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Task: Appraisal of the viewing cabinets
according to ISO 3664:2009.

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Submitted devices: CCS LED 130/2, CMB LED 70/5,
ADDENDUM:
PVB LED 501/3 C PRO

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1. Task

The viewing cabinets CCS LED 130/2, CMB LED 70/5 and PVB LED 501/3 C PRO shall be scrutinized according to the criteria for critical appraisal P1 stipulated by ISO 3664:2009.

2. Bibliography

- [1] Standard: ISO 3664:2009
Viewing conditions – Graphic technology and photography
Berlin: Beuth-Verlag, www.beuth.de

- [2] Standard: CIE 13.3-1995
Method of Measuring and Specifying Colour Rendering
Properties of Light Sources
CIE Publication, <http://www.cie.co.at/framepublications.html>

- [3] CIE Report 51.2 : 1999
A method for assessing the quality of daylight simulators for
colorimetry
CIE Publication, <http://www.cie.co.at/framepublications.html>

- [4] Standard: ISO 23603
Standard method of assessing the spectral quality of daylight
simulators for visual appraisal and measurement of colour
Berlin: Beuth-Verlag, www.beuth.de

- [5] CIE Report S012/E:2004
Standard Method of Assessing the Spectral Quality of Daylight
Simulators for Visual Appraisal and Measurement of Colour
CIE Publication, <http://www.cie.co.at/framepublications.html>

- [6] Standard: ISO 13655:2009
Graphic technology -- Spectral measurement and colorimetric
computation for graphic arts images
Berlin: Beuth-Verlag, www.beuth.de

3. Tested viewing cabinets and set ups

Details of the tested cabinets are shown in Table 1.

<i>Name</i>	<i>Surface of Viewing [mm]</i>
CCS LED 130/2	1300x910
CMB LED 70/5	700x500
PVB LED 501/3 C PRO	480x200

Table 1: Technical details of the tested viewing cabinets.

The tested set ups are presented in Table 2.

<i>Set up ID</i>	<i>Viewing cabinet</i>	<i>Appraisal</i>	<i>Illuminance</i>
01	CCS LED 130/2	P1	2000 lx
02	CMB LED 70/5	P1	2000 lx
03	PVB LED 501/3 C PRO	P1	2000 lx

Table 2: Tested set ups.

4. Test conditions

The test was conducted at the manufacturer premises in Tomaszow Mazowiecki, Poland.

5. Measurement devices

To determine the colour rendering properties of the viewing cabinet it is necessary to measure the spectral power distribution of the illumination. The light measurements are performed with a GL SPECTIS 5.0 TOUCH spectrometer. This measurement device allows measurement of the spectral irradiance and fulfils the requirements of ISO 3664:2009, namely to cover the wavelength range from 300 to 730 nm and to have a bandpass of 5 nm or narrower. It offers a calibrated wavelength range from 200 nm to 1050 nm with an optical resolution of 2.5 nm.

The spectral irradiance is assessed in the plane of viewing.

Uniformity measurement is derived from nine representative measurements: left, centre, right for each of front, middle and backside of the relevant format. The measurements of the surround (the bottom part of the viewing cabinet) are performed with Konica Minolta FD-7 according to [6].

6. Viewing condition criteria to be tested

ISO 3664:2009 defines criteria and corresponding tolerances for viewing conditions for images on reflective media, such as prints. It defines two levels of illumination; a high level for critical evaluation and comparison (ISO viewing condition P1), and a lower level for practical appraising the tone scale of an individual image under illumination levels similar to those under which it will be finally viewed (ISO viewing condition P2). It should be noted that except of the illumination level the same criteria apply for P2. According to the ISO 3664:2009 the following properties of a viewing cabinet are to be checked:

- Chromaticity
- M_{vis} , the visible range metamerism index
- M_{UV} , the ultraviolet range metamerism index
- Colour rendering index
- Illuminance and uniformity
- Neutral surround and diffuse reflecting surface
- Maintenance

7. Test criteria

Chromaticity

The chromaticity coordinates $CIExy$ and $CIEu'v'$ for the 10° standard observer are calculated based on the spectral illuminance. The maximum deviation shall be below $\Delta u'=0.005$, $\Delta v'=0.005$ from the

chromaticity of standard illuminant D50 ($u'_{10}=0.2102$, $v'_{10}=0.4889$).

