



Efficient Colour Workflow for Display and Printer Output in Offices based on Elementary Colours of CIE R1-47 and ISO 9241-306

Version 1.0, (30 pages, 300 KB), [/CIE_ECWG_10.PDF](#)

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For recent publications of the TUB group see: <http://130.149.60.45/~farbmetrik/XY91FEN.html>

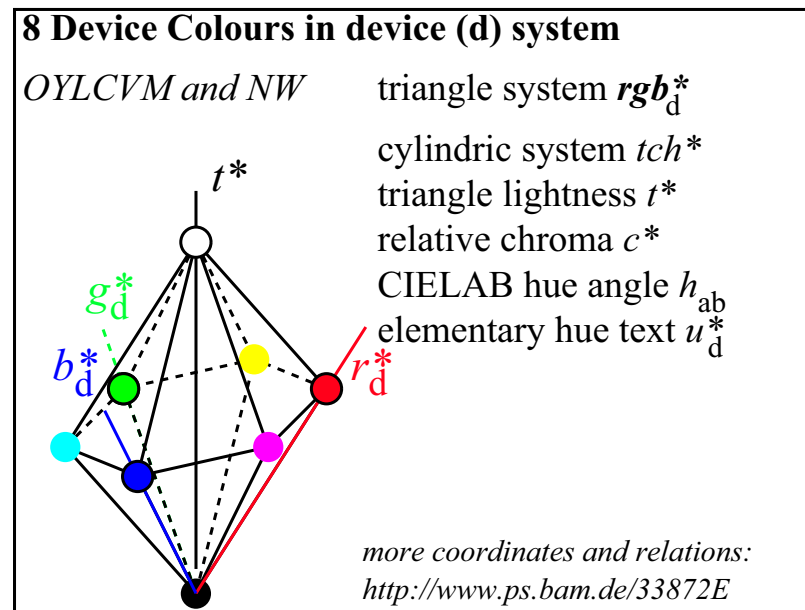
Introduction

The report CIE R1-47:2009 “Hue Angles of Elementary Colours” is used to define an efficient colour workflow for displays and printers in offices. The workflow is more efficient compared to a workflow of ISO 15076-1 in Annex A which is called the *ICC* workflow.

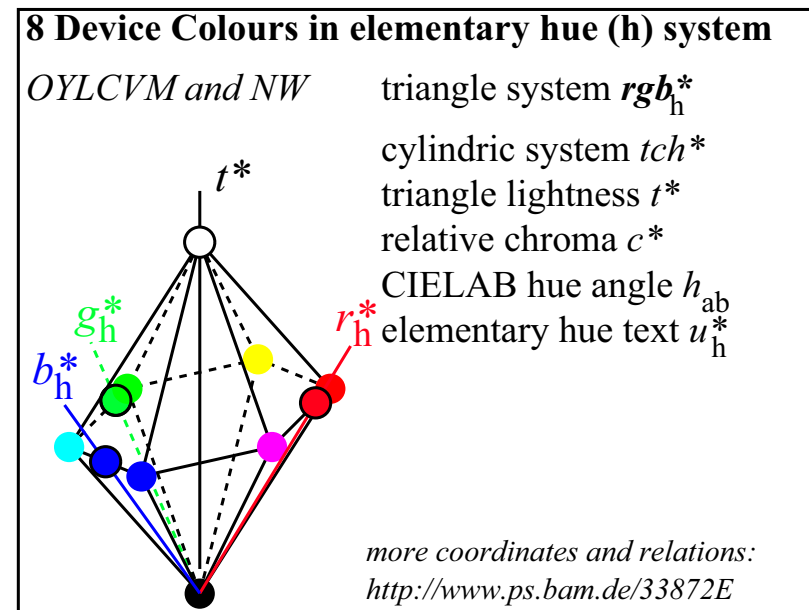
This paper defines an efficient description of the device gamut by visual human *rgb** coordinates. For example elementary Red *R* is defined by a visual criteria Red *R* as neither yellowish nor blueish.

Achromatic colours	Elementary colours "Neither-nor"-colours	Reproduction colours <i>Television (TV), Print (PR) Photography (PH)</i>
<i>five achromatic colours:</i>	<i>four elementary colours:</i>	<i>six reproduction colours:</i>
<i>N</i> black (french noir)	<i>R</i> red <i>neither yellowish nor blueish</i>	<i>C</i> cyanblue
<i>D</i> dark grey	<i>G</i> green <i>neither yellowish nor blueish</i>	<i>M</i> magentared
<i>Z</i> central grey	<i>B</i> blue <i>neither greenish nor reddish</i>	<i>Y</i> yellow
<i>H</i> light grey	<i>J</i> yellow (french jaune) <i>neither greenish nor reddish</i>	<i>O</i> orangered
<i>W</i> white		<i>L</i> leafgreen
		<i>V</i> violetblue

YE980-3



IE151-2N



IE151-4N

Figure 1: Definition of device and elementary colours and systems

There are 6 chromatic device colours: **OYLCVM** (e. g. *L*=Leaf green)

There are 4 chromatic elementary colours: **RJGB** (e. g. *J*=Yellow)

In addition for the most chromatic colours of a device one of the three coordinates rgb^* have the **value 1** and one other have the **value 0**.

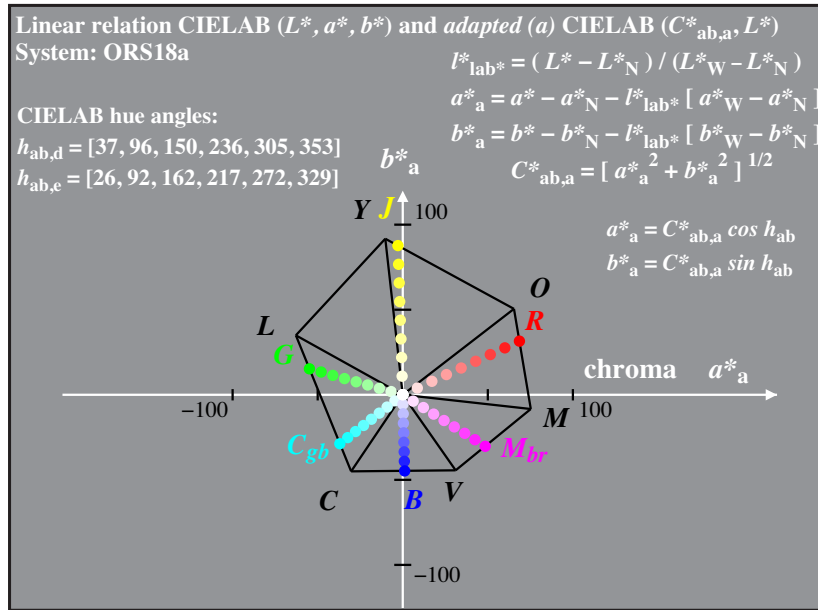
For example the yellow red colours have the values $rgb^* = \mathbf{1 \ x \ 0}$ with $x=0$ for elementary Red *R* and $x=1$ for elementary Yellow *J*.

Therefore for all yellow red colours x is in the range $0 \leq x \leq 1$.

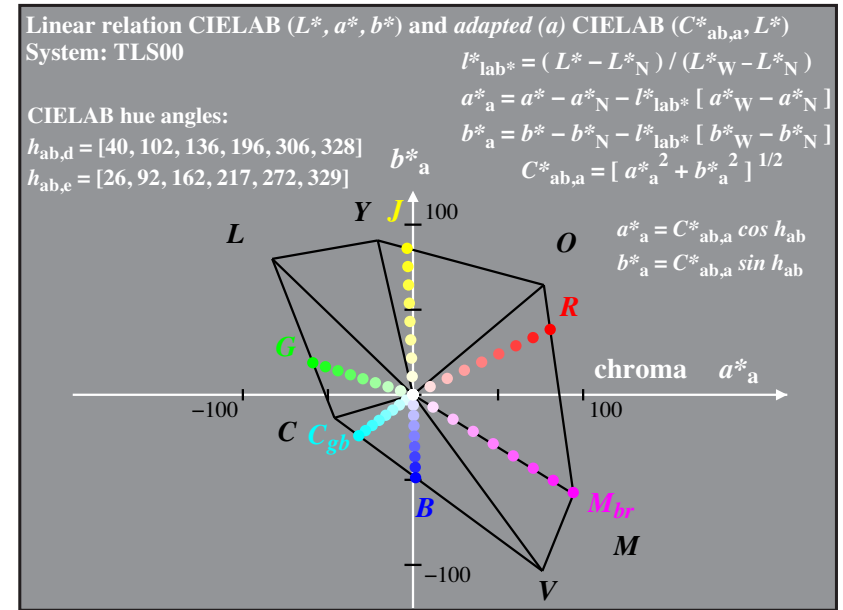
In CIE XYZ space and in any hue plane any colour of a *display* is located exactly within a colour **triangle**.

The colours of this triangle are defined by the three colours Black *N*, most chromatic *X*, and White *W*.

