
5. Preparation for Recycling – factors to stimulate recycling.
6. Packaging – hazardous substance content and recycling.

Potential environmental effects are evident at each stage of the product life cycle. Due to the complexity of the production of ICT products, it is often most effective to refer to indirect requirements on the production such as requirements for an environmental management system. Should a more direct quality-assured system for manufacturing processes become possible, TCO would consider that option for future requirements. The environmental requirements TCO has focused on in this criteria document are those that we consider most relevant to the product group. They have also proved to be attainable in volume production and are verifiable. Future updates of the criteria will likely focus on hazardous substances, social responsibility and climate issues.

All requirements except section A.6.3 *Climate* shall be verified by sending the requested information to an eco-verifier at a test laboratory approved by TCO Development. The energy consumption requirements in section A.6.3 shall be tested at a test laboratory approved by TCO Development.

## A.6.1 Product description

### Background

The aim of this product description is to provide information about the product that is to be reviewed for compliance with the environmentally related requirements of Section A.6 and also for information collection.

### Definitions

*Marking plate /Marking label* is the label that contains the projectors electrical rating in terms of voltage, frequency, current and the manufacturers name, trademark or identification mark together with the manufacturers model or type reference. The label shall be in accordance with IEC 60 950:1 clause 1.7.1.

### Applicability

All front screen projectors with fixed resolution.

### Clarification

B.6.1

### References

2 and 36.

#### **Mandate:**

**A product declaration shall be provided for the Projector.**

**The following information shall be submitted to an approved eco-verifier:**

1. The declaration below, completed where applicable.
2. A copy of the *marking plate* for the Projector.

**The information submitted shall be signed by the responsible person at the applicant company.**

**The following information shall be submitted with the application to TCO Development:**

**A copy of a verification report from an eco-verifier approved by TCO Development and a copy of the marking label.**

**Declaration of a projector.**

Projectors	Information
Manufacturer	
Brand name	
Brand Owner	
Type/Model name	
Type of lamp	
Lamp manufacturer	
Type of panel*	
Panel manufacturer*	
Type of DMD chip**	

\* Only for LCD

\*\* Only for DLP

**TCO Certificate holder**.....

We hereby guarantee that the above mandate is fulfilled.

.....  
Product brand name and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company

## **A.6.2 Organisation**

### **A.6.2.1 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. A certified environmental management system includes external independent reviews.

#### **Definitions**

*Manufacturing plant* is the site where the final assembly of the product is taking place.

#### **Applicability**

The company or companies which manufacture the Projector.

#### **Clarification**

B.6.2.1

#### **References**

37 and 38.

**Mandate:**

Each *manufacturing plant* must be certified in accordance with ISO 14001, or EMAS registered. If the product is manufactured by a third party, it is this company that shall be certified or registered.

If the *manufacturing plant* does not have an ISO 14001 certificate or EMAS registration at the time of application, the *manufacturing plant* is given a 12-month grace period to obtain ISO14001 certification or EMAS registration.

**The following information shall be submitted to an approved eco-verifier:**

1. A document showing the names and addresses of the manufacturing plants.
2. Copy of the ISO 14001 certificate or EMAS registration or, when not available, an estimated date of certification/registration.
3. A written guarantee that the certificate/registration is valid and that the mandate above is fulfilled, signed by the responsible person at the applicant company.

**The following information shall be submitted with the application to TCO Development:**

A copy of a verification report from an eco-verifier approved by TCO Development.

We hereby guarantee that the above mandate is fulfilled.

.....  
Product brand name and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company

## **A.6.2.2 Social Responsibility**

### **Background**

Expectations for social and environmental performance are increasing from customers and organisations. An important step towards a sustainable business is control of the effects the business has on both the natural environment and the workforce, throughout the supply chain. TCO Development is therefore introducing a requirement aimed at the situation in the production facilities.

TCO Development is accepting several ways of demonstrating commitment to corporate social responsibility.

### **Definitions**

*Brand owner* is the company that owns the brand name visible on the product.

### **Applicability**

The *Brand owner*.

### **Clarification**

B.6.2.2

### **References**

54, 55 56 and 57.



## A.6.3 Climate

### A.6.3.1 Energy Consumption

#### Background

Energy efficient equipment contributes to a sustainable development. The energy consumption of projectors is related to the amount of light that is projected on a maximum screen size. The life of the lamp in the projector is limited but it can be extended if the eco mode is initiated and if the projector is handled according to specified instructions. When the projector is set in eco mode the light flux is reduced as is the noise level and energy consumption level. This criteria concerns the power consumption levels for On mode, Eco mode, Standby mode and Off mode. In order to be able to make a preferable product choice it is important that the end user is given information on energy levels in the different modes as well as the life of the lamp and how much it can be extended.

#### Definitions

##### *On Mode with lamp in normal operation*

A state when the projector is producing an image.

##### *Eco Mode*

A reduced power state that the projector enters on the user's initiative following the manufacturer's instructions. Eco mode is when the projector consumes less energy than in on mode, the acoustic noise level is reduced and the possible life of lamp is increased.

##### *Standby Mode*

The reduced power state that the projector is capable of entering automatically after a period of inactivity or by manual selection.

##### *Off Mode*

The power consumption level in the lowest power mode which cannot be switched off by the user and that may persist for an indefinite time when a projector is connected to the main electricity supply and used in accordance with the manufacturer's instruction.

#### Applicability

All front screen projectors with fixed resolution.

#### Test procedure

B.6.3.1

#### References

51, 52, 53, 60 and 61

**Mandate:**

For Class B products pursuant to Part 15 subpart B of the FCC Rules or IEC/EN 55022

1. The Projector shall be possible to set in an eco mode.

2. The following requirement levels for maximum power consumption in the following modes shall be fulfilled and verified through testing by a test laboratory approved by TCO Development:

**On Mode**

**Area Requirement level**

$A_{Max/office}$  ***On Mode (normal operation)***

$\leq 3 \text{ m}^2$   $\leq 260 \text{ W}$

$\leq 6 \text{ m}^2$   $\leq 310 \text{ W}$

$> 6 \text{ m}^2$   $\leq 310+150*(A_{max}- 6) \text{ W}$

Projectors with a throw ratio of 0.82 and less 30% more energy consumption is allowed.

$\leq 3 \text{ m}^2$   $\leq 260 \times 1.30\text{W}$

$\leq 6 \text{ m}^2$   $\leq 310 \times 1.30\text{W}$

$> 6 \text{ m}^2$   $\leq (310+150*(A_{max}- 6)) \times 1.30\text{W}$

$A_{Max/video}$  ***On Mode (normal operation)***

$\leq 6.6 \text{ m}^2$   $\leq 260 \text{ W}$

$\leq 13.3 \text{ m}^2$   $\leq 310 \text{ W}$

$> 13.3 \text{ m}^2$   $\leq 310+150*(A_{max}- 13.3) \text{ W}$

Projectors with a throw ratio of 0.82 and less 30% more energy consumption is allowed.

$\leq 6.6 \text{ m}^2$   $\leq 260 \times 1.30\text{W}$

$\leq 13.3 \text{ m}^2$   $\leq 310 \times 1.30\text{W}$

$> 13.3 \text{ m}^2$   $\leq (310+150*(A_{max}- 13.3)) \times 1.30\text{W}$

*Eco mode*  $\leq 90\%$  of the measured *On Mode (normal operation)* value.

**Standby Mode  $\leq 1\text{W}$**

**Off Mode  $\leq 1\text{W}$**

There shall be an adequate description explaining how the projector is brought into its energy mode(s) and how this will be indicated on the projector. The description shall be signed by the responsible person at the applicant company and submitted to the test laboratory.

3. It shall be possible to set the projector to automatically enter Standby mode, after a specified time period when the video or computer interface is disconnected.

4. Energy consumption levels in all modes shall be declared in the user manual and product specification. There shall be an adequate description explaining how the projector is brought into its energy mode(s) and how this will be indicated on the projector.

For Class A products pursuant to Part 15 subpart B of the FCC Rules or IEC/EN 55022

*TCO Development reserves the right to introduce new energy levels to allow certification of class A projectors in TCO Certified Projectors 1.1.*

**The following information shall be submitted with the application to TCO Development:**

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

## A.6.4 Environmentally hazardous substances

### A.6.4.1 Cadmium (Cd), mercury (Hg), Lead (Pb) and hexavalent chromium (CrVI)

#### Background

The effects of the listed substances are well documented as environmental hazardous substances. EU regulated these substances in the RoHS directive (2002/95/EC).

#### Applicability

All front screen projectors with fixed resolution.

#### Clarification

B.6.4.1

#### References

39, 40 and 41.

#### Mandate:

1. The Projector shall not contain cadmium, mercury, lead and hexavalent chromium. The requirement applies to components, parts, and raw materials in all assemblies and sub-assemblies of the product e.g. paint, surface treatment, plastics and electronic components. For lamps containing mercury a declaration applies.
2. The total amount of mercury in the lamp(s) shall be declared in the "Mercury declaration template" below.

#### The following information shall be submitted to an approved eco-verifier:

1. A written guarantee that the mandate above is fulfilled. The guarantee shall be signed by the responsible person at the applicant company.
2. A declared "Mercury declaration template" below.

#### The following information shall be submitted with the application to TCO Development:

A copy of a verification report from an eco-verifier approved by TCO Development.

We hereby guarantee that the above mandate is fulfilled.

.....  
Product brand name and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company

**Mercury declaration template**

Projector brand name:.....

Projector type/model name:.....

Projector technology .....

Type of lamp: .....

Mercury lamp supplier:	Lamp ID code:	Max. mg Hg/lamp:

We hereby guarantee that the above mandate is fulfilled.

.....  
Product brand name and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company

## **A.6.4.2 Halogenated substances**

### **Background**

Brominated and chlorinated flame retardants and other halogenated substances are often persistent, can bioaccumulate in living organisms and have been detected in flora and fauna.

A series of international elimination activities in respect to brominated and chlorinated flame retardants is currently in progress within several national and international bodies, e.g EU, OECD, North Sea Conference.

### **Definitions**

*Plastic parts* are parts made mainly of plastics, e.g. the housing. Parts containing other materials in any significant amounts, e.g. cables with metal conductors, are not included in the definition.

*Printed wiring board laminate* is a printed board that provides point-to-point connections but not printed components in a predetermined configuration on a common base.

### **Applicability**

All front screen projectors with fixed resolution.

### **Clarification**

B.6.4.2

### **References**

44

**Mandate:**

1. *Plastic parts* weighing more than 25 grams shall not contain flame retardants that contain organically bound bromine or chlorine. The requirement applies to plastic parts in all assemblies and sub-assemblies. Exempted are *printed wiring board laminates*, electronic components and all kinds of cable insulation.

2. The Projector shall not contain PBB and PBDE, including DecaBDE. The requirements apply to components, parts and raw materials in all assemblies and sub-assemblies of the product e.g. batteries, paint, surface treatment, plastics and electronic components.

**The following information shall be submitted to an approved eco-verifier:**

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

**The following information shall be submitted with the application to TCO Development:**

A copy of a verification report from an eco-verifier approved by TCO Development.

We hereby guarantee that the above mandate is fulfilled.

.....  
Product brand name and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company

### **A.6.4.3 Non-halogenated substances**

#### **Background**

Recently it has been common practice to replace hazardous substances with new substances with unknown effects. This is one important focus of the new European chemical legislation, REACH. This mandate focuses on ensuring that the phase out of halogenated flame retardants doesn't risk a shift towards substances with unknown effects.

#### **Definitions**

*Plastic parts* are parts made mainly of plastics, e.g. the housing. Parts containing other materials in any significant amounts, e.g. cables with metal conductors, are not included in the definition.

*Printed wiring board laminate* is a printed board that provides point-to-point connections but not printed components in a predetermined configuration on a common base.

#### **Applicability**

All front screen projectors with fixed resolution.

#### **Clarification**

B.6.4.3

#### **References**

45, 46 and 47.

**Mandate:**

Flame retardants used in plastic parts weighing more than 25 grams shall not have been assigned one or more of the following risk phrases at the time of application (according to EU Directive 67/548/EEG (/EU Directive 1272/2008)):

R40(/H351) (limited evidence of a carcinogenic effect)

R45(/H350) (may cause cancer)

R46(/H340) (may cause heritable genetic damage)

R48(/H372) (danger of serious damage to health by prolonged exposure )

R50/53(/H400 and H410) (very toxic to aquatic organisms / may cause long-term adverse effects in the aquatic environment)

R60(/H360F) (may impair fertility)

R61(/H360D) (may cause harm to the unborn child)

Exempted are *printed wiring board laminates*, electronic components and all kinds of cable insulation.

**The following information shall be submitted to an approved eco-verifier:**

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

**The following information shall be submitted with the application to TCO Development:**

A copy of a verification report from an eco-verifier approved by TCO Development.

