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Task: Checking the conformity of reflection and
transmission targets according to ISO
12641-2

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Submitted material:

- Two reflection targets "R171004" and "R180726" and one transmission target "T171106"
- Two measurement files in the format .cxf and .txt corresponding to the batch values, for each of the targets
- One Excel-file with the reference colorimetric data for reflection and for transmission targets
- Hand in later with corrections:
 - A measurement file "R180726neu.cxf" to replace "R180726.cxf"
 - A monitoring procedure "Monitoring_Procedure_DE.pdf"

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1 Task

The client submitted three colour targets:

- Two reflection targets labelled “R171004” and “R180726”
- One transmission target labelled “T171106”

In this report, their conformity in accordance to ISO 12641-2 [2] shall be checked, focusing on their colorimetric accuracy.

As an example, the reflection target “R171004” is shown in Figure 1.

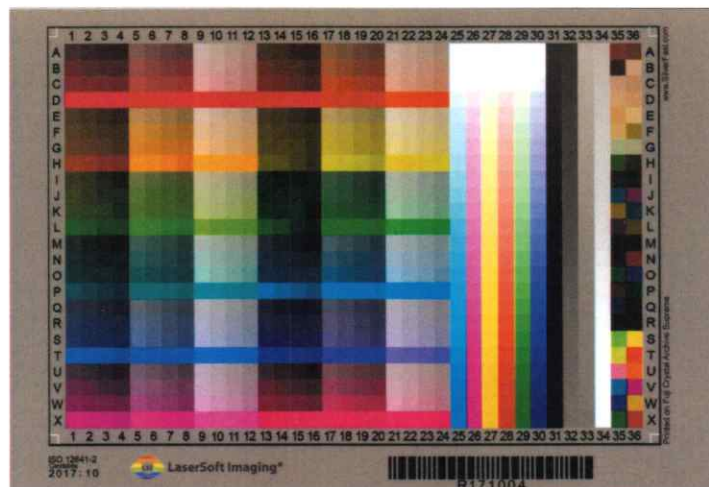


Figure 1: Scan of the reflection target “R171004” submitted by the client for conformity check.

2 Bibliography

- [1] Standard ISO 13655:2017
Graphic technology – Spectral measurement and colorimetric computation for graphic arts images
Beuth-Verlag, 10772 Berlin

- [2] Standard ISO 12641-2:2019
Graphic technology – Prepress digital data exchange – Part 2: Advanced colour targets for input scanner calibration
Beuth-Verlag, 10772 Berlin

3 Target design and measurement procedure

ISO 12641-2 defines requirements and tolerances for the creation and data reporting of advanced layouts of targets that are intended for calibrating or characterizing image capturing devices [2]. One example of such a design is shown in Figure 1.

The target is composed of

- a main body or sampled colour area (patches in columns 1 to 34)
- an identification section
- and an optional area for vendors (patches in columns 35-36).

Depending on the nature of the given colour measurement data, ISO 12641-2 differentiates two kinds of targets. Calibrated targets are test charts which have been measured individually, while uncalibrated targets are accompanied by measurements reflecting the batch mean. In this report, all three submitted targets represent “uncalibrated targets” where the reference values reflecting the batch mean have been submitted by the target manufacturer.

The submitted reflection targets “R171004” and “R180726” of type 2 (size 10 x 15 cm) have a main body of 120 mm width for 36 patches and 80 mm height for 24 patches, which corresponds to a patch size of 3,33 mm x 3,33 mm. They were measured with a Barbieri LFP qb Spectral Unit and Platform (serial number: B8100775). The measuring geometry of this device is 45°:0° circumferential. The measurement aperture was set to 2 mm and the measurement mode was set to M0, in order to match the measurement mode of the reference measurements for the batch targets performed by the manufacturer with a Barbieri Spectro 100XY.

The submitted transmission target “T171106” of type 1 (film of size 6 x 7 cm) has a patch size of 1,70 mm x 1,70 mm. It was measured with a Barbieri Spectro 100XY (serial number: A307914). The measuring device was utilized in transmission mode with a measurement aperture of 0,5 mm a measuring geometry d:0°.

The measurements were based on D50 illuminant and CIE1931 standard colorimetric observer, according to ISO 13655 [1].

4 Normative requirements for reflection and transmission targets

4.1 General

The reference values for batch targets submitted by the manufacturer were measured using D50 illuminant and 2-degree observer, in accordance with ISO 13655.

The measurement mode utilized by the measuring device was first missing in the batch measurement files submitted by the manufacturer for the 3 targets. After request to the manufacturer, one example of batch measurement file "R180726neu.cxf" was received, which comprises the measurement mode M0 utilized by their measuring device.

4.2 Target design

The targets are rectangular and planar and contain a main body with the colour patches, an identification section and an optional section chosen by the vendor, in accordance with ISO 12641-2.

4.3 Target layout and physical characteristics

The targets were produced on a single substrate material, as required in ISO 12641-2. A code for the substrate was not added to the material tag, unlike the requirement.