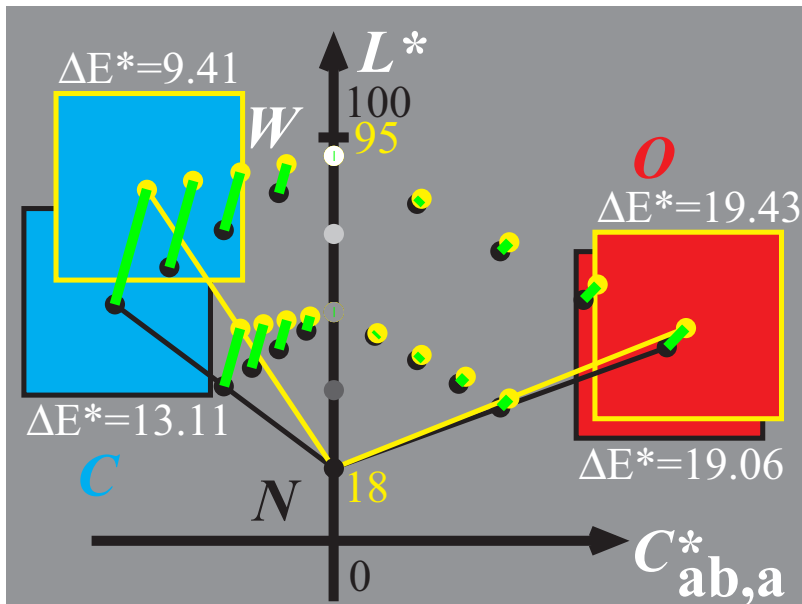
In CIELAB space the three colours *N* - *X* - *W* are still approximately on a colour triangle for any CIELAB hue h_{ab} in any hue plane L^* , C^*_{ab} .



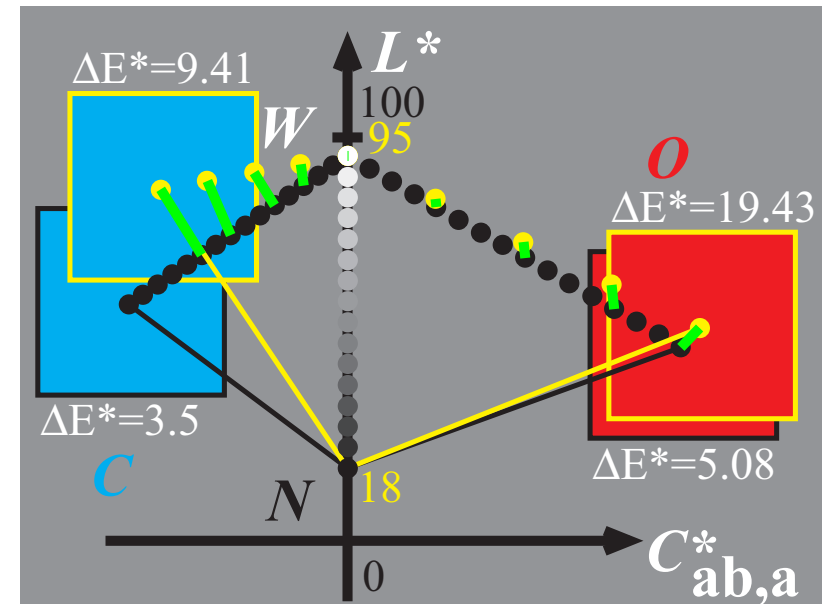
JE450-3N



JE450-7N



ZE421-4

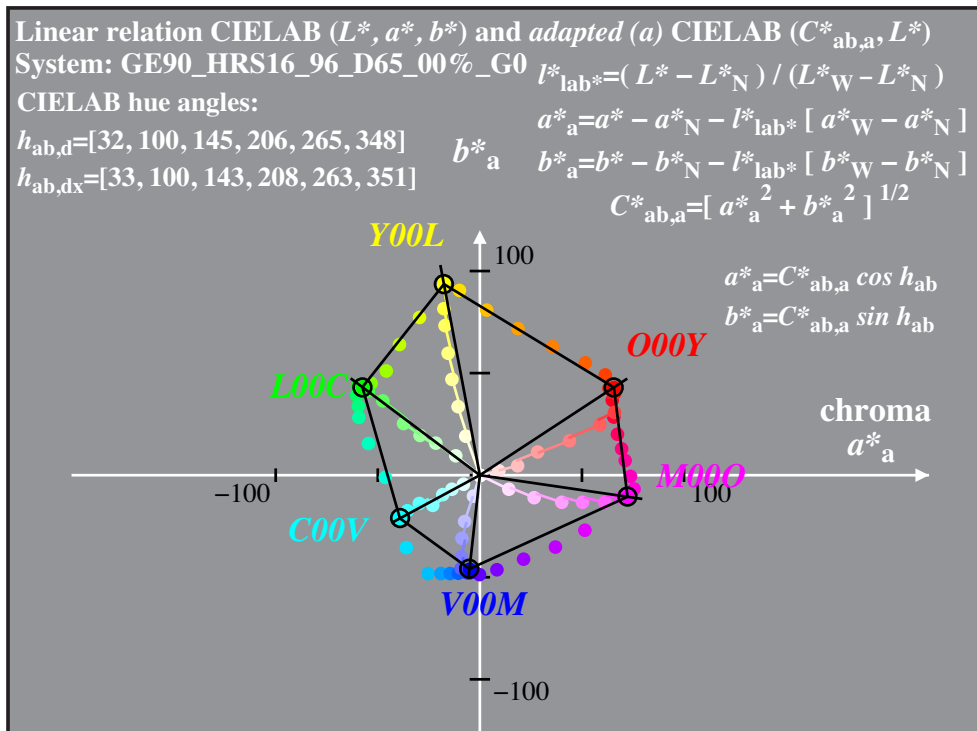


ZE421-5

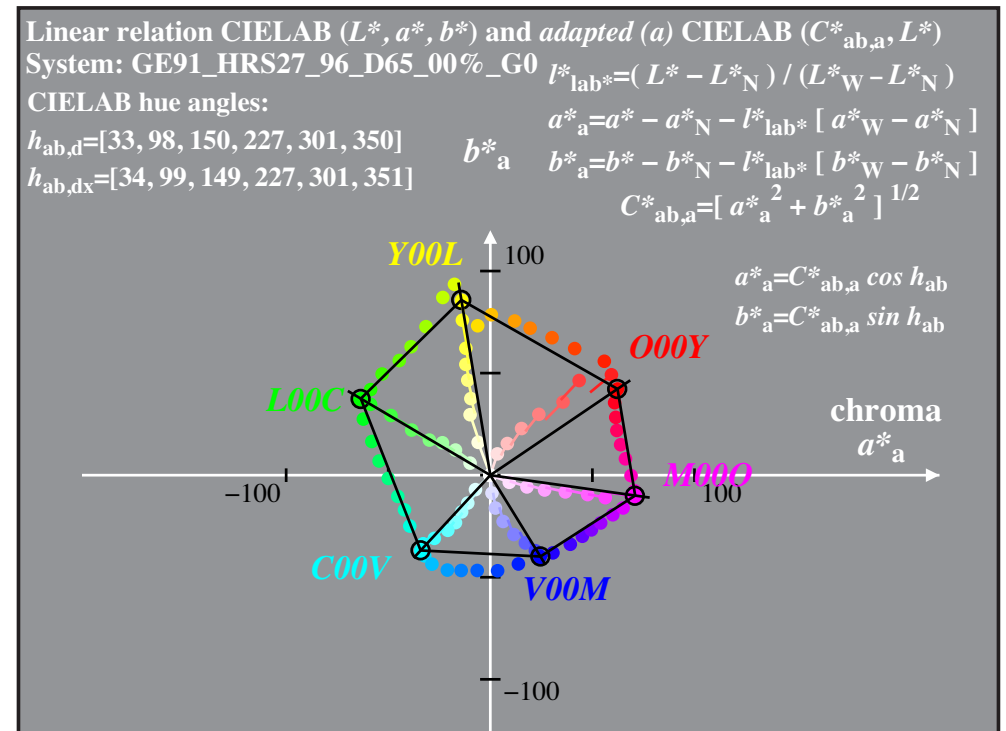
Figure 2: Hues; softcopy - hardcopy; matching and “affine” transfer

Often the display output serves as reference for the printer output. In CIELAB space this leads to an **affine** transformation which transfers the hue triangle of a display into a hue triangle of a printer for any hue.

Some displays and printers already produce the elementary hue output instead of the device hue output. For *rgb* input data Fig. 3 shows approximately elementary Blue *B* (272 degree) but not for *cmj* input data