We hereby guarantee that the above mandate is fulfilled.

.....  
Product brand name and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company

#### **A.6.4.4 Plastics with chlorine and bromine as part of the polymer**

##### **Background**

PVC is by far the most common halogen containing plastic. There are however other plastics that contain chlorine or bromine in the plastic itself. As the requirement concerning permissible flame retardants tightens, the risk increases that halogenated plastics will become more common. TCO Development sees a future environmental risk with such a development.

PVC is a much-debated plastic that can pose environmental problems in most parts of its life cycle. The magnitude of the environmental problems relating to PVC differs depending on the environmental status of a particular manufacturing facility and the uses of additives. At present there are very limited possibilities to distinguish between harmful and less harmful production facilities for PVC.

##### **Definitions**

*Plastic parts* are parts made mainly of plastics, e.g. the housing. Parts containing other materials in any significant amounts, e.g. cables with metal conductors, are not included in the definition.

*Printed wiring board laminate* is a printed board that provides point-to-point connections but not printed components in a predetermined configuration on a common base.

##### **Applicability**

All front screen projectors with fixed resolution.

##### **Clarification**

B.6.4.4

##### **References**

47 and 51.

**Mandate:**

**Plastic parts** in the projector weighing more than 25 grams shall not contain chlorine or bromine as a part of the polymer.

Note that *printed wiring board laminates*, and all kinds of internal and external cable insulation are not considered to be part of *plastic parts* and are therefore not included in the mandate.

**The following information shall be submitted to an approved eco-verifier:**

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

**The following information shall be submitted with the application to TCO Development:**

A copy of a verification report from an eco-verifier approved by TCO Development.

We hereby guarantee that the above mandate is fulfilled.

.....  
Product brand name and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company

#### **A.6.4.5 Information regarding plastics and flame retarding agents**

##### **Background**

This requirement is intended to give information about the plastics and flame retarding agents in the product to be reviewed for compliance with the environment requirements in this criteria document.

##### **Definitions**

*Plastic parts* are parts made mainly of plastics, e.g. the housing. Parts containing other materials in any significant amounts, e.g. cables with their metal conductors, are not included in the requirements.

*Printed wiring board laminate* is a printed board that provides point-to-point connections but not printed components in a predetermined arrangement on a common base.

##### **Applicability**

All front screen projectors with fixed resolution.

##### **References**

42, 43, 44 and 50.

**Mandate:**

The material specifications shall be provided for *plastic parts* and *printed wiring board laminates* weighing more than 25 grams and which have flame retardant concentrations above 1% by weight, in line with ISO 1043-4.

**The following information shall be submitted to an approved eco-verifier:**

The table below shall be completed and the guarantee signed by the responsible person at the applicant company.

Manufacturers of plastic materials who consider such information confidential may submit the information to an eco-verifier approved by TCO Development.

**The following information shall be submitted with the application to TCO Development:**

A copy of a verification report from an eco-verifier approved by TCO Development.

Plastic part and PWB	Weight in grams	Type of plastic	Plastic manufacturer name	Plastic model name	Flame retardant type	Flame retardant CAS number*)	Plastic label code **)

\*) Chemical Abstract Service number [www.cas.org](http://www.cas.org)

\*\*) Labelling according to ISO 11469

We hereby guarantee that the above mandate is fulfilled.

.....  
Product brand name and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company



## A.6.6 Preparation for Recycling

### A.6.6.1 Material coding of plastics

#### **Background**

Recycling of used electronic products is an important environmental issue. Material recycling and reuse are the best options from an environmental point of view. With material coding there is a better possibility for plastics to be recycled and used in new IT equipment.

#### **Definitions**

*Plastic parts* are parts made mainly of plastics, e.g. the housing. Parts containing other materials in any significant amounts, e.g. cables with their metal conductors, are not included in the requirements.

*Printed wiring board laminate* is a printed board that provides point-to-point connections but not printed components in a predetermined arrangement on a common base.

#### **Applicability**

All front screen projectors with fixed resolution.

#### **Clarification**

B.6.6.1

#### **References**

47, 49 and 50.

**Mandate:**  
 Plastic parts weighing more than 25 grams shall be material coded in accordance with ISO 11469 and ISO 1043-1, -2, -3, -4. Such parts shall be listed in the table at Section A.6.4.5.  
 Exempted are *printed wiring board laminates*.

**The following information shall be submitted to an approved eco-verifier:**  
 A written guarantee that the above mandate is fulfilled. The guarantee shall be signed by the responsible person at the applicant company.

**The following information shall be submitted with the application to TCO Development:**  
 A copy of a verification report from an eco-verifier approved by TCO Development.

We hereby guarantee that the above mandate is fulfilled.

.....  
Product brand name and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company

## A 6.6.2 Variety of plastics

### Background

Recycling of used electronic products is an important environmental issue. Material recycling and reuse are the best options from an environmental point of view. Therefore TCO Development presents requirements that facilitate material recycling.

### Applicability

All front screen projectors with fixed resolution.

### Clarification

B.6.6.2

### Definitions

Types of *plastic material* (using the abbreviation terms, symbols and concepts for plastics in ISO 1043 Part 1, 2, 3, and 4) are:

- Basic polymers
- Mixtures of polymers
- Basic polymers with flame retardants
- Mixtures of polymers with flame retardants

### References

47, 48 and 49.

**Mandate:**  
 No more than two different types of *plastic materials* are accepted for parts weighing more than 100 grams in each product unit.

**The following information shall be submitted to an approved eco-verifier:**  
 A written guarantee that the above mandate is fulfilled. The guarantee shall be signed by a responsible person at the applicant company.

**The following information shall be submitted with the application to TCO Development:**  
 A copy of a verification report from an eco-verifier approved by TCO Development.

We hereby guarantee that the above mandate is fulfilled.

.....  
 Product brand name and model name

.....  
 Signature

.....  
 Name and title in block capitals

.....  
 Date

.....  
 Company

### A.6.6.3 Moulded-in metal parts and metallization of plastic housing

#### Background

Recycling of used electronic products is an important environmental issue. Material recycling and reuse are the best options from an environmental point of view. Therefore TCO Development presents requirements that facilitate material recycling.

#### Definition

*Metallization* is a surface deposition process whereby a metallic layer is applied to the surface of a completed shaped plastic part. Examples of metallization processes are chemical coating and ion vapour deposition.

#### Applicability

All front screen projectors with fixed resolution.

#### Clarification

B.6.6.3

#### Mandate:

1. There shall be no internal or external *metallization* of the Projector outer plastic casing.
2. Moulded-in or glued metal parts are not accepted.

#### The following information shall be submitted to an approved eco-verifier:

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

#### The following information shall be submitted with the application to TCO Development:

A copy of a verification report from an eco-verifier approved by TCO Development.

We hereby guarantee that the above mandate is fulfilled.

.....  
Product brand name and model name

.....  
Signature

.....  
Name and title in block capitals

.....  
Date

.....  
Company

#### A.6.6.4 Take back system

##### **Background**

The amount of electronic waste in the world today is enormous and a growing environmental problem. It is important that manufacturers provide mechanisms to take back their equipment at end-of-life under the principle of individual producer responsibility wherein each producer must be financially responsible for managing its own brand products at end-of-life. Currently much electronic waste is being exported to developing countries where it is managed unsustainably and disproportionately burdens developing countries with this global environmental burden. The Basel Convention and its decisions govern the export of many types of electronic waste. However not all countries have properly implemented these decisions. With this mandate TCO Development aims to put more influence into spreading better electronic waste management practice to more countries.

##### **Definition**

*Brand owner* is the company that owns the brand name visible on the product.

*Take back system* is a system that makes sure that the customer can return used products to be recycled. The system can be with or without a fee.

*Environmentally acceptable recycling methods* are:

- Product and component reuse
- Material recycling with secured handling of hazardous chemicals and heavy metals
- Pollution-controlled energy recovery of parts of the Projector

##### **Applicability**

All front screen projectors with fixed resolution.

##### **Clarification**

B.6.6.4

##### **References**

50.

**Mandate:**  
 The *brand owner* (or its representative, associated company or affiliate) shall offer their customers the option to return used products for *environmentally acceptable recycling methods* in at least one market where the product is sold and where electronics take back regulation is not in practice at the date of application.

**The following information shall be submitted to an approved eco-verifier:**  
 The information stated in the list below shall be submitted and the guarantee signed by the responsible person at the *brand owner* company.

**The following information shall be submitted with the application to TCO Development:**  
 A copy of a verification report from an eco-verifier approved by TCO Development.

The requirement can be fulfilled by one of three options (to be verified):

- 1. Product only sold on markets with WEEE legislation or similar
- 2. World-wide product take back\*
- 3. One additional market lacking WEEE legislation where product take back is offered\*

Name of market.....

\*The brand owner shall also submit a short description, to an approved eco-verifier, of the take back system or reference to the representative, associated company or affiliate taking care of the take-back system

We hereby guarantee that the above mandate is fulfilled.

Product brand name	Model name(s) or "All products"
--------------------	---------------------------------

Signature	Name and title in block capitals
-----------	----------------------------------

Date (Declaration valid 1 year from date)	Brand Owner Company
---	---------------------





# References

International standard organisations referred to in the reference list below and their Web sites.

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2. ISO/IEC 21118 Information to be included in specification sheets – Data projectors.
3. IEC 61947-1:2002 Electronic projection – Measurement and documentation of key performance criteria – Part 1: Fixed resolution projectors
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5. Brennesholtz, M. S., Stupp, E. H., (2008) "Projection Displays, Second Edition" John Wiley & Sons Ltd. Chapter 2.
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7. Le Grand, Y. (1957). Light, colour and vision. Chapman and Hall, p. 119
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9. ISO/IEC 21118:2005 Information to be included in specification sheets — Data projectors
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11. ITU, International Telecommunication Union [www.itu.int/home/index.html](http://www.itu.int/home/index.html)
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21. ISO TC130 WD 12646 p. 5 Section 4.7 Chromaticity and luminance of the white and black points and tracking.
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28. E.B.U. Standard for chromaticity tolerances for studio monitors Tech. 3213-E August 1975.
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37. EMAS EU regulation no 761/2001 concerning the voluntary participation of industrial companies in the Union's environmental control and review structure.
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41. Proposal for an EU Directive 2003/0282 (COD) on batteries and accumulators and spent batteries and accumulators
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50. EU Directive 2002/96/EC on waste electrical and electronic equipment (WEEE)
51. Energy Star, EPA – <http://www.energystar.gov>
52. EU regulation 1275:2008
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58. Directive 94/62/EC on packaging and packaging waste.
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## Miscellaneous references

- ISO2813:1994.
- DIN 67 530.
- ISO 3664:1999, Viewing conditions for graphic technology and photography, p. 9 Uniformity of screen luminance.
- ISO 3664:1999, Viewing conditions for graphic technology and photography, p. 5, 4.2.4 Surround and backing for reflection viewing, Note 1 p. 8.
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- EC Directive 90/270/EEC
- EU Directive (76/769/EEC) on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations
- HELCOM article 5, annex I
- JPCA-ES-01
- IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits, the Institute for Interconnecting and Packaging Electronic Circuits (IPC).
- IEC 61947-1:2002 Electronic projection – Measurement and documentation of key performance criteria – Part 1: Fixed resolution projectors
- IEC 61947-2:2001 Electronic projection – Measurement and documentation of key performance criteria – Part 2: Variable resolution projectors
- CIE, Commission Internationale de l'Eclairage, International Commission on Illumination, [www.cie.co.at/cie/](http://www.cie.co.at/cie/)
- DIN, Deutsches Institut für Normung e. V., [www2.din.de](http://www2.din.de)
- EBU, European Broadcasting Union, [http://www.ebu.ch/tech\\_info.html](http://www.ebu.ch/tech_info.html)
- IEC, International Electrotechnical Commission, [www.iec.ch](http://www.iec.ch)
- ISO, International Organization for Standardization, <http://www.iso.org/>

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- SMTPE, Society of Motion Picture Television Engineers, [www.smtpe.org](http://www.smtpe.org)
- VESA, Video Electronics Standards Association, [www.vesa.org](http://www.vesa.org)

## **B Test Methods and clarifications**

- The following definitions, test conditions, requested specifications from clients, and other information apply to the test methods described in this document.
- Test results are valid only for the presentation form(s) and configuration(s) tested.

### **B.0 General test conditions**

#### **B.0.1 Definition of a test object**

- Test objects covered by this document are front screen projectors with fixed resolution.
- A test object with all necessary information for its operation shall be delivered to the test laboratory in test ready condition including any required accessories that are delivered as part of the product to the end user. All necessary information about how to operate and adjust the test object shall be provided.
- The performance of the test object shall in all aspects be fully in accordance with the performance of the final product.
- The client shall inform the test laboratory if any image enhancement software or hardware is used for the test object and which input ports that have image enhancement.