The results are given in Table 3.

<i>Set up ID</i>	<i>CIE u'_{10}</i>	<i>CIE v'_{10}</i>	<i>$\Delta u'$</i>	<i>$\Delta v'$</i>	<i>Tol.</i>	<i>Result</i>
01	0.2123	0.4925	0.002	0.004	0.005	OK
02	0.2104	0.4913	0.0002	0.002	0.005	OK
03	0.2128	0.4919	0.003	0.003	0.005	OK

Table 3: Examination of the chromaticity

The results show good conformance.

The visible range metamerism index MI_{vis}

The use of virtual metamers serves as an indirect method for checking the spectral distribution of the light source to be tested. In contrast to the metamers in the ultraviolet spectral region, the quality of the colour reproduction for samples without or with little optical brighteners can be inferred using the visible range metamers.

The metamerism indexes are classified into five different conformity classes according to [4], see Table 4. The MI_{vis} should fall into category B and shall fall into category C.

<i>Quality grade</i>	<i>MI_{vis} or MI_{UV}</i>
A	≤ 0.25
B	>0.25 to 0.5
C	>0.5 to 1
D	>1 to 2
E	> 2

Table 4: Quality grade vs metamerism index (MI_{vis} or MI_{UV}) [4].

The results of the evaluation of the MI_{vis} are presented in Table 5.

<i>Set up ID</i>	<i>MI_{vis}</i>	<i>Class</i>	<i>Target (minimum)</i>	<i>Result</i>
01	0.9	Class C	Class C	OK
02	0.9	Class C	Class C	OK
03	0.8	Class C	Class C	OK

Table 5: Evaluation results for MI_{vis}.

The colour rendering criterion for the visible spectral range is fulfilled.

The UV range metamerism index MI_{UV}

The spectral power distribution in the UV-range is important for a defined excitation of optical brightener agents used typically used in graphic arts papers. The requirements of ISO 3664 correspond to the spectral power distribution of measurement condition M1 specified in ISO 13655. MI_{UV} shall be less than 1.5 and should be less than 1. The results of the evaluation of the MI_{UV} are presented in Table 6.

<i>Set up ID</i>	<i>MI_{UV}</i>	<i>Tolerance</i>	<i>Result</i>
01	1.3	<1.5	OK
02	1.2	<1.5	OK
03	0.5	<1.5	OK

Table 6: Evaluation results for MI_{UV}.

The colour rendering criterion for the UV spectral range is fulfilled.

Colour Rendering Index (CRI)

The CIE general colour rendering index shall have a value of 90 or higher. In addition, the separate special colour rendering indices for samples 1 to 8 as defined in [2] shall each have a value of 80 or higher [2]. The calculation is based on the relative spectral power distribution. The results are given in Table 7.

Illuminance and uniformity

The illuminance for the critical appraisal P1 shall be 2000 lx \pm 500 lx, and should be 2000 lx \pm 250 lx. For the practical appraisal P2 the illuminance shall be 500 lx \pm 125 lx. In both cases the illuminance shall be measured at the centre of the illuminated viewing surface area. The evaluation of the illuminance is given in Table 8.

For P1 a viewing area up to 1 metre square, the illuminance at any point within the illuminated area shall not be less than 75 % of the illuminance measured at the centre of the illuminated viewing surface area. The uniformity is evaluated by measuring at 9 points, equally distributed on the viewing surface. The results are given in Table 9, Table 10 and Table 11. In each of the cases, centre point of the viewing plane serves as the reference.