GE90-4A, 1; cf1=0.90; nt=0.18; nx=1.0

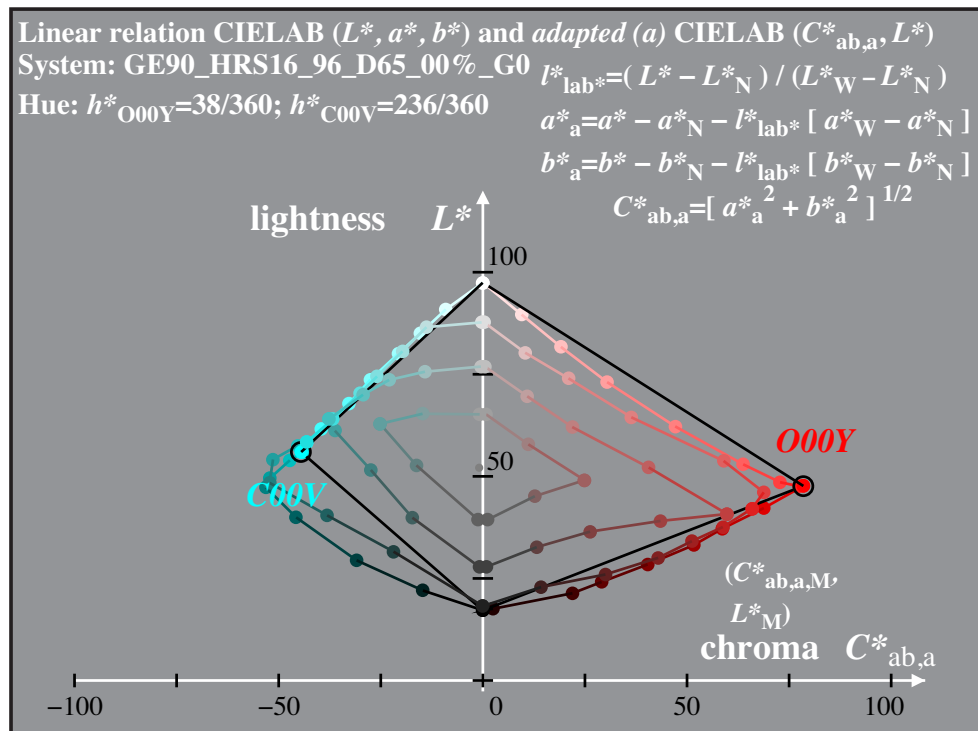


GE91-4A, 1; cf1=0.95; nt=0.18; nx=1.0

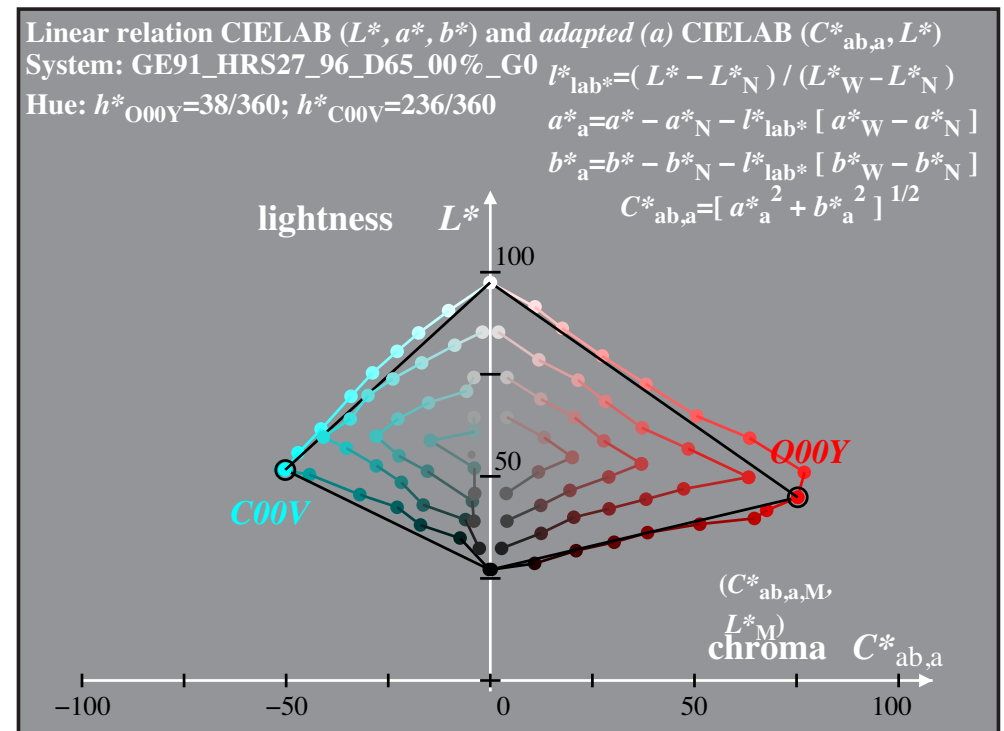
Figure 3: “Elementary” and device hue output by *rgb* and *cmj* input

According to ISO/IEC TR 19797 a continuous and roughly equally spaced output is required as setup_state for colour management.

For example this is not the case for an “*rgb* printer” with *rgb* input data (*left*). For *cmv* input data (*right*) this printer produces a regular output and this setup_stage can be used for colour management.



GE900-1A, 1; cf1=0.90; nt=0.18; nx=1.0



GE910-1A, 1; cf1=0.95; nt=0.18; nx=1.0

Figure 4: Output colours in (C^*_{ab} , L^*) plane for *rgb* and *cmv* input

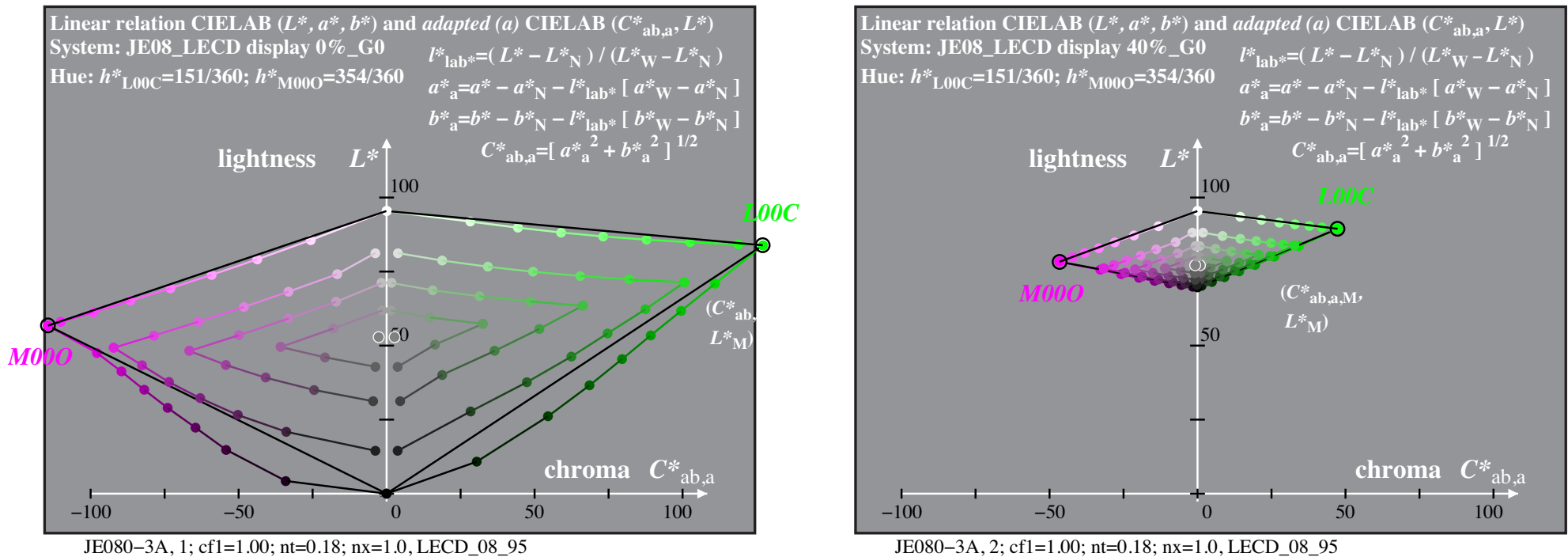


Figure 5: Output colours in (C^*_{ab} , L^*) for LECD with $L_r=0$ and 40%

Figure 5 shows the output colours in a (C^*_{ab} , L^*) hue plane for an LCD display with LED backlight and luminance reflections $L_r=0\%$ and $L_r=40\%$.

There is a decrease of the grey and chromatic range to 30%. Therefore the 3D size (volume) of the output gamut reduces from 100% for $L_r=0\%$ to about 3% for $L_r=40\%$. The last case may occur for a data projector. In this case the grey output is not equally spaced.

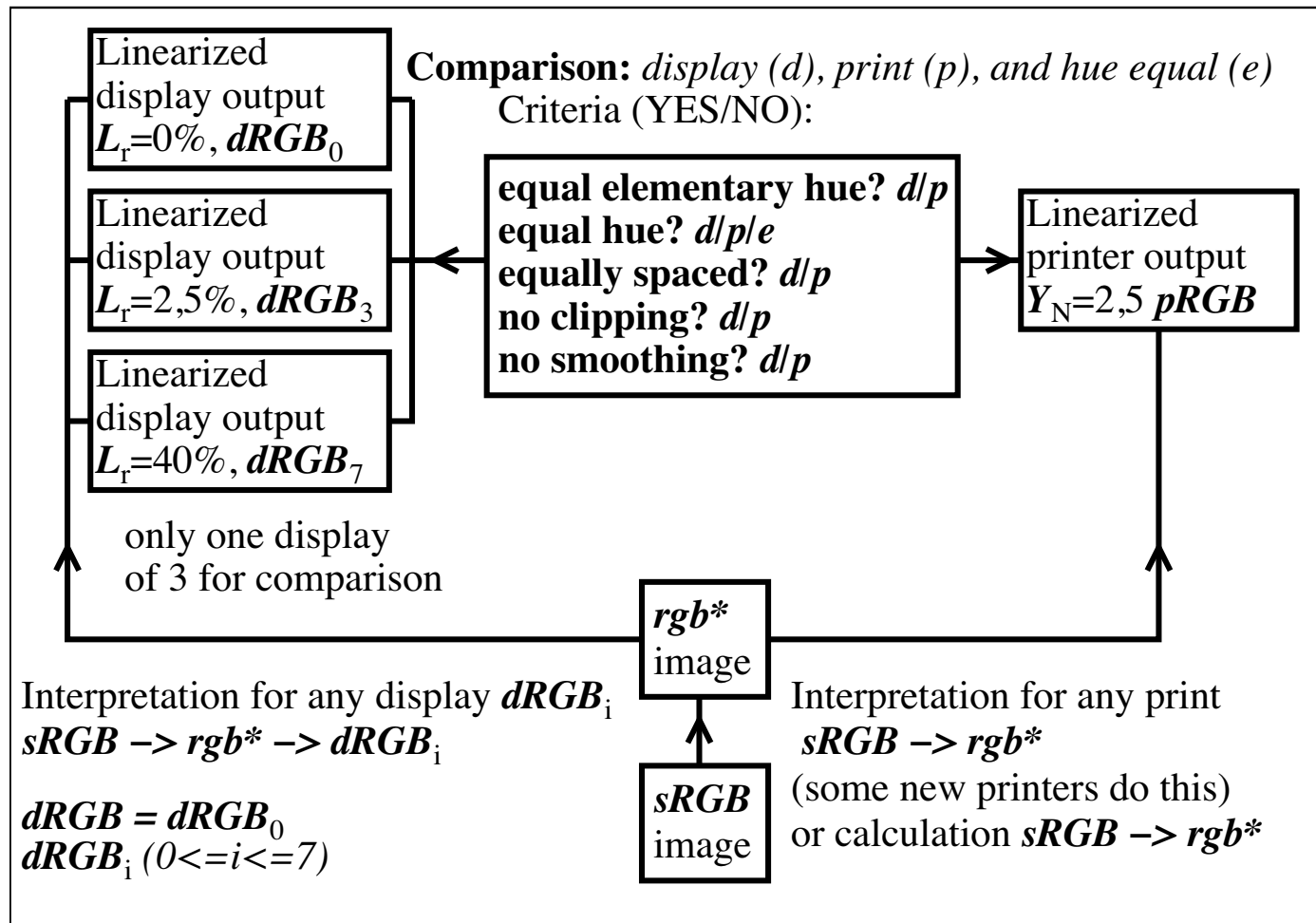


Figure 6: Workflow rgb interpretation as elementary colours rgb^* and rgb^* linearization

The rgb^* data are used for linearization and this will produce on all devices the elementary and equal hues, equal spacing, and *no* clipping.