#### **B.0.2 Required test object information**

- The client shall supply:
- Name(s), type designation(s) and manufacturer for all different exchangeable parts of the test object
- Photo/copy of the type plate (rated voltage, rated frequency, rated current, rated power consumption)
- Information of type of projection system, Projection lamp, Lifetime of projection lamp and information on different power modes
- Lens, model/type name, effective focal length, zoom. Throwing distance (equation or graph which show the relationship between the throwing distance  $d$  [m] and the TCO Image Size [m<sup>2</sup>])
- Displayable formats including the native resolution and aspect ratio
- Video and computer compatibilities
- Vertical frequency band width, horizontal frequency band width, video band width (max. pixel rate)
- Declared sound power level
- User's Manual

### **B.0.3 Conditions for the equipment under test**

- The projector being tested shall be physically prepared for testing and shall be warmed up until it is fully stabilised, but at least for 30 minutes and after lamp aging (see B.0.6).
- The projector lens surface shall be clean when tested.
- The projector shall be tested under nominal conditions of input voltage, current, etc. If sold on different markets, one setup shall be chosen by the manufacturer which shall represent the conditions of the country in where it will be sold the most.
- The projector shall be connected to a computer, if the manufacturer does not specify a different presentation host. Within the computer a graphics board of high quality, which offers a typical output voltage on RGB of  $0.7 \text{ V} \pm 10\%$  shall be used.
- When possible testing shall be done with the digital signal input. In the case of several digital inputs use the most common signal input specified by the manufacturer. The same signal input shall be used for testing of all parameters. The signal input used shall be specified in the test report.
- A video generator shall not be used to drive the projector

### **B.0.4 Projector alignment for testing**

- The distance between front lens of the projector and the measurement plane (screen), the throwing distance, should be according to manufacturer's specifications.
- The measuring plane shall be perpendicular to the optical axis of the projector lens, if not specified otherwise in the test method. The measuring plane shall be defined as the focus plan at the centre of the projected image.
- The image shall be focused and the main focus shall be set for the centre of the image. Use a test image containing both horizontal and vertical black and white details of different sizes. If no change of focus arises during the test period, no refocusing should be necessary between the different tests.

### **B.0.5 Instruments used for testing**

- All instruments used for testing of a projector shall be of good quality and validated by a recent test certificate from a certified testing laboratory. Any necessary instrument calibration shall be done before the tests are performed. Calibrations shall be traceable to national standards.

- The surface of the sensor of the illuminance meter shall be parallel to the screen surface. Make sure not to shadow the illuminance meter or get in front of it so that you reflect a bunch of light into the illuminance meter.

## **B.0.6 Settings of the Projector**

- The Projector resolution shall be set to the native resolution.
- The projector shall be put in its factory default mode. The CCT of the default mode shall be used. All tests shall be performed with the projector settings set in the factory default mode if not stated otherwise in the test methods.
- Testing may be done with a preset instead of the default mode if the user is informed in the user manual which preset is used for TCO compliance. In this case this preset shall be treated as the default mode in the criteria document and noted in the test report.
- The focal length of the lens of the projector shall be set to the minimum, if not specified otherwise by the manufacturer. The focal length used for testing shall be specified in the test report.
- Measurements shall be carried out between the 48 and 64 working hours of the projection lamp as this is necessary to get realistic and repeatable results.
- All measurements shall be taken with no adjustments made between the measurements, if not specified otherwise in the test method.
- The colour depth of the source signal shall be 24 bits (8 bits per colour channel) or more.

## **B.0.7 Test report**

- The test results are valid only for the presentation form(s) and configuration(s) tested. If other configurations are accepted by the laboratory based on the results of the tested ones it shall be clearly specified in the test report that these configurations have not been tested.
- Any changes in the test methods shall be stated in the test report.
- The working hours of the lamp when the testing started shall be declared in the test report.
- The manufacturer, brand name, model/type name, lens and lamp used and serial number, if available shall be stated in the test report.
- List of all exchangeable parts used during the test.
- The mode(s) (i. e. horizontal and vertical scan frequency and resolution) used during the test shall be stated in the test report.
- The supply voltage and frequency used during the test shall be stated in the test report together with the type of Projector, type of AC adapter, definition of and whether the product is CLASS I or CLASS III.
- The degree of uncertainty for each given measurement result shall be stated in the test report.

## **B.1 General information**

### **B.1.1 TCO Document**

The TCO document shall accompany the product as provided by TCO Development. No editorial changes without TCO's consent are accepted. The TCO Document is available at the TCO Development web site [www.tcodevelopment.com](http://www.tcodevelopment.com).

If the TCO Document is part of a User's Manual or is provided as an electronic file the TCO Document must be separated from other text portions so that it is obvious that the TCO Document is not accountable for the content of the other texts.

The brand name owner may post the TCO Document on its web site, e.g. by showing TCO logos or icons that redirect the visitor by links to the TCO Document

If the product that is to be TCO labelled is branded differently from the applicant name, the applicant company signing the guarantee shall be sure that the brand name holder agrees with the requirement.

## B.2 Visual ergonomics

### B.2.0 General test conditions for visual ergonomics

#### B.2.0.1 Basic test requirements

As described in section B.0.

#### B.2.0.2 Photometric laboratory general requirements

Photometric measurements shall be performed under darkroom conditions. This means that measurement data shall not be affected by direct light from sources or light reflected from interiors, equipment, clothes etc.

(All calculations shall correspond to a projector screen with a gain=1.0.)

#### B.2.0.3 Power supply and test room climate requirements for testing

AC mains voltage*	230 VAC RMS, tolerance $\leq 1 \%$
AC mains frequency*	50 Hz, tolerance $\leq 2 \%$
Test room temperature	$23 \pm 4 \text{ }^\circ\text{C}$
Humidity	10-85 % RH (non condensing)

\* – or other voltage and frequency combination specified by the client.

#### B.2.0.4 Photometric and spectrometric measurements

Several instruments are to be used when carrying out measurements for visual ergonomics. All instruments shall be recently calibrated and carry a calibration certificate from a certified testing laboratory.

The following instrument types shall be used for testing:

**Illuminance meter.** An illuminance meter shall have a  $V(\lambda)$ -sensitivity (Requirements for luminance meters are covered by CIE Publication 69 (1987). Illuminance meters of CIE Class A (with a combined performance characteristic  $\leq 5 \%$  shall be used.). The illuminance meter must incorporate an appropriate time constant of integration in order to ensure averaging of the pulsation of the light emitted by projectors. Use a cosine corrected illuminance meter. The illuminance meter shall be calibrated both at very low and high illuminance levels.

**Colour neutral reflectance standard.** The colour neutral reflectance standard shall have a reflectance factor of  $0.95 \pm 0.05$  and vary  $\leq \pm 0.01$  within the wavelength interval 380 nm till 780 nm and be calibrated to the angles involved. This shall only be used for colour measurements as the reflectance standard may be unreliable for luminance measurements at certain angles.

**Spectro-radiometer.** An instrument for the measurement of radiant flux as a function of wavelength shall be used. A spectro-radiometer for the measurement of light and colour is normally equipped with a microprocessor that makes it possible to obtain luminance and colour co-ordinates directly from raw measurement data. A spectro-radiometer can replace the luminance meter when suitable. The wavelength resolution shall be at least 4nm for accurate colour measurements. The sensitivity shall be independent of the polarization of the measured light (often referred to as  $f_8$  error).

The relevant CIE material – conversion formulae and tabulated data for  $u'_{CCT}$  and  $v'_{CCT}$  – can also be found on the TCO Development Web site, [www.tcodevelopment.com](http://www.tcodevelopment.com). A computer program based on the given equations can be supplied by TCO Development.

### **B.2.0.5 Stray light**

Stray light may cause errors which can negatively affect measurement of illuminance and chromaticity coordinates. It is therefore necessary to make an evaluation of stray light influence for the different measurement procedures described in this document.

If it is verified that stray light from outside the projector affect the measurement result it is necessary to take actions to eliminate the source of error. One possible way to solve the problem is to use a lab with low reflections from walls, floor and ceiling or a much larger room (*an infinitely large room with white walls is black*).

The lightproof room shall fulfil the requirements given by IEC 61947-1 clause 4: Less than 1% of the light on the screen where a white image is projected shall be from any source other than direct light from the projector.

For contrast ratio measurement, less than 10 % of the light on the screen where a black image is projected shall be from any source other than direct light from the projector.

### **B.2.0.6 Overall uncertainty**

The overall uncertainty of the test laboratory shall be calculated for each measurement procedure in this document and presented in the test report. The uncertainty shall be within the required levels for each criterion. All measurement uncertainties claimed for used instruments shall be referred to traceable calibration reports.

## B.2.1 Light flux characteristics

### B.2.1.1 Luminous flux

#### B.2.1.1.1 Preparation of the projector for testing

- All necessary preparations described in B.0 and B.2.0 shall be done.
- For determination of the light flux the default test image is a full-screen with colour “bright white” (RGB setting of 255, 255, 255).

#### B.2.1.1.2 Equipment

Illuminance meter.

#### B.2.1.1.3 Test method for the light flux

The illuminance is measured at location 1 to 9 according to the following figure.

The optical axis of the illuminance meter shall be perpendicular to the surface of the test image and parallel of the optical axis of the projector.

The chosen test-area of the projected image  $A_{test}$  in m<sup>2</sup> is measured in dark room conditions.

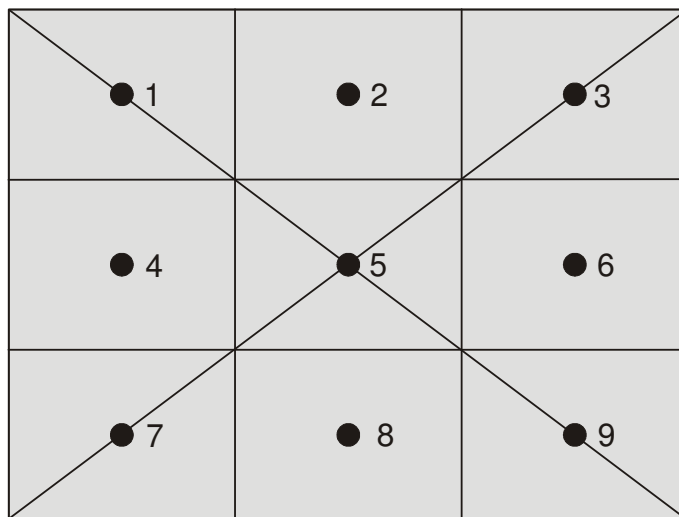


Figure B.2.1.1. Measurement locations.

Measuring point	Horizontally from left edge in screen widths	Vertically from upper edge in screen heights	Comments
Point 1	1/6	1/6	
Point 2	3/6	1/6	
Point 3	5/6	1/6	
Point 4	1/6	3/6	
Point 5	3/6	3/6	Screen centre point
Point 6	5/6	3/6	
Point 7	1/6	5/6	
Point 8	3/6	5/6	
Point 9	5/6	5/6	

**Table B.2.1.1****B.2.1.1.4 Test evaluation for the light flux**

The measured light flux is determined by the following equation:

$$\Phi_{\text{white/measured}} = \frac{A_{\text{test}}}{9} \times E_{\text{white/measured}} = \frac{A_{\text{test}} \times \sum_{n=1}^9 E_{\text{white/measured}_n}}{9}$$

Where:

$A_{\text{test}}$  is the chosen test-area of the projected white screen in m<sup>2</sup> in a dark room.

$E_{\text{white/measured}}$  is the illuminance of white (255, 255, 255) in lux at location n = 1 to 9.

$\Phi_{\text{white/measured}}$  is the luminous flux in lumen (according to IEC 61947-1).

**B.2.1.1.5 Test evaluation for the TCO Image Size****Office projectors**

For **office projectors** (projectors intended to be used in illuminated rooms) the declared TCO Image Size in m<sup>2</sup> shall be calculated according to the following formula:

$$A_{\text{max/office}} = \frac{\Phi_{\text{white/measured}}}{L_{\text{white/office}} \times \pi + E_{\text{amb/office}}} = \frac{\Phi_{\text{white/measured}}}{170 \times \pi + 100}$$

Where:

$A_{\text{max/office}}$  = TCO Image Size for office projectors in m<sup>2</sup>.

$L_{\text{white/office}}$  = Minimum luminance of white screen in a dark room in cd/m<sup>2</sup> for office projectors according to reference 4.

$E_{\text{amb/office}}$  = ambient illuminance falling on the projection screen for office projectors according to reference 4.