<i>CRI</i>	<i>ID01</i>	<i>ID02</i>	<i>ID03</i>	<i>Minimum</i>	<i>Erg.</i>
Ra	96.7	98.0	98.0	90	OK
FWI #1	97.5	98.3	97.4		
FWI #2	99.3	99.8	99.2		
FWI #3	93.1	95.5	92.8		
FWI #4	97.5	98.8	97.4		
FWI #5	98.1	98.5	98.1	80	OK
FWI #6	97.2	98.2	96.9		
FWI #7	97.2	98.3	97.3		
FWI #8	95	96.9	95.1		

Table 7: Conformance of the colour rendering indices.

<i>Set up ID</i>	<i>Illuminance</i>	<i>Tolerance</i>	<i>Result</i>
01	1618 lx	2000 lx ± 500 lx	OK
02	1947 lx	2000 lx ± 500 lx	OK
03	1877 lx	2000 lx ± 500 lx	OK

Table 8: Conformance of the illuminance of the viewing cabinets.

<i>Position</i>	<i>Left</i>	<i>Centre</i>	<i>Right</i>	<i>Tolerance</i>	<i>Result</i>
Back	79%	88%	81%	≥75%	OK
Centre	91%	100%	93%	≥75%	OK
Front	82%	88%	82%	≥75%	OK

Table 9: Normalized illuminance in percent for the set up ID01. Centre point of the viewing plane serves as the reference.

<i>Position</i>	<i>Left</i>	<i>Centre</i>	<i>Right</i>	<i>Tolerance</i>	<i>Result</i>
Back	81%	89%	75%	≥75%	OK
Centre	82%	100%	83%	≥75%	OK
Front	80%	92%	77%	≥75%	OK

Table 10: Normalized illuminance in percent for the set up ID02. Centre point of the viewing plane serves as the reference.

<i>Position</i>	<i>Left</i>	<i>Centre</i>	<i>Right</i>	<i>Tolerance</i>	<i>Result</i>
Back	91%	117%	95%	≥75%	OK
Centre	80%	100%	80%	≥75%	OK
Front	97%	115%	95%	≥75%	OK

Table 11: Normalized illuminance in percent for the set up ID03. Centre point of the viewing plane serves as the reference.

8. Surround

To aid a neutral chromatic adaption of the eye the surround and backing shall be neutral and matt. To achieve this the surround of a print shall have a diffuse reflecting surface and a CIELAB chroma value no greater than 2. The chroma value is calculated as the mean of the measurements at different locations of the surround (e.g. bottom and walls of viewing cabinets). In addition, the luminous reflectance CIE Y shall be between 10 % and 60 % (20 % is recommended for critical appraisal). The results are given in Table 12.

	<i>ID01</i>	<i>ID02</i>	<i>ID03</i>	<i>Tolerance</i>	<i>Result</i>
CIE C*	0.6	0.6	0.6	≤2	OK
CIE Y in %	26%	26%	26%	≥10% and ≤60%	OK
Surface	diffuse	diffuse	diffuse	diffuse	OK

Table 12: Evaluation of conformity of the surround. Measurements are mean values from five readings.

9. Requirements for practical setup

Manufacturers of viewing apparatus shall specify the average number of hours during which the apparatus is expected to remain within specification. The apparatus should include a time-metering device or some other mechanism for indicating degradation. However, it is the responsibility of the user, both before and beyond this time limit, to undertake measurements to ensure compliance, unless it can be otherwise demonstrated that the equipment remains within tolerance [1].

The control panels of the tested cabinets ID01 and ID02 inform the user about the number of hours the devices were used, hence the requirement for the practical setup is fully satisfied. The cabinet with ID03 satisfies the requirement as well with the help of a status LED.

The LED changes this colour from green to orange to red over the course of the usage of the cabinet. Whereas red indicates the cabinet should be validated again.

10. Conclusion

All three viewing cabinets, namely CCS LED 130/2, CMB LED 70/5 and PVB LED 501/3 C PRO fulfil all normative criteria for critical appraisal P1 according to ISO 3664:2009.

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