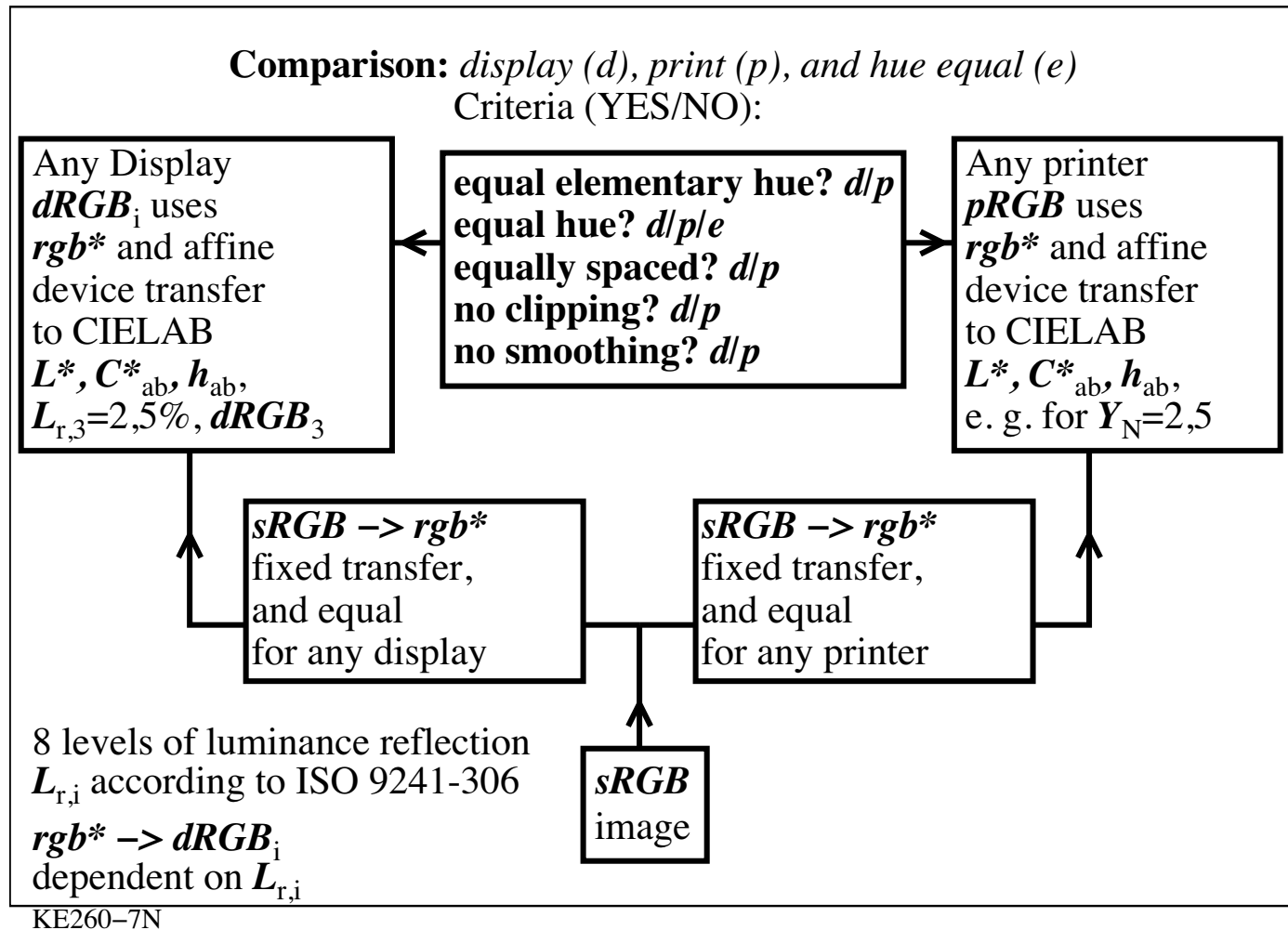


Figure 7: Workflow rgb interpretation as elementary colours rgb^* and rgb^* linearization

Figure 7 indicates, that the transfer between $sRGB$ and rgb^* is *independent and equal* for any display or printer output.



rgb → *rgb** and CIE data of a elementary hue circle according to CIE R1-47:2009 for sRGB display $L_r=2,5\%$

3 colours of the elementary hues RJGB: $h_{ab,a} = 25.4, 92.3, 162.2, 271.7$

Code	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	<i>rgb</i> → <i>rgb*</i>
<i>r00j=R</i>	53.0	72.6	34.5	80.4	25.4	1.00 0.00 0.00
<i>0,5(R+N)</i>	35.5	36.3	17.2	40.2	25.4	0.50 0.00 0.00
<i>0,5(R+W)</i>	74.2	36.3	17.2	40.2	25.4	1.00 0.50 0.50
<i>j00g=J</i>	83.8	-3.0	77.4	77.5	92.2	1.00 1.00 0.00
<i>0,5(J+N)</i>	50.9	-1.5	38.7	38.7	92.2	0.50 0.50 0.00
<i>0,5(J+W)</i>	89.6	-1.5	38.7	38.7	92.2	1.00 1.00 0.50
<i>g00b=G</i>	85.4	-61.5	19.7	64.6	162.1	0.00 1.00 0.00
<i>0,5(G+N)</i>	51.7	-30.7	9.8	32.3	162.1	0.00 0.50 0.00
<i>0,5(G+W)</i>	90.4	-30.7	9.8	32.3	162.1	0.50 1.00 0.50
<i>b00r=B</i>	60.9	1.6	-53.5	53.6	271.7	0.00 0.00 1.00
<i>0,5(B+N)</i>	39.4	0.8	-26.7	26.8	271.7	0.00 0.00 0.50
<i>0,5(B+W)</i>	78.1	0.8	-26.7	26.8	271.7	0.50 0.50 1.00

5 step equidistant grey scale: $L^* = 18.0, 37.3, 56.7, 76.0, 95.4$

Code	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	<i>rgb</i> → <i>rgb*</i>
<i>n000w=N</i>	18.0	0.0	0.0	0.0	0.0	0.00 0.00 0.00
<i>n025w</i>	37.3	0.0	0.0	0.0	325.3	0.25 0.25 0.25
<i>n050w</i>	56.7	0.0	0.0	0.0	324.8	0.50 0.50 0.50
<i>n075w</i>	76.1	0.0	0.0	0.0	323.7	0.75 0.75 0.75
<i>n100w=W</i>	95.4	0.0	0.0	0.0	0.0	1.00 1.00 1.00

KE171-8N, LAB*la3, adapted=not adapted

rgb → *rgb** and CIE data of a elementary hue circle according to CIE R1-47:2009 for offset print

3 colours of the elementary hues RJGB: $h_{ab} = 25.4, 92.3, 162.2, 271.7$

Code	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	<i>rgb</i> → <i>rgb*</i>
<i>r00j=R</i>	48.7	66.7	31.8	73.9	25.4	1.00 0.00 0.00
<i>0,5(R+N)</i>	35.5	33.3	15.9	36.9	25.4	0.50 0.00 0.00
<i>0,5(R+W)</i>	72.5	33.3	15.9	36.9	25.4	1.00 0.50 0.50
<i>j00g=J</i>	86.1	-3.3	83.2	83.3	92.3	1.00 1.00 0.00
<i>0,5(J+N)</i>	54.2	-1.6	41.6	41.6	92.3	0.50 0.50 0.00
<i>0,5(J+W)</i>	91.2	-1.6	41.6	41.6	92.3	1.00 1.00 0.50
<i>g00b=G</i>	56.9	-61.5	19.6	64.5	162.2	0.00 1.00 0.00
<i>0,5(G+N)</i>	39.6	-30.7	9.8	32.2	162.2	0.00 0.50 0.00
<i>0,5(G+W)</i>	76.6	-30.7	9.8	32.2	162.2	0.50 1.00 0.50
<i>b00r=B</i>	41.2	1.3	-45.0	45.0	271.7	0.00 0.00 1.00
<i>0,5(B+N)</i>	31.7	0.6	-22.5	22.5	271.7	0.00 0.00 0.50
<i>0,5(B+W)</i>	68.8	0.6	-22.5	22.5	271.7	0.50 0.50 1.00

5 step equidistant grey scale: $L^* = 22.2, 40.7, 59.3, 77.8, 96.3$

Code	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	<i>rgb</i> → <i>rgb*</i>
<i>n000w=N</i>	22.5	0.0	0.0	0.0	37.9	0.00 0.00 0.00
<i>n025w</i>	40.8	-0.3	-1.4	1.4	256.8	0.25 0.25 0.25
<i>n050w</i>	59.2	-0.3	-1.8	1.8	258.1	0.50 0.50 0.50
<i>n075w</i>	77.8	-0.2	-1.4	1.4	259.2	0.75 0.75 0.75
<i>n100w=W</i>	96.4	0.0	0.0	0.0	100.0	1.00 1.00 1.00