**Video projectors**

For **video projectors** intended to be used in dark or sparsely illuminated rooms, the declared TCO Image Size in m<sup>2</sup> shall be calculated according to the following formula:

$$A_{\max/video} = \frac{\phi_{white/measured}}{L_{white/video} \times \pi + E_{amb/video}} = \frac{\phi_{white/measured}}{85 \times \pi + 20}$$

Where:

$A_{\max/video}$  = TCO Image Size for video projectors in m<sup>2</sup>.

$L_{white/video}$  = Minimum luminance of white screen in a dark room in cd/m<sup>2</sup> for video projectors according to reference 4.

$E_{amb/video}$  = ambient illuminance falling on the projection screen for video projectors according to reference 4.

(The mandate, according to clause A.2.1.1 is the following:

The diagonal length in inch for the “TCO Image size” for the native aspect ratio of the projector shall be declared in the TCO document (see A.1.1).

The highest possible light output measured according to the test procedures in this document shall be declared in the test report.)

**B.2.1.1.5 Overall uncertainty**

≤ ± 10 % in illuminance measurements.

See B.2.0.6.

**B.2.1.2 Black level and contrast ratio****B.2.1.2.1 Preparation of the projector for testing**

- All necessary preparations described in B.0 and B.2.0 shall be done.
- The default test image is a full-screen with colour “black” (RGB setting of 0, 0, 0).
- The projector shall be adjusted to the default CCT.

**B.2.1.2.2 Equipment**

Illuminance meter.

**B.2.1.2.3 Test method**

Measure the black illuminance  $E_{black/measured}$  at location 1 to 9 according to figure B.2.1.1 using the test pattern according to B.2.1.2.1 to see that the result is lower or equal to the required calculated level  $\Phi_{black/max/office}$  for office projectors or  $\Phi_{black/max/video}$  for video projectors.

**B.2.1.2.4 Test evaluation****1. Measurements of black illuminance**

Calculate the average light flux  $\Phi_{black/measured}$  from the measured illuminance  $E_{black/measured}$  according to the following formula:

$$\Phi_{black/measured} = \frac{A_{test} \times \sum_{n=1}^9 E_{black/measured,n}}{9}$$

- $\Phi_{black/measured}$  is the calculated average light flux of the 9 points measured.
- $E_{black/measured}$  is the measured average illuminance of the 9 points measured.
- $A_{test}$  is the chosen test-area of the projected image in m<sup>2</sup> measured in dark room conditions.

**2. Calculation of requirements level****For office projectors:**

$\Phi_{black/max/office}$  is the requirements level of the maximum light flux for office projectors. This is the requirement level which the measured illuminance  $\Phi_{black/measured}$  shall be compared against.

$$\Phi_{black/max/office} \leq \frac{\Phi_{white/measured} - 400 \times A_{max/office}}{5}$$

- $\Phi_{white/measured}$  is the measured light flux of the tested white projected image in dark room conditions (see A.2.1.1).
- $A_{max/office}$  is the ”TCO Image Size” (see A.2.1.1).

**For video projectors:**

$\Phi_{black/max/video}$  is the requirements level of the maximum light flux for video projectors. This is the requirement level which the measured illuminance  $\Phi_{black/measured}$  shall be compared against.

$$\phi_{black / max / video} \leq \frac{\phi_{white / measured} - 180 \times A_{max / video}}{10}$$

- $\phi_{white / measured}$  is the measured light flux of the tested white projected image in dark room conditions (see A.2.1.1).
- $A_{max / video}$  is the "TCO Image Size" (see A.2.1.1).

A quick reference table showing the relation between measured ANSI flux,  $A_{max}$  and max black level is found at the TCO Development homepage.

(The mandate, according to clause A.2.1.2, is the following:

Office projectors shall be able to give a contrast ratio of 5:1 for "TCO Image size" in normal "conference room" ambient illuminance (100 lux).

Video projectors shall be able to give a contrast ratio of 10:1 for "TCO Image size" in normal "video room" ambient illuminance (20 lux). )

**B.2.1.2.5 Overall uncertainty**

$\leq \pm 10 \%$  in illuminance.

See B.2.0.6.

**B.2.1.3 Light flux uniformity****B.2.1.3.1 Preparation of the projector for testing**

- All necessary preparations described in B.0 and B.2.0 shall be done.
- The default test image is a full-screen with colour “bright white” (RGB setting of 255, 255, 255). The size of the test image shall be the “TCO image Size”. However, if the laboratory is not large enough to project the “TCO Image Size” it is allowed to do testing on an image size larger or equal to 50% of the “TCO Image Size”.

**B.2.1.3.2 Equipment:**

Illuminance meter.

**B.2.1.3.3 Test method:**

The illuminance is measured at location 1 to 9 according to figure B.2.1.1.

It is not recommended to perform this parameter together with B.2.3.2 Colour uniformity, since the reflectance standard used in B.2.3.2 Colour uniformity is likely not calibrated for the angles involved and consequently will give false luminance results for the light flux uniformity.

**B.2.1.3.4 Test evaluation**

Evaluate the equation as given in A.2.1.3.

(The mandate, according to clause A.2.1.3 is the following:

The ratio between the highest and lowest illuminance across the projected image shall be:

$$\frac{E_{\max}}{E_{\min}} \leq 1.55$$

**B.2.1.3.5 Overall uncertainty**

$\leq \pm 10 \%$  in illuminance measurements.

See B.2.0.6.

## B.2.2 Image detail characteristics

### B.2.2.1 Native display resolution requirement

#### B.2.2.1.1 Preparation of the projector for testing

No specific preparation of the projector is needed.

#### B.2.2.1.2 Equipment

Calculator and projector manual or similar information about the resolution of the projector.

#### B.2.2.1.3 Test method

The maximum resolution and frequencies of the projector are found in the manual or similar information from the manufacturer.

#### B.2.2.1.4 Test evaluation

For TCO Image sizes equal to or larger than 1.5 m<sup>2</sup> a viewing distance of 1.5 times the diagonal is defined for the first row of viewers.

However, for very small TCO Image Sizes (e.g. presented by pico projectors) it is likely that the first row of viewer is slightly further away than 1.5 times the diagonal. This means that a lower resolution can be accepted for small TCO Image sizes. Because of this, the viewing distance in this TCO criteria document is defined for three different TCO Image Size spans.

#### **Example:**

To achieve 30 pixels/degree for a 4:3 aspect ratio image with a viewing distance of 1.5 times the diagonal it is necessary to have XGA native resolution. In the same way it is necessary to have SVGA native resolution if the viewing distance is increased to 1.8 times the diagonal and VGA native resolution is acceptable if the viewing distance is increased to 2.2 times the diagonal.

This means that if the intended use is to project 4:3 images of 0.5m<sup>2</sup> it is enough with VGA native resolution. If the intended use is to project larger images than 1.5m<sup>2</sup> it is necessary with XGA resolution.

The minimum resolution to fulfil the criteria can be calculated for any aspect ratio in the following way:

#### **Minimum amount of pixels in the vertical direction**

Half the TCO Image Size height at the viewing distance expressed in degrees is:

- $\arctan(\text{width}/2/\text{viewing distance})$

The whole TCO Image Size height expressed in degrees is:

- $2 \times \arctan(\text{width}/2/\text{viewing distance})$

The requirement is 30 pixels/degree which gives the amount of pixels needed in the vertical direction to:

- $30 \times 2 \times \arctan(\text{width}/2/\text{viewing distance})$

**Example:**

For the format 5:4:3 and viewing distance 1.5 this gives the formula:

- $30 \times 2 \times \arctan(4/2/(1.5 \times 5)) = 896 \text{ pixels}$

The principle is the same in the vertical direction.

**(The mandate, in accordance with clause A.2.2.1, is the following:**

**The projected image shall have a *pixel* density  $\geq 30$  pixels/degree visual angle. To achieve this the necessary native resolution is dependent on the viewing distance.**

**For projectors with a declared TCO Image size  $\geq 1.5 \text{ m}^2$  ( $\approx 70''$  diagonal) the viewing distance is considered to be 1.5 x diagonal of the TCO Image Size. (This corresponds to at least XGA for 4:3).**

**For projectors with a declared TCO Image size  $< 1.5 \text{ m}^2$  ( $\approx 70''$  diagonal) the viewing distance is considered to be 1.8 x diagonal of the TCO Image Size. (This corresponds to at least SVGA for 4:3).**

**For projectors with a declared TCO Image size  $\leq 0.5 \text{ m}^2$  ( $\approx 40''$  diagonal) the viewing distance is considered to be 2.2 x diagonal of the TCO Image Size. (This corresponds to at least VGA for 4:3).**

**B.2.2.1.4 Overall uncertainty**

Uncertainty is not applicable in this case. Product data information is sufficient.

## B.2.3 Screen colour characteristics

### B.2.3.1 Correlated colour temperature (CCT) variation

#### B.2.3.1.1 Preparation of the Projector for testing

- All necessary preparations described in B.0 and B.2.0 shall be done.
- The default test image is a full-screen with colour “bright white” (RGB setting of 255, 255, 255).

#### B.2.3.1.2 Equipment

- Spectro-radiometer capable of presenting CIE u' and v' chromaticity co-ordinates with at least 3 decimals.
- Colour neutral reflectance standard.

#### B.2.3.1.3 Test method

Place the colour neutral reflectance standard in the centre of the projected image (at measurement location 5 figure B.2.1.1.). Measure the spectral properties at the centre of the colour neutral reflectance standard with a spectro-radiometer.

The spectral data shall then be processed, which is normally done directly in the instrument microprocessor, to give chromaticity co-ordinates. In this case the CIE co-ordinates u' and v' are needed for the test evaluation and are often presented directly by the spectroradiometer used.

If the client has stated pre-set CCTs, preparation and testing shall be repeated for all additional CCTs

The following rules shall apply:

The recommended default CCTs is 6500 K, but the CCT can be anywhere between 5000 K and 10000 K.

Only CCTs with exactly specified numerical values have to fulfil the requirements for Pre-set CCTs.

CCTs lower than 5000 K shall not be tested.

#### B.2.3.1.4 Test evaluation

The measured  $u'_m$  and  $v'_m$  values of the screen for the pre-set CCT and the CIE reference chromaticity co-ordinates  $u'_{CCT}$  and  $v'_{CCT}$  values for the reported CCT shall be used to calculate the colour difference as follows:

$$\Delta u'v' = \sqrt{(u'_{CCT} - u'_m)^2 + (v'_{CCT} - v'_m)^2}$$

This calculation shall be done for all tested pre-set CCTs.

The CIE 1976 u' and v' reference chromaticity co-ordinates for five common CCTs are given in Table B.2.3.1.1.

**Table B.2.3.1.1**

<b>CCT in K</b>	<b><math>u'_{cct}</math></b>	<b><math>v'_{cct}</math></b>
9300	0.1889	0.4457
7500	0.1935	0.4586
6500	0.1978	0.4684
5500	0.2044	0.4808
5000	0.2091	0.4882

If preset CCTs other than those given in Table B.2.3.1.1 are used in the test,  $u'_{CCT}$  and  $v'_{CCT}$  can be found by using CIE tabulated data or by using CIE formulae presented in CIE Publication 15.2 (1986), Colorimetry, p.11, p. 27-28 and p. 53-54, Table 1.3.

If the spectro-radiometer used can only produce CIE 1931 x and y chromaticity co-ordinates these can be transformed to  $u'$  and  $v'$  chromaticity co-ordinates by using the formulae in the CIE Publication 15.2 mentioned above.

The relevant CIE material – conversion formula and tabulated data for  $u'_{CCT}$  and  $v'_{CCT}$  – can also be found on the TCO Development homepage, [www.tcodevelopment.com](http://www.tcodevelopment.com). A computer program based on the given equations can be supplied by TCO Development.

The resulting colour difference calculation shall be presented to 3 decimal places.

If no pre-set correlated colour temperature exists, report the measured correlated colour temperature.

(The mandate, according to clause A.2.3.1, is the following:

The correlated colour temperature of the projected bright white image shall be in the range of 5000K to 10000K.

Each pre-set correlated colour temperature shall have a colour difference  $\Delta u'v' \leq 0.015$  when compared to CIE  $u'$  and  $v'$  chromaticity co-ordinates for corresponding correlated colour temperatures.)

- B.2.3.1.5 Overall uncertainty**  
 $\leq \pm 0.003$  in  $u'$  and  $v'$ .  
 See B.2.0.6.

## B.2.3.2 Colour uniformity

### B.2.3.2.1 Preparation of the projector for testing

- All necessary preparations described in B.0 and B.2.0 shall be done.
- The default test image is a full-screen with colour “bright white” (RGB setting of 255, 255, 255).

### B.2.3.2.2 Equipment

- Spectro-radiometer capable of presenting CIE  $u'$  and  $v'$  chromaticity co-ordinates with at least 3 decimals.
- Colour neutral reflectance standard.

### B.2.3.2.3 Test method

The colour uniformity shall first be evaluated visually by the technician in order to find those areas where the colour varies the most. The most applicable of the following colour uniformity test shall then be performed.

Measure the chromaticity co-ordinates  $u'$  and  $v'$  in the visually most colour-deviating areas. Then, in addition to this, measure the chromaticity co-ordinates in the corner positions as shown in Figure B.2.1.1 and in the centre.

It is not recommended to perform this parameter together with B.2.1.3 Light flux uniformity, since the reflectance standard is likely not calibrated for the angles involved and consequently will give false luminance results for the light flux uniformity.

### B.2.3.2.4 Test evaluation

$\Delta u'v'$  according to the CIE (1976) uniform chromaticity scale diagram shall be calculated for each measured position using the formula

$$\Delta u'v' = \sqrt{(u'_A - u'_B)^2 + (v'_A - v'_B)^2}$$

where A and B are the two points found to have the largest colour difference between them.

The largest difference in  $\Delta u'v'$  value shall be reported.

The result shall be presented to 3 decimal places.

(The evaluation procedure is exemplified below)

Make a table of colour chromaticity values for each measured position similar to the example below

Measurement position no.	$u'$	$v'$
1	0.190	0.447
2	0.186	0.441
3	0.186	0.437
-	-	-
-	-	-
n-1	0.185	0.434
n	0.186	0.432
<b>Largest difference</b>	<b>0.005 in this example</b>	<b>0.015 in this example</b>

The largest  $u'$  difference,  $\Delta u'$ , is 0.005 (between 0.190 and 0.185) at measurement positions 1 and n-1.

The largest  $v'$  difference,  $\Delta v'$ , is 0.015 (between 0.447 and 0.432) at measurement positions 1 and n.

Since  $\Delta v'$  (= 0.015) is much larger than  $\Delta u'$  (= 0.005), the  $\Delta v'$  value shall be used for the calculation of  $\Delta u'v'$ .

The corresponding two pairs of  $u'$  and  $v'$  to be used for the calculation are thus the values found at position 1 and position n and thus become the values used for points A and B such that

$u'_1 = u'_A = 0.190$  and  $v'_1 = v'_A = 0.447$  for point A in this example

and

$u'_n = u'_B = 0.186$  and  $v'_n = v'_B = 0.432$  for point B in this example

Hence  $\Delta u'v' = \sqrt{0.000016 + 0.000225} = 0.01552$ , which shall be reported as 0.016.)

(The mandate, according to clause A.2.3.2 is the following:

$\Delta u'v' \leq 0.015$  for the maximum colour deviation between measured active areas on the TCO Image Size that is intended to maintain the same colour)

- B.2.3.2.5 Overall uncertainty**  
 $\leq \pm 0.003$  in  $u'$  and  $v'$ .  
 See B.2.0.6.

**B.2.3.3 Colour gamut****B.2.3.3.1 Preparation of the projector for testing**

- All necessary preparations described in B.0 and B.2.0 shall be done.
- Use full-screen test pattern with the following RGB settings:  
(255, 0, 0) for red,  
(0, 255, 0) for green,  
(0, 0, 255) for blue.

**B.2.3.3.2 Equipment**

- Spectro-radiometer capable of presenting CIE  $u'$  and  $v'$  chromaticity co-ordinates with at least 3 decimals.
- Colour neutral reflectance standard.

**B.2.3.3.3 Test method**

Place the colour neutral reflectance standard at measurement location 5 (see figure B.2.1.1.). Measure the spectral properties at the centre of the colour neutral reflectance standard with a spectro-radiometer for red, green and blue according to B.2.3.3.1.

**B.2.3.3.4 Test evaluation**

The recorded chromaticity co-ordinates  $u'$  and  $v'$  for red, green and blue shall be reported.

The  $u'$  and  $v'$  shall be presented to 3 decimal places.

(The mandate, in according to clause A.2.3.3 is the following:

The minimum colour triangle shall have the following coordinates at factory default setting:						
	Red		Green		Blue	
Co-ordinate	$u'$	$v'$	$u'$	$v'$	$u'$	$v'$
Requirement	$\geq 0.400$	$\geq 0.510$	$\leq 0.160$	$\geq 0.550$	$\geq 0.145$	$\leq 0.210$

)

**B.2.3.3.5 Overall uncertainty**

$\leq \pm 0.003$  in  $u'$  and  $v'$  for red and green.

$\leq \pm 0.007$  in  $u'$  and  $v'$  for blue.

See B.2.0.6.

**B.2.3.4 Colour greyscale linearity****B.2.3.4.1 Preparation of the projector for testing**

- All necessary preparations described in B.0 and B.2.0 shall be done.
- Use full-screen test pattern with the following RGB settings: R=G=B=255, 225, 195, 165, 135, 105, 75 and 45.

**B.2.3.4.2 Equipment**

- Spectro-radiometer capable of presenting CIE u' and v' chromaticity co-ordinates with at least 3 decimals.
- Colour neutral reflectance standard.

**B.2.3.4.3 Test method**

Place the colour neutral reflectance standard at measurement location 5 (see figure B.2.1.1.). Measure the spectral properties at the centre of the colour neutral reflectance standard for the RGB settings stated above with a spectro-radiometer.

**B.2.3.4.4 Test evaluation**

The evaluation procedure is exemplified below

- TCO will provide an excel spreadsheet at the TCO website [www.tcodevelopmet.com](http://www.tcodevelopmet.com) which will calculate the  $\Delta u' v'$  differences between all the greyscale levels according to the equation:

$$\Delta u'v' = \sqrt{(u'_A - u'_B)^2 + (v'_A - v'_B)^2}$$

- Fill in the chromaticity values of u' and v' for each measured greyscale step into the corresponding cells of the spread sheet.

The table below contains coloured cells indicating difference requirements. The principle is that the darker the greyscale the more difficult it is to see a colour difference.

Examples on how to use the table: By using the column 255 (greyscale 255) and go down to line 165 (greyscale 165) you find that the maximum allowed colour difference  $\Delta u' v'$  is 0.020 (orange cell). For the greyscales 225 and 75 the maximum allowed difference is 0.035 (green cell).

(The mandate, according to clause A.2.3.4 is the following:

<b>Mandate:</b>								
	Maximum $\Delta u'v'$ difference							
Greyscale	255	225	195	165	135	105	75	45
255	0							
225	0,015	0						
195	0,015	0,015	0					
165	0,020	0,020	0,020	0				
135	0,025	0,025	0,020	0,020	0			
105	0,025	0,025	0,025	0,025	0,020	0		
75	0,035	0,035	0,035	0,035	0,035	0,025	0	
45	0,035	0,035	0,035	0,035	0,035	0,035	0,035	0

The  $\Delta u'v' \leq$  the maximum allowed difference for each step according to table 2.3.4  
**The following information shall be submitted with the application to TCO Development:**  
 A copy of a test report from a test laboratory approved by TCO Development.

- B.2.3.4.5 Overall uncertainty**  
 $\leq \pm 0.003$  in  $u'$  and  $v'$ .  
 See B.2.0.6.

## **B.2.4 Compatibility characteristics**

### **B.2.4.1 Video- and computer ports**

#### **B.2.4.1.1 Preparation of the projector for testing**

- No preparations are needed

#### **B.2.4.1.2 Equipment**

Visual inspection.

#### **B.2.4.1.3 Test method**

Visual inspection together with information from manual.

#### **B.2.4.1.4 Test evaluation**

All input and output port shall be reported.

#### **B.2.4.1.5 Overall uncertainty**

Not applicable.

## **B.4 Emissions**

### **B.4.0 General test conditions for emissions**

#### **B.4.0.1 Basic test requirements**

As described in section B.0.

For the test methods for emissions described in this document the following conditions apply:

AC mains voltage\*                      230 VAC RMS, tolerance  $\leq 1 \%$

AC mains frequency\*                  50 Hz, tolerance  $\leq 2 \%$

The equipment shall be connected to phase and neutral.

\* – or other voltage and frequency combination specified by the client.

#### **B.4.0.2 Conditions and set up for the test object**

The tests shall be performed with the full TCO Image Size activated.

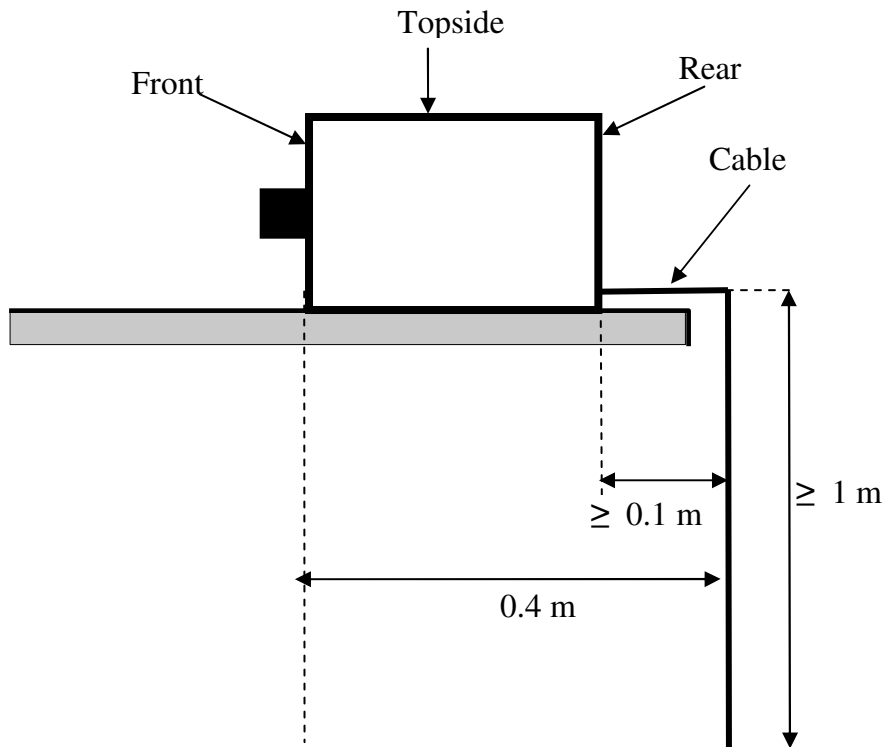
The projector control settings shall be the same as for visual ergonomics. This means the light flux test image at the default setting shall be used for the emission testing of alternating electric and magnetic fields. See section B.0.6 for details concerning this setting.

The projector shall focus the test image defined in B.2.1.1.

The projector must comply with the mandatory requirements without having to rely on an earth connection via the signal cable. In order to test a projector without an earth connection via the power cable, a battery operated computer, with no connection to earth, can be used to operate the projector.

If the projector is connected to mains via a detachable mains cord, the measurement shall be performed with a non-shielded mains cord of normal type, (connected to earth for CLASS I device). A shielded power cord may be used if the cord is permanently attached to the projector. By permanently we mean that tools are necessary to remove and change the cord.

A projector without an external power supply shall be connected to mains via the above mentioned power cable, which shall run from the point of its connection on the projector and then horizontally straight to a point 0.4 m behind the projector surface. The cable shall then from this point run downwards at least 1 m. – see figure B.4.0.2.1.



#### Figure B.4.0.2.1 Projector without external power supply units.

If the projector is provided with a fixed holder for the power and signal cables, to secure them together, then this holder is to be used during the test.

The external power supply unit, if any, will contribute to the electromagnetic fields around the projector. Power supply units, which are connected via a primary cable to the outlet, shall be positioned centrally, directly behind the test sample, on the (turn)table, with the secondary side towards the projector. The primary cable shall extend horizontally, on the (turn)table to a point 0.4 m behind the screen surface. The cable shall then, from this point run downwards at least 1 m. If the power supply can be positioned with different sides up, it shall be tested in all positions and the worst case shall be used. However, if it is obvious which side is intended to be the top side or bottom side by the placement of LED indicator or integrated supports to stand on, it is enough to test the power supply in the one intended position.

The secondary cable of the power supply shall run the shortest distance from the point of its connection on the projector to the secondary side of the power supply. The unused portion of the secondary cable, if any, shall be bundled together with the power supply unit. The bundle loops shall have a length equal to the longest dimension of the power supply. For supply units with dimensions less than 0.1 m, a 0.1 m bundle loop length shall be used.

For power supply units which are designed to be put directly in the outlet, without a primary cable, the secondary cable shall run vertically down to the (turn)table from the point of its connection on the projector and then horizontally straight to a point 0.4 m behind the projector surface. The cable shall then, from this point, run downwards at least 1 m.

For measurements of alternating magnetic fields (B.4.2) the power cable may be positioned in another way, as the cable contributes a negligible amount to the magnetic field. However external power supplies must be correctly positioned, as they may give rise to magnetic fields.

If positioning in accordance with the above rules is not possible, then the positioning of the supply unit and cables shall be described in the test report.