KE110-8N, Offset print, model separation cmyn6*

rgb → *rgb** and CIE data of a elementary hue circle according to CIE R1-47:2009 for photo printer

3 colours of the elementary hues RJGB: $h_{ab} = 25.4, 92.3, 162.2, 271.7$

Code	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	<i>rgb</i> → <i>rgb*</i>
<i>r00j=R</i>	34.1	61.4	29.2	68.0	25.4	1.00 0.00 0.00
<i>0,5(R+N)</i>	21.4	30.7	14.6	34.0	25.4	0.50 0.00 0.00
<i>0,5(R+W)</i>	63.4	30.7	14.6	34.0	25.4	1.00 0.50 0.50
<i>j00g=J</i>	83.9	-4.3	106.1	106.2	92.3	1.00 1.00 0.00
<i>0,5(J+N)</i>	46.2	-2.1	53.0	53.1	92.3	0.50 0.50 0.00
<i>0,5(J+W)</i>	88.3	-2.1	53.0	53.1	92.3	1.00 1.00 0.50
<i>g00b=G</i>	46.8	-58.9	18.9	61.8	162.1	0.00 1.00 0.00
<i>0,5(G+N)</i>	27.7	-29.4	9.4	30.9	162.1	0.00 0.50 0.00
<i>0,5(G+W)</i>	69.7	-29.4	9.4	30.9	162.1	0.50 1.00 0.50
<i>b00r=B</i>	38.1	1.3	-43.4	43.5	271.7	0.00 0.00 1.00
<i>0,5(B+N)</i>	23.4	0.6	-21.7	21.7	271.7	0.00 0.00 0.50
<i>0,5(B+W)</i>	65.4	0.6	-21.7	21.7	271.7	0.50 0.50 1.00

5 step equidistant grey scale: $L^* = 8.6, 29.6, 50.6, 71.6, 92.6$

Code	L^*_a	a^*_a	b^*_a	$C^*_{ab,a}$	h_{ab}	<i>rgb</i> → <i>rgb*</i>
<i>n000w=N</i>	8.7	0.0	0.0	0.0	1.2	0.00 0.00 0.00
<i>n025w</i>	29.6	-0.3	-7.1	7.1	266.8	0.25 0.25 0.25
<i>n050w</i>	50.7	-2.8	-5.4	6.1	242.2	0.50 0.50 0.50
<i>n075w</i>	71.7	-1.8	-5.0	5.3	250.0	0.75 0.75 0.75
<i>n100w=W</i>	92.6	0.0	0.0	0.0	220.9	1.00 1.00 1.00

KE110-4N, photo printer, printer separation olv*

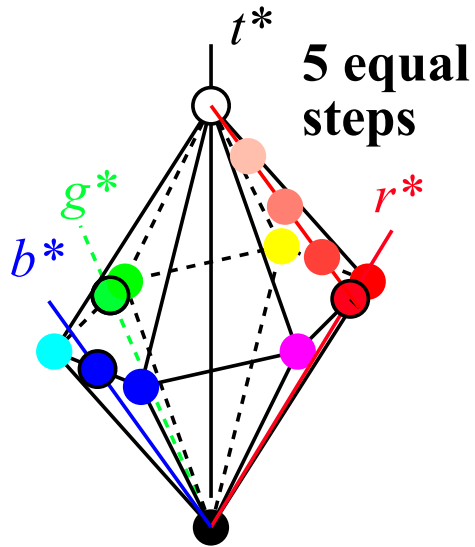
Figure 8: *rgb and CIE data of elementary colours RJGB and mixtures with W and N for the standard sRGB₃ display with $L_r=2,5\%$, standard offset print pRGB, and a photo printer pRGB.**

For the colour output the CIELAB hue angles h_{ab} are equal for the three colour outputs. However, CIELAB L^* and C^*_{ab} data are different.

6 Elementary (e) colours $rgb_e^* = rgb^*$ in CIELAB: RJGB and NW

Hexagon-triangle system based on elementary (e) colours: $rgb_e^* = rgb^*$ with **linear relations** between $rgb_e \rightarrow rgb^* - LCH^*$

(compare linear relations between rgb_{sRGB} and L^*)



Equations $rgb^* - LCH^*$ in both directions have been published, see: Richter, CIE-Proceedings, Beijing, 2008, Volume 3 und DIN 33872-1

Three equations (tables) are needed for office applications:

$rgb_e - LCH^{*'}$ for a 9x9x9 grid of equally spaced rgb_e -input data

$rgb^* - LCH^*$ a 9x9x9 grid of equally spaced data rgb^* and LCH^*

$rgb'^* - LCH^*$ Device output linearisation by $rgb_e \rightarrow rgb'^*$

KE291-5N

Figure 9: Elementary colour data rgb^* and three sets of relations for device linearization

A first table connects the rgb_e input data with the measurement data $LCH^{*'}$ of the start output, for the notation compare ISO/IEC 15775.

The second relation $rgb^* - LCH^*$ is an equation in both directions, see for example DIN 33872-1.

The third relation shows the calculated rgb'^* input data for the output of the intended LCH^* data.

Finally, if the table $rgb_e - rgb'^*$ is applied then the intended equally spaced colour series will appear on the output device. These tables are available for offset print, different rgb displays and printers and different cmy separations of *PostScript (PS)* printers.

There are a few limitations:

- The start output LCH^* should produce continuous output series.
- All output colours shall be reproducible within any hue triangle.

For examples of calculated rgb'^* data for different printers and separations see <http://130.149.60.45/~farbmetrik/HE.HTM>

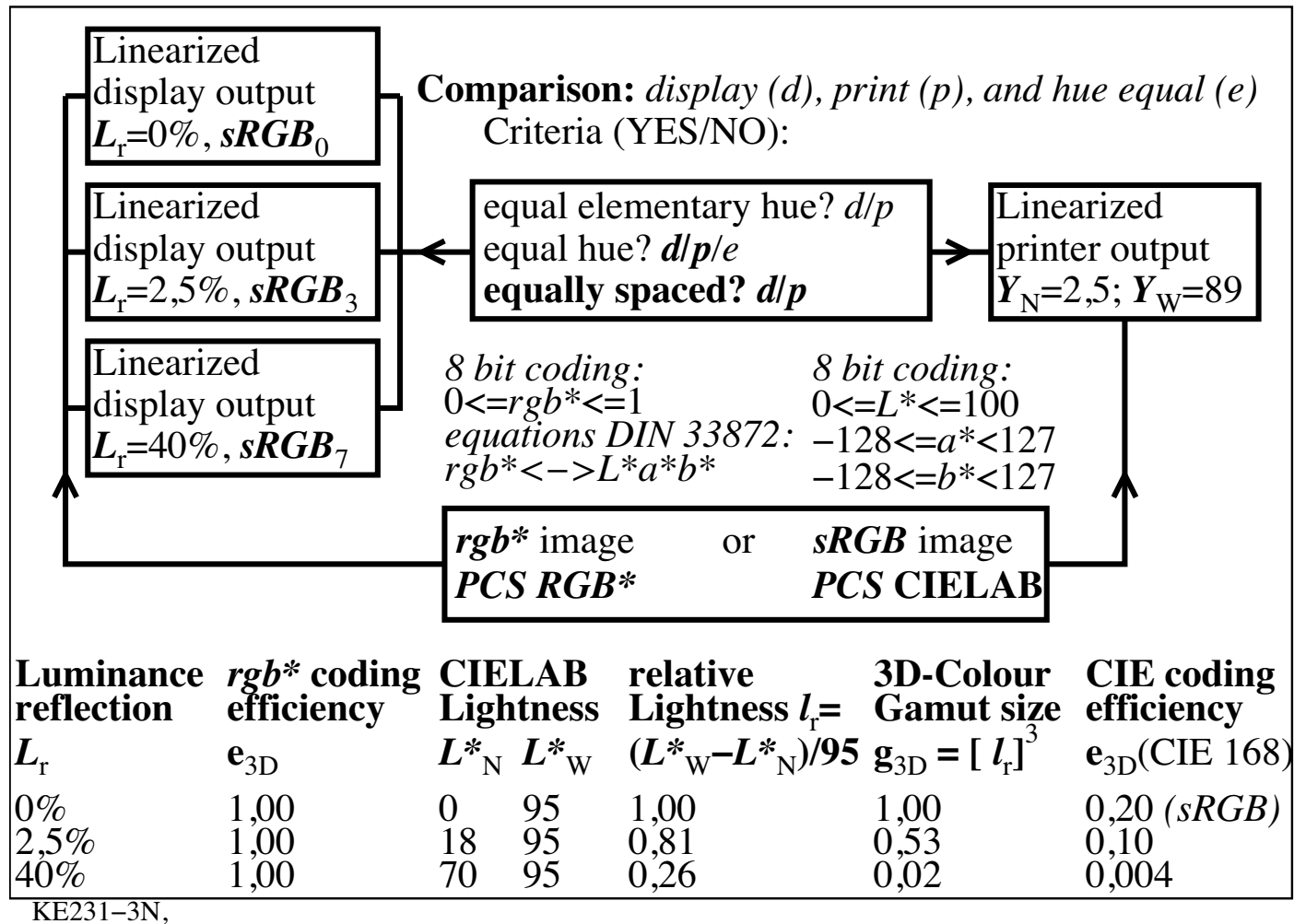


Figure 10: Workflow and efficiency with Profile Connection space (PCS) RGB* and CIELAB.

If the *Profile Connection Space (PCS) RGB** is used, then the coding efficiency has the value 1,00 for the three luminance reflections.

If the *PCS CIELAB* is used, then the coding efficiency reduces from the value 0,2 to 0,004.

Therefore the *PCS RGB** of this paper produces a much higher coding efficiency.

This coding efficiency has a constant value 1 for all display luminance reflections.