### **B.4.0.3 Emission measurement instruments**

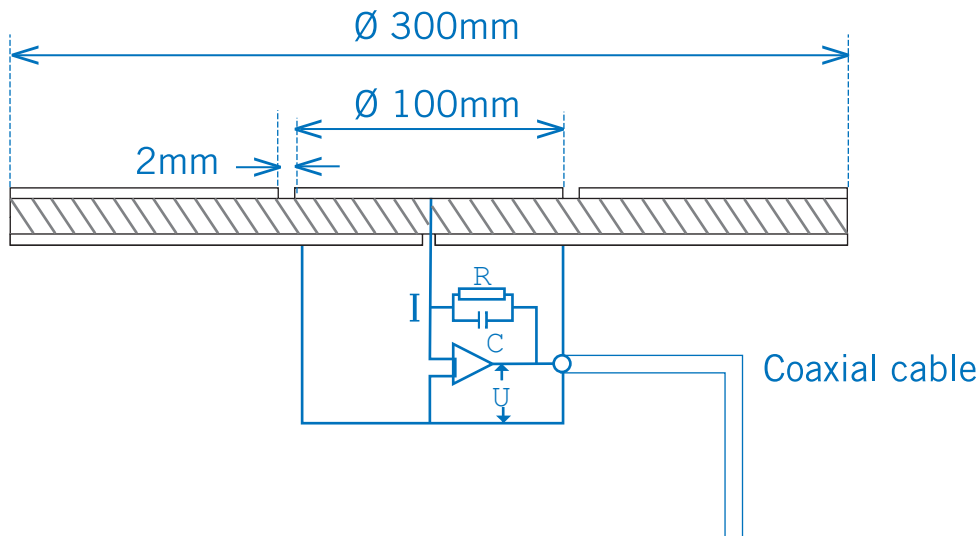
The instruments used for emission testing shall comply with the requirements and calibration procedures described below:

#### **Alternating electric field meter**

The alternating electrical field emission from the projector under test shall be determined by measuring the displacement current passing a given surface of the measuring probe. The probe consists of a disc of double sided printed circuit board laminate with a diameter of 300 mm. On the front of the board the copper layer is removed in the annulus between radii 50 and 52 mm, see Figure B.4.0.3.1.

The copper foil surrounded by the annulus is the active measuring surface. It is connected to one input terminal of an operational amplifier, with capacitive feedback. The other input terminal of the operational amplifier, the copper ring outside the active surface, and the back of the board are connected to ground. The output voltage (U) from the probe (active surface with area (A)) is related to the incident electrical field, E, averaged over the active surface in accordance with

$U = \epsilon \times E \times A / C$  where C is the capacitance in the feedback loop of the operational amplifier and  $\epsilon$  is the permittivity for a vacuum.



**Figure B.4.0.3.1** Sketch and circuit principle of the Alternating electric field meter for alternating electrical field measurements. The feedback circuit of the operational amplifier is a capacitance  $C$  in parallel with a high value resistor  $R$  to ensure that there is no DC voltage across the plates of the capacitor  $C$ .

The specifications for the frequency response of the alternating field meter are given by the calibration procedure. The signals from the probe shall be filtered by high-pass and low-pass filters. The specification of the filters is given in Table B.4.0.3.1.

**Table B.4.0.3.1** Filter specifications

Frequency Band I					
Frequency	< 5 Hz	5 Hz	100 Hz	2 kHz	> 2 kHz
Attenuation	> 80 dB/decade	3 dB	0 dB	3 dB	> 40 dB/decade
Frequency Band II					
Frequency	< 2 kHz	2 kHz	30 kHz	400 kHz	> 400 kHz
Attenuation	> 80 dB/decade	3 dB	0 dB	3 dB	> 40 dB/decade

After amplification and filtering the output voltage of the measuring probe shall be used to determine the r.m.s. value of the electric field strength in both frequency bands.

The measuring time shall be sufficiently long to enable measurements with an accuracy of  $\pm 5\%$  at 50/60 Hz.

The measuring system shall be capable of measuring at least down to 2.0 V/m in band I and down to 0.20 V/m in band II.

The measuring probe shall be calibrated using a parallel plate capacitor (air dielectric) consisting of the measuring probe and a metal plate of at least 300 mm diameter. The distance between the surface of the probe and the plate shall be 30 mm.

The calibration shall be performed with sinusoidal fields at the amplitudes and frequencies specified in Table B.4.0.3.2.

**Table B.4.0.3.2 Calibration frequencies and amplitudes**

	Frequencies	Amplitude
Band I	50, 100, 500, 1000 Hz	10, 25 V/m
Band II	15, 30, 60, 120 kHz	1.0, 2.5, 10 V/m

Recorded values at these calibration points shall be within  $\pm 5\%$  of the nominal value. Due to the nature of the specified filters the deviation shall be calculated at 1 kHz from 9.5 and 22.5 V/m and at 120 kHz from 0.95, 2.4 and 9.5 V/m.

**Alternating magnetic field meter in band I and band II**

The magnetic field shall be measured using coil systems that shall consist of three mutually perpendicular concentric circular coils each with an area of 0.01 m<sup>2</sup>. The coils may depart from a circular shape where they intersect. The minimum inner diameter shall be 110 mm and the maximum outer diameter 116 mm. The measuring coils shall not be sensitive to electric fields.

The resonance frequency of each coil appropriately connected to cables and amplifiers shall not be so low that it may influence the specified frequency response according to table B.4.0.3.1.

Amplifiers and integrating networks to make the output voltage proportional to the magnetic flux density and independent of frequency shall follow each coil. The specifications in respect of the frequency response are given in the calibration procedure.

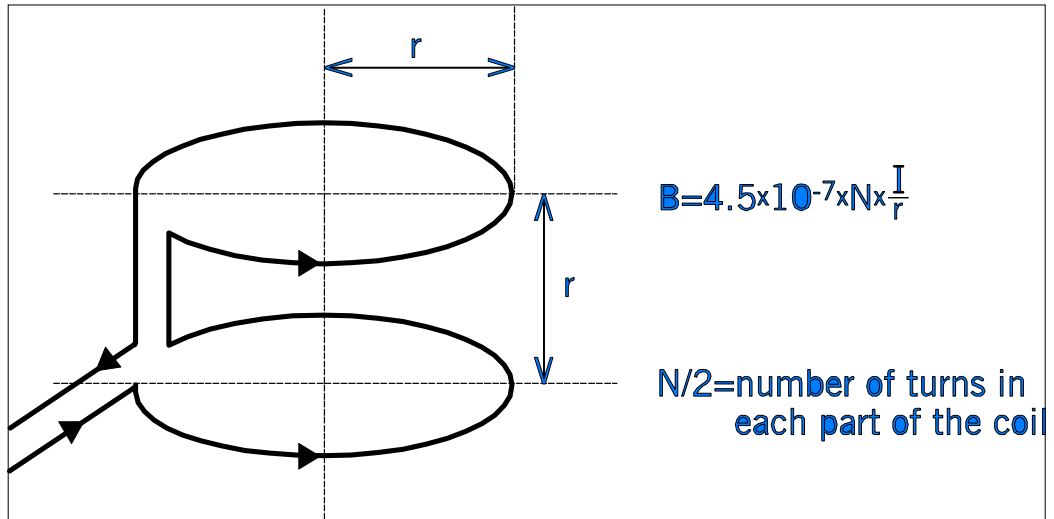
High-pass and low-pass filters shall filter the signals from the coil systems. The specifications of the filters are given in Table B.4.0.3.1.

After amplification, integration and filtering, the signals from the three coils in each coil set shall be used as input values for calculating the r.m.s. values of the amplitudes of the magnetic flux density vectors in both frequency bands. It is permissible to calculate the r.m.s. value for each of the coil signals and use the root of the squared sum of those r.m.s. values as the test result.

The measuring time shall be sufficiently long to enable measurement with an accuracy of  $\leq 5\%$  at 50/60 Hz.

The alternating magnetic field meter in band I and band II shall be capable of measuring down to at least 40 nT in band I and down to 5.0 nT in band II.

The alternating magnetic field meter in band I and band II shall be calibrated using a Helmholtz-type calibration coil as shown in the Figure B.4.0.3.2. Calibration set-up. Calibration shall be performed with sinusoidal fields at the amplitudes and frequencies specified in Table B.4.0.3.3.



**Figure B.4.0.3.2. Calibration using a Helmholtz-type calibration coil.**

**Table B.4.0.3.3 Calibration frequencies and amplitudes**

	Frequencies	Amplitudes
<b>Band I</b>	60, 100, 500, 1000 Hz	200, 2000 nT
<b>Band II</b>	15, 30, 60, 120 kHz	25, 250 nT

Recorded values for these calibrations shall not deviate more than  $\pm 5\%$  from the nominal value. Due to the nature of the specified filters the deviation at 1 kHz shall be calculated from 180 nT and 1800 nT and at 120 kHz from 24 nT and 240 nT.

The calibration shall be performed for each of the three individual coils separately exposed and for one situation where approximately the same flux density passes through all three coils.

## B.4.1 Alternating electrical fields

### B.4.1.0 Test laboratory requirements

Background electric field strengths in the test laboratory, including disturbances transmitted by power lines and internally generated noise in the measuring system, shall together not exceed 2.0 V/m in band I and 0.20 V/m in band II.

The mains voltage to the projector under test shall be within  $\pm 3\%$  of its nominal value.

### B.4.1.1 Preparation of the projector for testing

All necessary preparations described in B.0 and B.4.0 shall be done.

An external optical filter may not be used in order to comply with the mandatory requirement.

### B.4.1.2 Equipment

Alternating electric field meter.

### B.4.1.3 Test Method

The true r.m.s.-value of the amplitude of the electric field strength, at the surface of the measuring probe, is measured in four azimuths in band II. The frequency ranges are selected by means of filters in the measuring equipment.

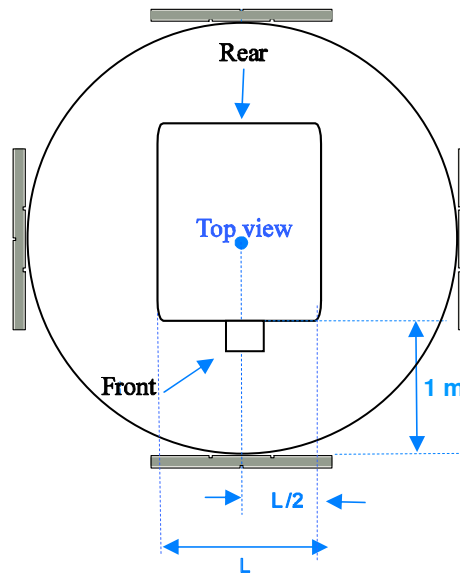
The projector shall be positioned such that the tangential plane, to the centre-centre point of the projector lens, is at a right angle to the horizontal plane. The distance between the centre-centre points of the projector lens and the back of the projector, including an eventual part of a stand holder, along the normal to this tangential plane is called L, see Figure B.4.1.3.1.

The origin of the cylindrical co-ordinate system is chosen to be situated at a distance  $L/2$  behind the projector lens on the normal to the tangential plane through the centre-centre point. The z-axis is chosen to be at a right angle to the horizontal plane. The angular reference direction is along the above mentioned normal in the direction pointing outwards from the projector. An angle ( $\vartheta$ ) is positive in the counter-clockwise direction.

Measurements are taken in four directions around the product at  $0^\circ$ ,  $90^\circ$ ,  $180^\circ$  and  $270^\circ$ . Measurements shall be made at all points and have a clearance of 1 m to the outer surface of the projector. Another measurement of the top of projector shall be taken at the centre, centre

In case of less than 1 m clearance the instrument shall be moved out radial until 1 m clearance is achieved.

Distances are given in metres and angles in degrees. The co-ordinates are given for the centre of the measuring probe. The surface of the probe shall be perpendicular, within  $\pm 5^\circ$ , to the radial axis.



**Figure B.4.1.3.1. Measurement geometry for band I (top) and band II (bottom).**

The projector under test and the measuring probe shall be positioned at least 2 m from all significant metallic structures and objects.

Additional units and connecting cables necessary for the operation of the projector, which are not part of the test, shall be placed so far away from the measuring setup that the fields they emit do not influence the measurement. Shielding may be added to these units and cables, as long as the 2 m clearance is maintained.

The measuring probe shall be connected to ground. Any eventual cables running between the measuring probe and the measuring instrument shall be positioned in such a way that they do not influence the measured value.

The power cable of the test object shall be connected to the phase and the neutral conductors of the mains power supply. The projector does not need to be measured with the phase and neutral interchanged in this case, as the Band II electric fields are not influenced by such a change.

be taken with the connection that gives the highest reading in band I.

#### **B.4.1.4 Test evaluation**

Results shall be presented as r.m.s. values of the alternating electric field expressed in volt per meter (V/m). For band II, the measured values in front of the projector and the maximum value at rotation shall be presented for normal and stand-by operations if they differ.

If the measured values are less than 1.0 V/m in band II the result shall be reported as “< 1.0 V/m”.

(The mandate, according to clause A.4.1, is the following:

Band II: 2 kHz to 400 kHz,  $\leq 1.0$  V/m measured at 1 m around and topside of the projector..)

**B.4.1.5 Overall uncertainty**

The test shall be performed in such a way that the total extended uncertainty in the test result will be less than  $\pm (10 \% \text{ of the reading} + 0.1 \text{ V/m})$  for band II.

## B.4.2 Alternating magnetic fields

### B.4.2.0 Test laboratory requirements

Background magnetic fields in the test laboratory, including disturbances transmitted along the power line and internally generated noise in the measuring system, shall together not exceed 40 nT in band I and 5 nT in band II.

### B.4.2.1 Preparation of the projector for testing

All necessary preparations described in B.0 and B.4.0 shall be done.

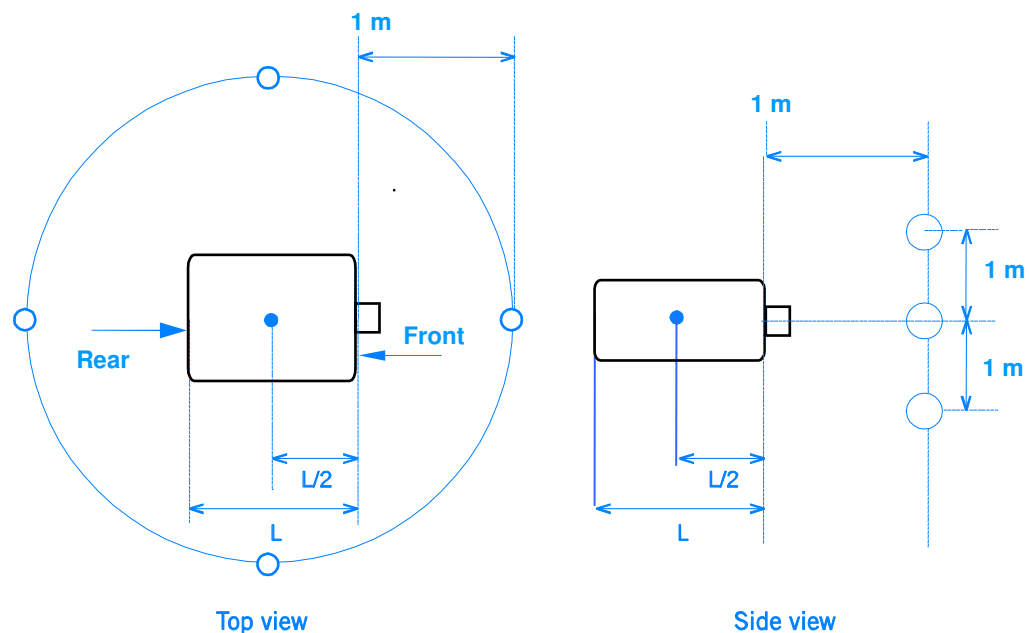
### B.4.2.2 Equipment

Alternating magnetic field meter in band I and band II

### B.4.2.3 Method

The true r.m.s. value of the amplitude of the magnetic flux density vector is measured at 12 points on a cylindrical surface around the test object in the two frequency ranges, band I and band II. The frequency ranges are selected by specified filters in the alternating magnetic field meter.

The measuring geometry is illustrated in Figure B.4.2.3.1. The measurement points are mathematically defined in the following way.



**Figure B.4.2.3.1. Measurement geometry for the test object.**

The projector shall be positioned such that the tangential plane, to the centre-centre point of the projector lens, is at a right angle to the horizontal plane. The distance between the centre-centre points of the projector lens and the back of the projector, including an eventual part of a stand holder, along the normal to this tangential plane is called L.

The origin of the cylindrical co-ordinate system is chosen to be situated at a distance  $L/2$  behind the projector lens on the normal to the tangential plane through the centre-centre point. The z-axis is chosen to be at a right angle to the horizontal plane. The angular reference direction is along the above-mentioned normal in the direction pointing outwards from the projector. An angle ( $\vartheta$ ) is positive in the counter-clockwise direction.

Measurements are taken in four directions around the product at  $0^\circ$ ,  $90^\circ$ ,  $180^\circ$  and  $270^\circ$ . Measurements shall be made at all points and have a clearance of 1 m to the outer surface of the projector. Another measurement of the top of projector shall be taken at the centre, centre point at 1 m clearance over the projector.

In case of less than 1 m clearance the instrument shall be moved out radial until 1 m clearance is achieved.

Distances are given in metres and angles in degrees.

The measuring coils shall be stationary during the measurements.

For projector luminance settings – see General test conditions for emissions.

The power cable of the test object shall be connected to the phase and the neutral conductors of the mains power supply. The projector does not need to be measured with the phase and neutral interchanged in this case, as the magnetic fields are not influenced by such a change.

#### **B.4.2.4 Test evaluation**

Results shall be presented as r.m.s. values of the magnetic flux density expressed in nanotesla (nT) for the two frequency bands. The maximum value around the projector and its position shall be given both for normal and for standby operation if they differ. If measured values are less than 200 nT in band I or less than 25.0 nT in band II the result shall be reported as “< 200 nT” and “< 25.0 nT” respectively.

(The mandate, according to clause A.4.2, is the following:

Band I: 5 Hz to 2 kHz,  $\leq 200$  nT, measured at 1 m around and topside of the Projector.

Band II: 2 kHz to 400 kHz,  $\leq 25$  nT measured at 1 m around and topside of the Projector.)

#### **B.4.2.5 Overall uncertainty**

The test shall be performed in such a way that the total extended uncertainty in the test result will be less than  $\pm (10 \% \text{ of the reading} + 30 \text{ nT})$  for band I and  $\pm (10 \% \text{ of the reading} + 1.5 \text{ nT})$  for band II.

#### **Note**

The uncertainties given are worst case limits. In many cases it will be possible to obtain better accuracy, especially in band II.

### **B.4.3 Acoustic noise**

The noise measurements shall follow ISO 7779:1999 and shall be declared according to ISO 9296:1988.

In addition to reporting the measured *A-weighted sound power level* ( $L_{WA}$ ) in Bels (B) the single measurement values of the 9 measurement positions and the mean value of these *A-weighted sound pressure level* ( $L_{pA}$ ) in Decibels (dB) have to be included in the test report.

## **B.6 Environmental requirements**

### **B.6.0 General information**

#### **B.6.0.1 Signatures**

The templates in the ecological declaration shall be sent either with original signatures or as copies of original documents with original signatures. "Copies" are for example telefaxes or pdf-files of scanned signed documents. TCO Development and/or the responsible laboratory may later request the original signed document.

However, copies will not be accepted where the signature has been scanned and pasted into the document.

TCO accepts digital signature as an alternative to traditional signature on test reports and declarations submitted as pdf files. To approve a digital signature it is necessary to also submit a digital key to the eco-verifier to facilitate identification.

### **B.6.1 Product description**

The type key for unidentified characters, if any, in the model name and panel identification name shall be submitted. The type key must include two or more options.

### **B.6.2 Organisation**

#### **B.6.2.1 Environmental management system certification**

The certificate shall be issued by a certification body that is accredited by an accreditation body covered by the International Accreditation Forum, [www.iaf.nu](http://www.iaf.nu), Multilateral Arrangement on Environmental Management Systems.

For applicants submitting several applications, it is enough to attach an ISO 14001 certificate or EMAS registration with the first application.

The certificate or an appendix to the certificate shall show the scope of the certification.

### B.6.2.2 Social responsibility

At this stage we recognise that the level of implementation often is limited to first-tier suppliers. Although we see the ambition as covering all production we will for now not demand active engagement further down the chain.

To ensure that the document(s) sent in are really implemented and used, the report/certificate/membership or other document used as verification of this requirement must have a signature by a person at the brand owner company (approved to sign such documents by the brand owner company). All documents must also be dated to ensure that the documentation is up-to-date. The document(s) sent in by the brand owner is valid and verifies requirement A.6.2.2 one year from the signature date.

The different alternatives of verifying social responsibility, described below, are:

1. Global Reporting Initiative (GRI)
2. Global Compact
3. Electronic Industry Citizenship Coalition (EICC)
4. SA8000
5. Other relevant initiative and / or Own work

#### B.6.2.2.1 Global Reporting Initiative (GRI)

– a reporting standard

The Global Reporting Initiative (GRI) produces a standard in sustainability reporting guidelines. Sustainability reporting is the action where an organization publicly communicates their economic, environmental, and social performance. The GRI's mission is to make sustainability reporting by all organizations as routine and comparable as financial reporting.

The guideline consists of a set of Profile Disclosures and Disclosures of Management Approach as well as *79 performance indicators*, divided into the following six categories:

- 1. Environmental**  
Indicators on materials, energy, water, biodiversity, emissions, effluents, waste, transport, products, services etc
- 2. Human rights**  
Indicators on Investment and procurement practices, non-discrimination, freedom of association, collective bargaining, child labour, forced and compulsory labour etc
- 3. Labour practices and decent work**  
Indicators on Employment, occupational health and safety, labour/management relations, training, diversity and equal opportunity etc
- 4. Social**  
Indicators on Community, corruption, public policy etc.
- 5. Product responsibility**  
Indicators on Customer health and safety, product and services labelling, customer privacy etc

## 6. Economic

Indicators on Economic performance, market presence, indirect economic impacts etc

There are 3 Application Levels: A, B and C. These levels can be self-declared, third-party-checked and/or GRI-checked, each with the option of recognizing external assurance (“+”).

Reporting according to “level C” includes reporting on some of the Profile Disclosures and also reporting of a minimum of 10 Performance Indicators, including at least one of each Indicator Dimension (Economic, Environmental, and Social). Reporting on Disclosures of Management Approach is not needed.

### Accepted documentation:

A report according to the GRI Sustainability Reporting Guidelines, G3 level C or higher. The report shall be a maximum of one year old at the time of application.

### More information:

<http://www.globalreporting.org/Home>

#### B.6.2.2.2 Global Compact

– an initiative stating principles for sustainable business

The United Nations Global Compact (UNGC) is a United Nations initiative to encourage businesses worldwide to adopt sustainable and socially responsible policies, and to report on their implementation. The Global Compact is a principle based framework for businesses, stating ten principles in the areas of human rights, labour, the environment and anti-corruption:

#### 1. Human Rights

Businesses should:

- Principle 1: Support and respect the protection of internationally proclaimed human rights;
- Principle 2: Make sure that they are not complicit in human rights abuses.

#### 2. Labour Standards

Businesses should uphold:

- Principle 3: the freedom of association and the effective recognition of the right to collective bargaining;
- Principle 4: the elimination of all forms of forced and compulsory labour;
- Principle 5: the effective abolition of child labour; and
- Principle 6: the elimination of discrimination in employment and occupation.

#### 3. Environment

Businesses should:

1. Principle 7: support a precautionary approach to environmental challenges;
2. Principle 8: undertake initiatives to promote environmental responsibility; and
3. Principle 9: encourage the development and diffusion of environmentally friendly technologies.

#### **4. Anti-Corruption**

Businesses should:

- Principle 10: work against corruption in all its forms, including extortion and bribery.

The Global Compact is not a performance or assessment tool. It does not provide a seal of approval, nor does it make judgements on performance.

Participants are expected to publish in their annual report or similar corporate report (e.g. sustainability report) a description of the ways in which they are supporting the Global Compact and progress on implementing its ten principles. This is known as the "Communication on Progress" (COP). The Global Compact believes that this sort of openness and transparency encourages good practices by participants. The COP is an important demonstration of a participant's commitment to the Global Compact and its principles. Failure to provide a COP will result in a non-communicating or inactive status for a participant.

#### **Accepted documentation:**

A Communication on Progress (COP) report demonstrating active participation in the Global Compact initiative. The report shall be a maximum of one year old at the time of application.

More information:

<http://www.unglobalcompact.org/>

### **B.6.2.2.3 Electronic Industry Citizenship Coalition (EICC)**

– a business cooperation on implementation of social responsibility

The Electronic Industry Citizenship Coalition (EICC) is a group of companies working together to create a comprehensive set of tools and methods that support credible implementation of the Electronic Industry Code of Conduct throughout the Electronics and Information and Communications Technology (ICT) supply chain.

The Electronic Industry Code of Conduct is a code of best practices adopted and implemented by some of the world's major electronics brands and their suppliers. The goal is to improve conditions in the electronics supply chain. Development of the Code was a multi-stakeholder effort, influenced by internationally-recognized standards.

By consolidating and standardizing compliance, audit and reporting efforts, suppliers can focus on achieving the high standards of performance set forth by the Code. This approach is also conducive to fostering a culture of social responsibility throughout the global electronics supply chain.