Therefore especially for displays with the standard luminance reflection according to ISO 9241-306 at office work places and for data projectors which much ambient light the colour management according to ISO 15076-1 (ICC colour management) has a low efficiency.

Applications of ICC colour management for example for softcopy - hardcopy comparison may not be useful.

At office work places there are problems with the luminance reflection:

The user wishes not only to linearize the file output, for example of

<http://www.ps.bam.de/ME15/10L/L15E00FP.PDF>

The *whole display* output *shall change* according to the ambient light!

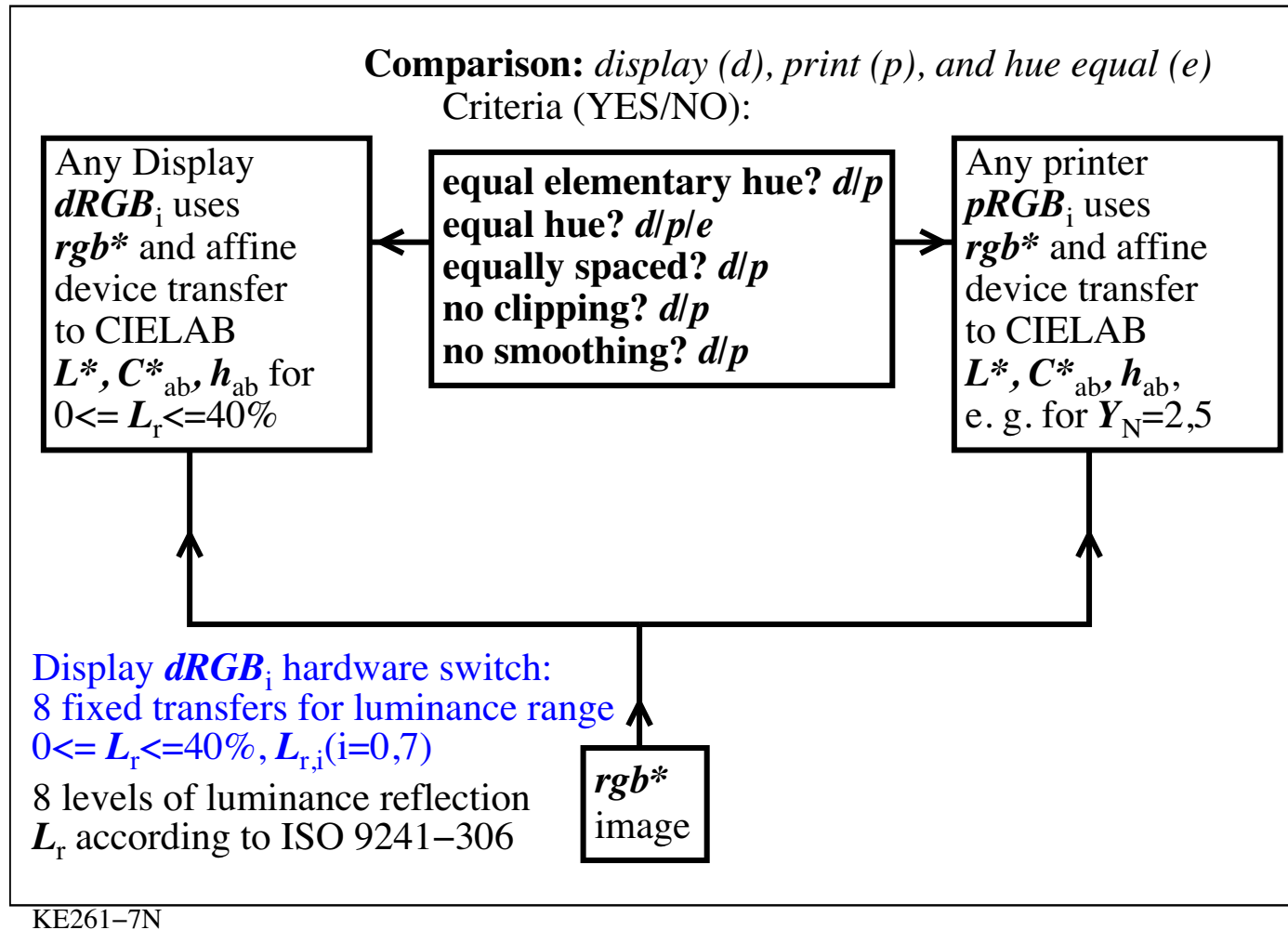


Figure 11: Workflow rgb interpretation as elementary colours rgb^* and rgb^* linearization

The $rgb_e \rightarrow rgb^*$ data tables of Fig. 9 may be used for linearization within

the devices which will produce on both devices the elementary hues, the equal hues, the equal spacing and no clipping.

If 8 data tables are within the display a hardware switch allows to choose visually the equal output spacing for example with the ISO-test chart according to ISO 9241-306, see the ISO-test charts (200 KB, 1 page) for a hardware switch

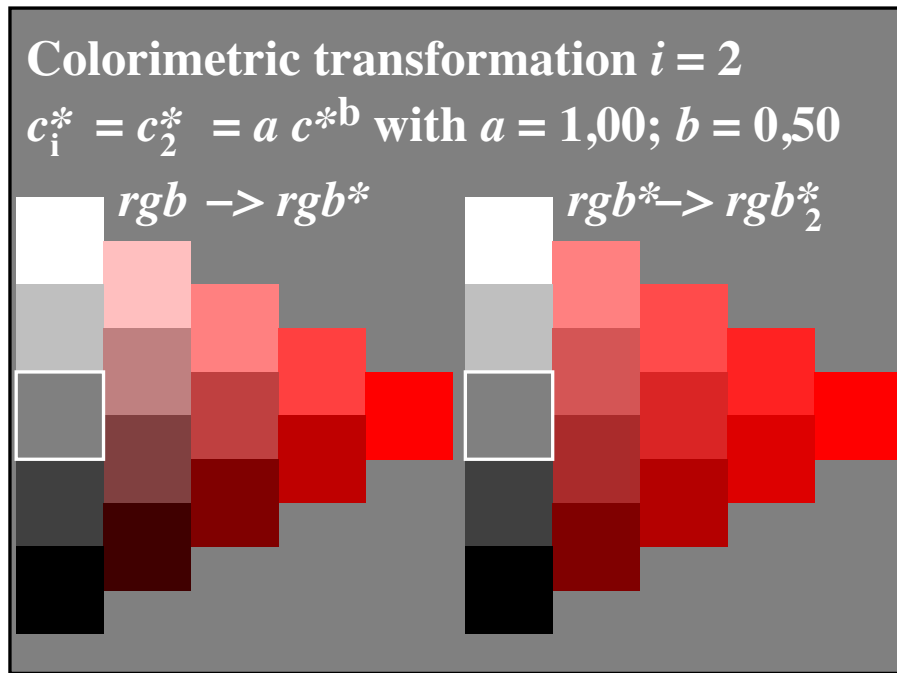
<http://www.ps.bam.de/ME16/10L/L16E00NP.PDF>

and (1800 KB, 16 pages) for a software solution

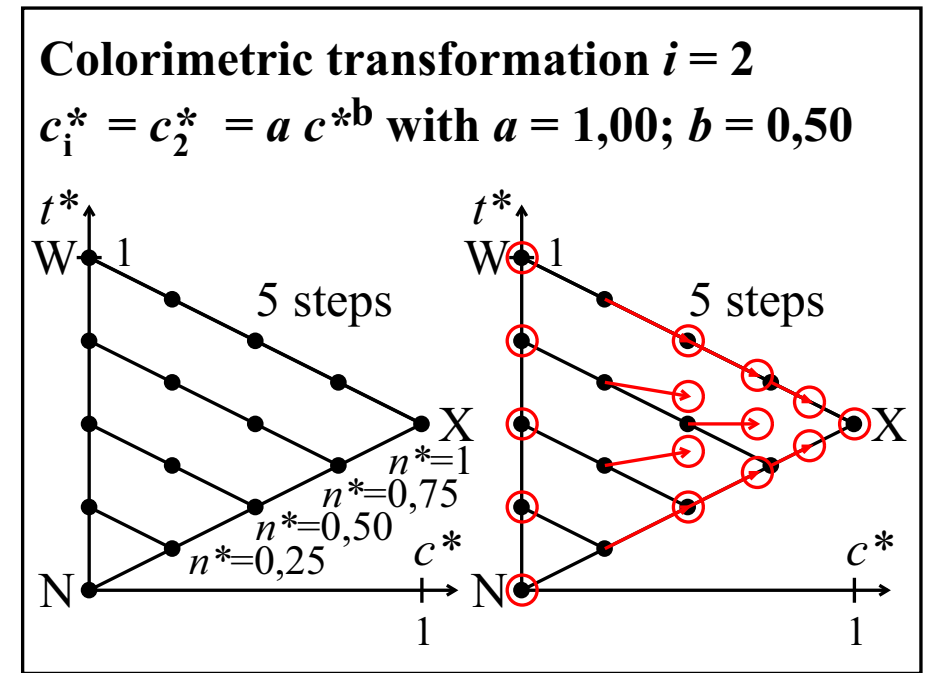
<http://www.ps.bam.de/ME15/10L/L15E00FP.PDF>

Annex D of ISO 9241-306 includes a solution for the computer operation system *MAC OS 10.4 or later*.

The equal output spacing is the requirement for a “trusted” output. The trusted output does not allow any colour enhancement, any clipping or smoothing. However, in other cases there may be a user wish to make the output more chromatic compared to the original



IE660-6N, 31



IE660-5N, 3

Figure 12: Chroma enhancement by $c^{*'} = c^{*0,5}$ and visualization in hue triangle $N - X - W$

Figure 12 shows the chroma change by a formula $c^{*'} = c^{*0,5}$.