EICC sets forth performance, compliance, auditing and reporting guidelines across five areas of social responsibility:

- Labour
- Health and Safety
- Environmental
- Management System
- Ethics

#### **Accepted documentation:**

Proof of Brand owner being an active member of the EICC initiative.

More information:

<http://www.eicc.info/>

## B.6.3 Climate

### B.6.3.0 General test conditions for Energy measurements

As described in section B.0.1-B.0.9.

#### B.6.3.0.1 Basic test requirements

AC mains voltage*	230 VAC RMS, tolerance $\pm 1\%$
AC mains frequency*	50 Hz, tolerance $\pm 0.5$ Hz
Line impedance	0.25 $\Omega$
Total harmonic distortion	< 2%
Test room temperature	23 $\pm$ 3 °C
Humidity	20-75 % RH (non-condensing)

\* – or other voltage and frequency combination specified by the client.

#### B.6.3.0.2 Power measurements

Several instruments are to be used when carrying out measurements for power as well as the prerequisite luminance and luminance levels. All instruments shall have been recently calibrated and bear a calibration certificate from a certified laboratory.

The following instrument types are to be used for testing:

RMS power meter

The RMS power meter shall have a crest factor of at least five, and a frequency response of at least 3 kHz.

#### B.6.3.0.3 Measurement stability

Measurements shall be taken after a stable wattage value has been obtained over a three-minute period. Values are considered to be stable when variations in wattage values are 1% or less for the duration of the three minute period.

### **B.6.3.1 Energy requirement**

#### **B.6.3.1.1 Preparation of the projector for testing**

The projector shall be warmed-up for a minimum of 20 minutes.

Connect a computer to the projector that produces an image.

Record the AC voltage.

The measurements have to be performed with graphics or computer interface connected and without any connection of any other peripheral devices.

#### **B.6.3.1.2 Equipment**

RMS power meter

#### **B.6.3.1.3 Test method**

The following are test steps for measuring the true energy requirements of the projector in On Mode, Eco Mode, Standby Mode and Off Mode. Please note that the testing shall be performed in normal operation with no additional equipment connected.

**On Mode with lamp in normal operation**

Initiate the projector to present a default test image, full screen bright white picture, RGB settings 255, 255, 255 (100% image loading) on the declared maximum projected screen size Amax/office or Amax/video. Allow the projector to remain in this mode until stable energy readings are measured. Measurements are considered stable if the wattage reading does not vary by more than 1% for the duration of a three-minute period.

**Eco Mode**

Eco mode helps to reduce energy consumption.

Initiate the projectors Eco mode. An adequate method of adjustment shall be documented. Allow the projector to remain in this mode until stable energy readings are measured. Measurements are considered stable if the wattage reading does not vary by more than 1% for the duration of a three-minute period.

**Standby Mode**

Initiate the projectors Standby Mode. An adequate method of adjustment shall be documented. Allow the projector to remain in Standby Mode until stable energy readings are measured. Measurements are considered stable if the wattage reading does not vary by more than 1% for the duration of a three-minute period.

**Off Mode**

Initiate the projectors Off Mode. An adequate method of adjustment shall be documented. Allow the projector to remain in Off Mode until stable energy readings are measured. Measurements are considered stable if the wattage reading does not vary by more than 1% for the duration of a three-minute period.

**B.6.3.1.4 Test evaluation**

Record the test conditions and test results as specified for each mode in section B.6.3.1.3.

(Mandate:

For Class B products pursuant to Part 15 subpart B of the FCC Rules or IEC/EN 55022

1. The Projector shall be possible to set in an eco mode.

2. The following requirement levels for maximum power consumption in the following modes shall be fulfilled and verified through testing by a test laboratory approved by TCO Development:

On Mode

Area Requirement level

$A_{Max/office}$  On Mode (normal operation)

$\leq 3 \text{ m}^2$   $\leq 260 \text{ W}$

$\leq 6 \text{ m}^2$   $\leq 310 \text{ W}$

$> 6 \text{ m}^2$   $\leq 310+150*(A_{max}- 6) \text{ W}$

Projectors with a throw ratio of 0.82 and less 30% more energy consumption is allowed.

$\leq 3 \text{ m}^2$   $\leq 260 \times 1.30\text{W}$

$\leq 6 \text{ m}^2$   $\leq 310 \times 1.30\text{W}$

$> 6 \text{ m}^2$   $\leq (310+150*(A_{max}- 6)) \times 1.30\text{W}$

$A_{Max/video}$  On Mode (normal operation)

$\leq 6.6 \text{ m}^2$   $\leq 260 \text{ W}$

$\leq 13.3 \text{ m}^2$   $\leq 310 \text{ W}$

$> 13.3 \text{ m}^2$   $\leq 310+150*(A_{max}- 13.3) \text{ W}$

Projectors with a throw ratio of 0.82 and less 30% more energy consumption is allowed.

$\leq 6.6 \text{ m}^2$   $\leq 260 \times 1.30\text{W}$

$\leq 13.3 \text{ m}^2$   $\leq 310 \times 1.30\text{W}$

$> 13.3 \text{ m}^2$   $\leq (310+150*(A_{max}- 13.3)) \times 1.30\text{W}$

*Eco mode*  $\leq 90\%$  of the measured *On Mode (normal operation)* value.

Standby Mode  $\leq 1\text{W}$

Off Mode  $\leq 1\text{W}$

There shall be an adequate description explaining how the projector is brought into its energy mode(s) and how this will be indicated on the projector. The description shall be signed by the responsible person at the applicant company and submitted to the test laboratory.

3. It shall be possible to set the projector to automatically enter Standby mode, after a specified time period when the video or computer interface is disconnected.

4. Energy consumption levels in all modes shall be declared in the user manual and product specification. There shall be an adequate description explaining how the projector is brought into its energy mode(s) and how this will be indicated on the projector.

For Class A products pursuant to Part 15 subpart B of the FCC Rules or IEC/EN 55022

*TCO Development reserves the right to introduce new energy levels to allow certification of class A projectors in TCO Certified Projectors 1.1. )*

**B.6.3.1.5 Overall uncertainty**

The uncertainty in the test results shall be better than  $\pm 5\%$ .

## B.6.4 Environmentally hazardous substances

### B.6.4.1 Cadmium (Cd), mercury (Hg), lead (Pb) and hexavalent chromium (CrVI)

Exemptions are according to EU Directive 2002/95/EC (RoHS) and the documents supporting the directive.

Limit values for cadmium, lead and hexavalent chromium are according to EU Directive 2002/95/EC (RoHS) and the documents supporting the directive.

TCO Development supports the use of recycled plastic. To avoid making it more difficult to use recycled plastic, exceptions to this requirement can be accepted. If recycled plastic is used in the product please contact TCO Development for further instructions.

### B.6.4.2 Halogenated substances

1. Plastic components weighing more than 25 g shall not contain flame retardants or plasticizers that contain organically bound chlorine or bromine.

2. The **whole projector** (for definition see A.1.1) shall not contain PBB and PBDE.

Printed Wiring Boards are included.

The limit value will be according to EU Directive 2002/95/EC (RoHS), the following amendments to the Directive and other documents supporting the Directive. The limit value for PBB and PBDE, including decaBDE (see list below) is 0.1 % by weight in homogeneous materials.

Monobromodiphenyl ether (monoBDE)	CAS no 101-55-3
Dibromodiphenyl ether (diBDE)	CAS no 2050-47-7
Tribromodiphenyl ether (triBDE)	CAS no 49690-94-0
Tetrabromodiphenyl ether (tetraBDE)	CAS no 40088-47-9
Pentabromodiphenyl ether (mentaBBDE)	CAS no 32534-81-9
Hexabromodiphenyl ether (hexaBDE)	CAS no 36483-60-0
Heptabromodiphenyl ether (heptaBDE)	CAS no 68928-80-3
Octabromodiphenyl ether (octaBDE)	CAS no 32536-52-0
Nonabromodiphenyl ether (nonaBDE)	CAS no 63936-56-1
Decabromodiphenyl ether (decaBDE)	CAS no 1163-19-5
Decabromobiphenyl (DeBB)	CAS nr 13654-09-6

TCO Development supports the use of recycled plastic. To avoid making it more difficult to use recycled plastic, exceptions to this requirement can be accepted. If recycled plastic is used in the product please contact TCO Development for further instructions.

### B.6.4.3 Non-halogenated substances

There are currently two EU directives describing classification of chemicals. Classification, Labelling and Packaging of Substances and Mixtures, known as the CLP Regulation, EC 1272/2008 will replace directives 67/548/EEG and 1999/45/EG.

To determine if a substance has been assigned a specific R-phrase, please check the substance against the information in the European chemical Substance Information System (<http://ecb.jrc.ec.europa.eu/esis/>).

See below for a restricted substances list matching:

<b>R-phrase (according to 67/548/EEG)</b>	<b>Phrase</b>	<b>H-statement (according to EC 1272/2008)</b>	<b>Statement</b>
<b>Human health hazards</b>			
<b>R40</b>	Limited evidence of a carcinogenic effect	<b>H351</b>	Suspected of causing cancer
<b>R45</b>	May cause cancer	<b>H350</b>	May cause cancer
<b>R46</b>	May cause heritable genetic damage	<b>H340</b>	May cause genetic defects
<b>R48</b>	Danger of serious damage to health by prolonged exposure	<b>H372</b>	Causes damage to organs through prolonged or repeated exposure
<b>R60</b>	May impair fertility	<b>H360F</b>	May damage fertility
<b>R61</b>	May cause harm to the unborn child	<b>H360D</b>	May damage the unborn child
<b>Environmental hazards</b>			
<b>R50/53</b>	Toxic to aquatic organisms/may cause long-term adverse effects in the aquatic environment	<b>H411</b>	Toxic to aquatic life with long lasting effects

TCO Development supports the use of recycled plastic. To avoid making it more difficult to use recycled plastic, exceptions to this requirement can be accepted. If recycled plastic is used in the product please contact TCO Development for further instructions.

### B.6.4.4 Plastics with chlorine and bromine as part of the polymer

TCO Development supports the use of recycled plastic. To avoid making it more difficult to use recycled plastic, exceptions to this requirement can be accepted. If recycled plastic is used in the product please contact TCO Development for further instructions.

## **B.6.5 Product lifetime**

### **B.6.5.1 Warranty and spare parts**

That spare parts shall be available for three years from “the time that production ceases” is only applicable to the production of the specific projector, certified by the brand owner.

Regarding spare parts:

1. If a part of a product is broken the end user shall not need to replace the whole product, only the broken part. The broken part shall be possible to replace with an equivalent part (this part does not have to be identical to the broken part).
2. If the cost of replacing the broken part is not economically reasonable for the end user, it is acceptable to replace the whole product.

## **B.6.6 Preparation for recycling**

### **B.6.6.1 Material coding of plastics**

If the amount of flame retardant exceeds 1 % by weight the coding shall be complemented in accordance with ISO 1043-4.

### **B.6.6.2 Variety of plastics**

Clarification: A different additive marking will not make the plastic a different plastic type. For example ABS with FR40 and ABS with FR50 is considered *one* plastic type (two are still allowed).

### **B.6.6.3 Moulded-in metal parts and metallization of plastic housing**

The requirement applies to the outer plastic casing. Housings for electronic components inside the outer casing are not included in the requirement.

When the virgin plastic already in its granulated form contains additives, consisting for example of metal oxides in the form of pigment or metal flakes, this is not considered to be metallization, and is not included in the prohibitions defined in A.6.6.3.

Metallized plastic control buttons for the adjustment of screen contrast, brightness, colour, etc. are accepted.

Metal parts and metallised plastics parts such as logotype, brand name, and design details are acceptable if they are of snap-fastening type or can be easily removed using standard tools. Moulded-in or glued metal parts are not accepted.

Clarification: All exceptions on metallised parts described above must fulfil the RoHS Directive.

### **B.6.6.4 Take back system**

Tick the box of the option chosen.

If the applicant chooses **option 1** (*Product only sold on markets with WEEE legislation or similar*) and signs the declaration, the requirement is fulfilled.

If **option 2 or 3** (*World-wide product take back or One additional market lacking WEEE legislation where product take back is offered*) is chosen, the declaration must be signed and the applicant must provide a short description of how the take-back system on that market works. This can also be done by giving a reference (for example a link to a website) to the representative, associated company or affiliate taking care of the take-back system on that market.

In case of option 3 the applicant must also provide the name of the market (country) where a take back system is provided.

TCO Development has no requirement on the take-back system being free of charge.

It is important to point out that any recycling and waste export control legislation in countries where the applicant company operates must always be met.

## **B.6.7 Product packaging**

### **B.6.7.1 Hazardous substances in product packaging**

Limit values are according to Directive 94/62/EC on packaging and packaging waste.