The changed colours are still located within the colour triangle and can therefore be reproduced. The achromatic colours and the most chromatic colour are not changed. This transfer is used for photographic chroma enhancement.

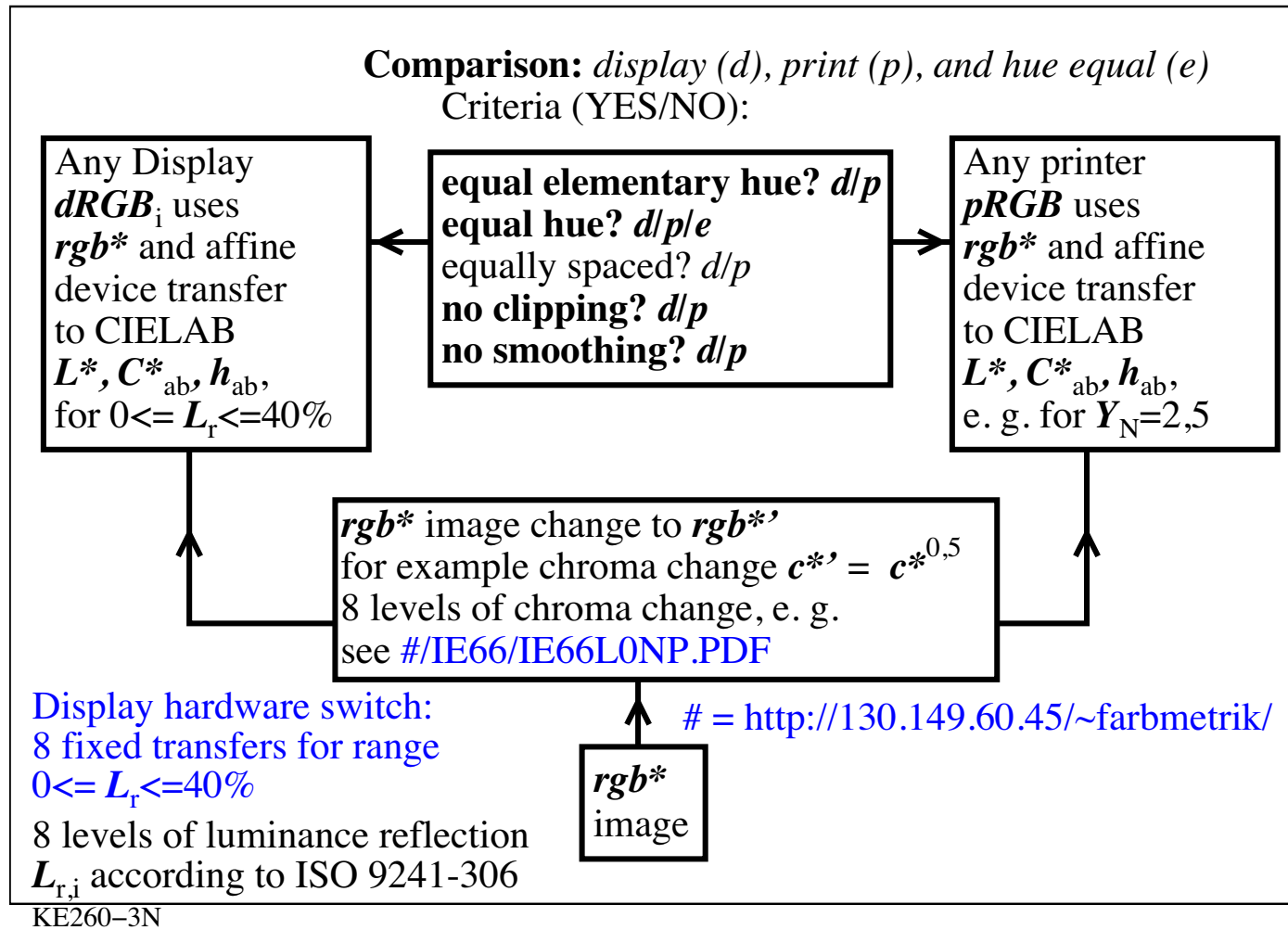


Figure 13: Workflow, rgb^* output linearization, and change of chroma by a simple formula

By a chroma transfer the rgb^* data are changed. Both devices produce the elementary hues, the equal hues and no clipping.

However, in this case equal spacing does not appear, the chroma differences are large near the achromatic axis and small near the maximum chroma.

A hardware switch can for example produce 8 transfers (see Fig. 11).

Additional remarks:

There are ISO-test charts according to ISO/IEC TR 24705 which allow to test the output properties of displays and printers, see for the test charts:

<http://www.ps.bam.de/24705TE>

There are DIN-test charts according to DIN 33872 (in print) which allow to test the properties of the workflow between the digital file and the output on displays and printers, see

<http://www.ps.bam.de/33872E>

The DIN-test chart according to DIN 33872-6 allows to test if *no* smoothing occurs.

The DIN-test chart according to DIN 33872-5 allows to test if there is elementary hue agreement.

The DIN-test chart according to DIN 33872-2 and -3 allow to test if there is equal spacing of the chromatic and achromatic output respectively.

Summary

The report CIE R1-47:2009 “Hue Angles of Elementary Colours” is used to define an efficient rgb^* colour workflow for displays and printers in offices compared to the *ICC*-workflow of ISO 15076-1.

In addition an efficient description of the device gamut by visual human rgb^* coordinates is described.

The efficiency of the rgb^* workflow is constant and has the equal value 1 for any luminance reflection of the display.

If colour management according to ISO 15076-1 is applied and if 8 bit coding in *ICC-LAB* is used, then the efficiency reduces between 0,2, 0,1, and 0,004 for the luminance reflections between 0%, 2,5%, and 40% respectively.

Therefore a large improvement is reached if the proposed *Profile Connection Space PCS RGB^{*}* is used.

For many application in offices colour management without a PCS and still the high efficiency is possible, for example if the device manufacturers have included the transfer $rgb_e - rgb'^*$ in their device.

Display manufacturers may include the transfer for 8 luminance reflections.

A similar hardware switch may allow to produce 8 chroma transfers between more chromatic and achromatic.

Instead of the hardware solutions there are already software solutions, see for example Annex D of ISO 9241-306.

Some of these solutions linearize only one file output and leave the computer operating screen of the display unchanged.

However, most users wish a change of the whole computer operating screen. For example users wish an independent change of the computer display and the data projector display which both have different luminance reflections

A example software solution is given in Annex D of ISO 9241-306.

References

CIE R1-47:2009, Hue angles of elementary colours (35 pages, 2,1 MB), see the CIE web site under “Meetings”

<http://div1.cie.co.at>

CIE 168:2005: Criteria for the Evaluation of Extended-Gamut Colour Encodings

DIN 33872-1 to -6 (in print), Information technology - Office machines - Method of specifying relative colour reproduction with YES/NO criteria

- Part 1: Classification, terms and principles

- Part 2: Test charts for output properties - Testing of discriminability of 5 and 16 step colour series

- Part 3: Test charts for output properties - Testing of equality for four equivalent grey definitions and discriminability of the 16 grey steps

- Part 4: Test charts for output properties - Testing of equality for two equivalent colour definitions with 5 and 16 step colour series

- Part 5: Test charts for output properties - Testing of elementary hue agreement and hue discriminability

- Part 6: Test charts for output properties - Testing of the equivalent spacing and of the regular chromatic spacing

For additional information see the PDF file (41 pages, 1,4 MByte) with the title Colorimetric supplement to DIN 33872-1 to -6

<http://www.ps.bam.de/D33872-AE.PDF>

For the test charts according to DIN 33872-1 to -6 see

<http://www.ps.bam.de/33872E>

ISO 9241-306:2009, Ergonomics of human-system interaction - Part 306: Field assessment methods for electronic visual displays

For the test charts according to ISO 9241-306 see

<http://www.ps.bam.de/9241E>

ISO 11664-4:2008(E)/CIE S 014-4/E:2007: Joint ISO/CIE Standard: CIE Colorimetry — Part 4: 1976 L*a*b* Colour Space (CIELAB)

ISO 15076-1:2005, Image technology colour management -- Architecture, profile format and data structure -- Part 1: Based on ICC.1:2004-10

ISO/IEC 15775:1999, Information technology – Office machines – Method of specifying image reproduction of colour copying machines by digital and analog test charts – Realization and application

ISO/IEC TR 19797:2004, Device output of 16-step colour scales, output linearization method (LM) and specification of the reproduction properties

For the test charts according to ISO/IEC TR 19797 see

<http://www.ps.bam.de/19797TE>

ISO/IEC TR 24705:2005, Method of specifying image reproduction of colour devices by digital and analog test charts

For the test charts according to ISO /IEC TR 24705 see

<http://www.ps.bam.de/24705TE>

Annex A

Abbreviations used for the workflow of this paper

The abbreviations display (d), print (p) and standard (s) lead to image coding in the spaces:

dRGB, ***pRGB***, and ***sRGB***.

ISO 9241-306 defines 8 luminance reflections: $L_{r,i} = 0, 0,6, 1,2, 2,5, 5, 10, 20, 40\%$ ($i=0$ to 7).

This leads to 8 image data sets ***dRGB_i*** and/or ***sRGB_i*** and 8 luminance reflections $L_{r,i}$ ($i=0$ to 7).

Fig. 5 includes ***YES/NO questions*** for the ***comparison softcopy - hardcopy***. The three displays and the printer fulfills all the ***YES criteria*** according to the workflow.

Fig. 6 shows for the **sRGB** image the workflow with *rgb* interpretation as elementary colours **rgb*** (*rgb*->*rgb**), and **rgb*** linearization.

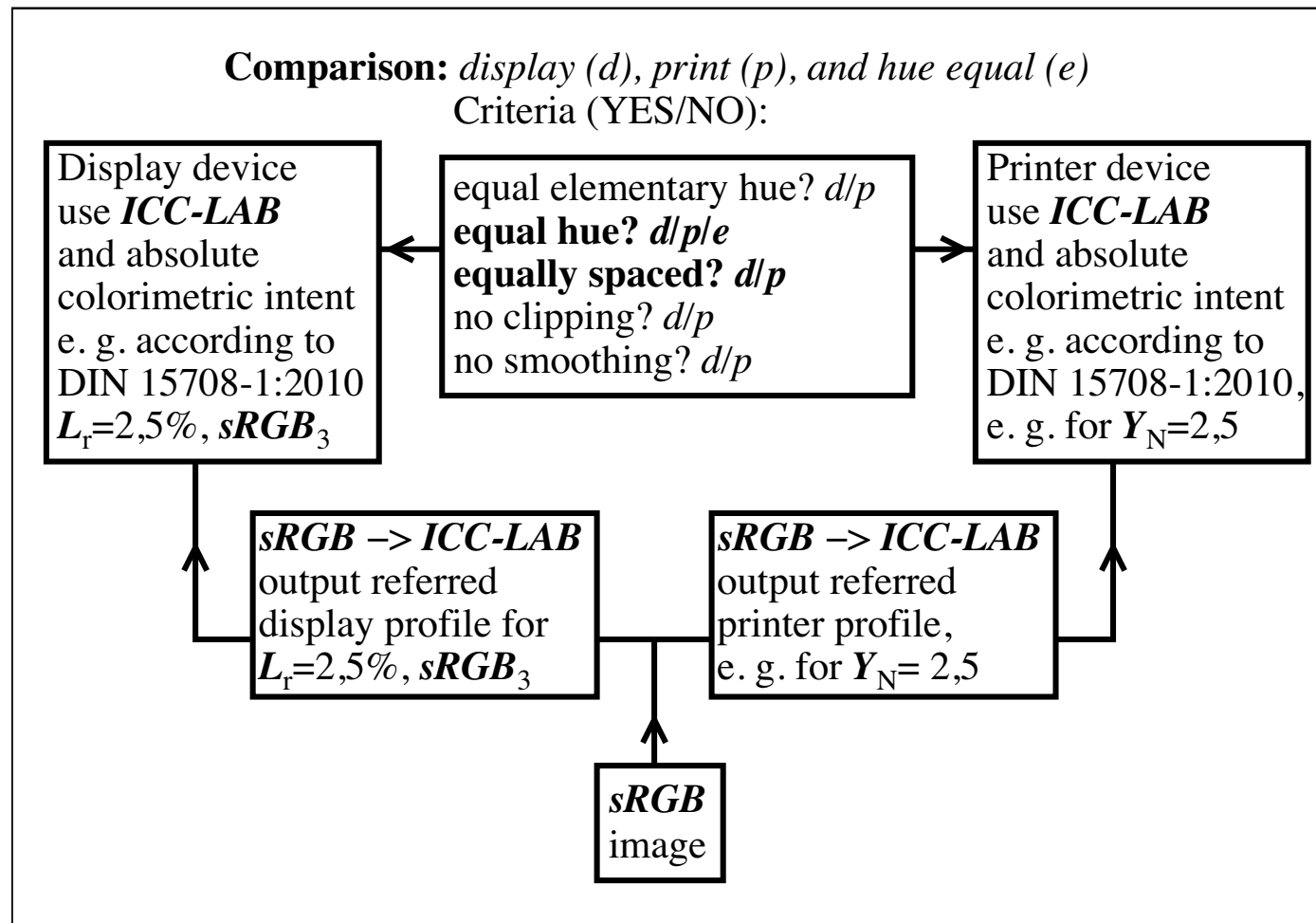
The *rgb** data are used for linearization which will produce on both devices the elementary hues, the equal hues, the equal spacing and no clipping.

The DIN-test chart according to DIN 33872-6 allow to test if *no* smoothing occurs. In addition DIN-test chart according to DIN 33872-5 may be used for the equal elementary hue test.

Fig. 6 includes the technical property, that the *rgb** data are equal for the display device and the printer device. In addition they are equal for all display devices **dRGB_i** and the standard display devices **sRGB_i** (i=0 to 7).

Annex B

Intended output by “absolute” ICC-colour management according to ISO 15076-1



KE261-3N

Figure 14: Workflow sRGB interpretation as output referred device

colours *ICC-LAB*

For the *sRGB* image Figure 9 shows the workflow *rgb* interpretation as output referred device colours *ICC-LAB*. For 8 display reflections 8 *ICC-LAB* profiles are necessary. According to ISO 9241-306 the gamma value changes from 2,4 for $L_r=0\%$ to about 1,1 for $L_r=40\%$.

The main part of this paper describes the output gamut boundary of any display or printer by an equation in both directions similar to the following equations for any hue plane:

$$rgb^* \leftrightarrow L^*, C_{ab}^*, h_{ab}$$

In addition in both directions there is an equation

$$sRGB \leftrightarrow L^* C_{ab}^*, h_{ab}$$

and an equation

$$sRGB \leftrightarrow ICC-LAB$$

Remark: ICC-LAB is not identical to CIELAB. For example there are differences in normalization (media white in ICC instead of perfect white

diffuser in CIELAB equations).

All relations together allow to make *ICC*-profiles for colour management according to ISO 15076-1. If the *ICC-LAB* data are calculated for the 9 step colour series in an elementary hue plane and sent to the display or printer device with the task to reproduce the *ICC-LAB* data by "absolute" colour management, then the equally spaced colour series in CIELAB will appear on the display or the printer.

Examples of this kind of "absolute" colour management are given in the new standard DIN 15708-1:2010 with the title: Electronic still picture - Quality check of digital RGB input data - Part 1: Output on printing devices.

For the DIN-test charts according to DIN 15708-1 see

http://130.149.60.45/~farbmetrik/_Referenzkeil_DIN_15708-1/

The last figures show an example change of digital data by "smoothing".

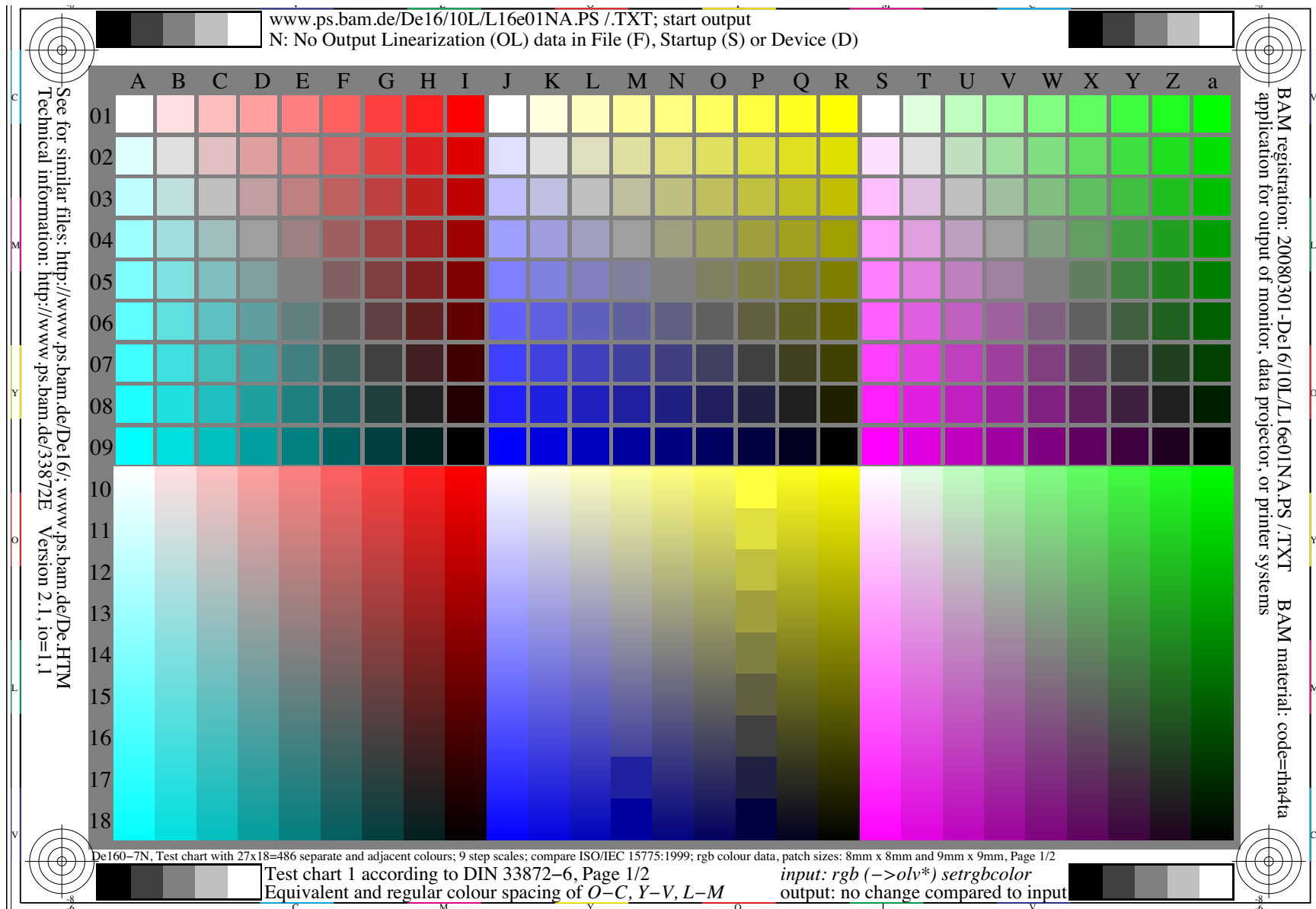


Figure 15: Smoothing of the 9 steps of DIN-test chart according to DIN 33872-6 if the PS-file is displayed on Mac OS 10.4 or later.