Concerning the main body of the targets:

- a) The requirements about form, uniformity, structure and amount of the patches are fulfilled, since the patches are rectangular, uniform and are structured using rows named A to X and columns named 1 to 36, which corresponds to a total of 864 patches.
- b) The fiducial marks present at the corners of the main body are conform to the norm ISO 12641-2, and no other lines are present within the main body of the targets.
- c) The patch size for the reflection targets is 3,33 mm x 3,33 mm, which fulfils the minimum size of 2 mm x 2 mm. The patch size for the transmission target is smaller: As noted in Annex A of ISO 12641-2 for transmission targets of type 2, their size is 1,7 mm x 1,7 mm.
- d) The materials utilized are “Fuji Crystal Archive Supreme” and “Kodak Professional Endura” for the reflection targets labelled “R171004” and “R180726” resp., and “Fuji Provia Professional Film” for the transmission target labelled “T171106”. This means that they are consistent with the materials to be characterized, as intended.
- e) The non-patch areas are neutral as required by the norm. In [2] the informative criteria are a maximum CIELAB C^* =3,5 and a lightness (L^*) of 50 with $\Delta E^*_{ab}<3$, and these conditions were not satisfied by any of the targets. As shown in Table 1, the reflection targets “R171004” and “R180726” exceeded the proposed limit of colour difference ΔE^*_{ab} , while the transmission target “T171106” exceeded both proposed limits for the maximum CIELAB C^* value and for ΔE^*_{ab} .
- f) The non-image area extends more than 1 mm beyond the patches, as required in ISO 12641-2.

	Mean CIELAB L*	Mean CIELAB a*	Mean CIELAB b*	Max. CIELAB C*	ΔE^*_{ab}	Informative criteria met?
Informative criteria				$\leq 3,5$	< 3	
"R171004"	55,3	0,9	1,8	2,4	5,7	Not ok
"R180726"	52,0	0,0	1,6	1,9	2,5	Not ok*
"T171106"	53,2	-2,6	-3,0	4,1	5,1	Not ok

Table 1: Colorimetric results concerning the non-patch areas for the submitted reflection and transmission targets, based on 6 measurements performed with the measuring device Barbieri LFP qb presented in Section 3. The maximum CIELAB C* should be 3,5 or less, and the colour difference ΔE^*_{ab} with respect to [50 0 0] should be under 3.

*The result is "not ok" for target "R180726", since the value ΔE^*_{ab} is rounded to the precision of the tolerance.

g) The placement of the identification section fulfills the requirement since this section is at the bottom of the targets. However, its content is not completely as required in ISO 12641-2:

- Its name is only "ISO 12641-2", where it shall be "ISO 12641-2 advanced target"
- The materials used (substrate, paint, dyes, etc.) are not provided in this section, but the substrate is indicated in an additional documentation, namely in the batch measurement file that was handed in afterwards. The substrate is also written on the right of the main body, i.e., outside of the identification section.
- The year and month of production as well as the area for unique identification are present as required.

After contact with the target manufacturer, they promised to fix the identification section for future production.

5 Normative requirements concerning data reporting

The data reported for the batch targets contain values for X,Y,Z tristimulus values as well as for L*,a*,b* colour space coordinates, for each patch, as required. The standard deviation of this data as well as the 95th percentile of the distribution of color differences in ΔE^*_{00} units were first missing and were added by the manufacturer to the program generating the data reports after request. One example of complete data report was submitted for the color chart "R180726" afterwards. However, it contains spurious values for the standard deviation and the 95th percentile, which should be subject to final correction.

The batch data is also submitted in txt file format.

5.1 Data file format

The compliance with the requirements concerning the cxf file format are detailed here.

5.1.1 General description

The general description of the submitted cxf files do not completely meet the requirements presented in Annex C of the norm:

- The creator, creation date and description of the measurement are present,
- No description element of the file includes the mention "CxF/X" and the number of the corresponding international standard,
- The indication that the files are used in support of ISO 12641-2 is not present in the comment text, but in the target type.

5.1.2 Requirements

The required colorimetric data was not complete at first, since only the mean values were provided for each patch and not the standard deviation. This was improved after discussion with the manufacturer, who provided afterwards a measurement file "R180726neu.cxf" that contains the required data.

The XYZ tristimulus values are given with accuracy higher than 2 decimal places, which meets the requirement.

5.1.3 Informative comments for CxF/X-2 data exchange

The files that were first submitted did not meet the criteria for CxF/X-2 data exchange for output target data files, which is not a requirement from ISO 12641-2. However, such a file format is recommended. After informative comments about missing or incomplete data, the manufacturer provided a new, improved reference data for the color chart "R180726", which fulfills the requirements for CxF/X-2 data exchange.

5.1.4 Layout reporting

There is no data concerning the layout in the submitted cxf files. Such information is only informative and not required.

5.2 Usable target life

At first, there was no recommendation concerning the monitoring procedure to follow with the submitted targets. When this was pointed out to LaserSoft Imaging AG, they decided to create a documentation for their customer and to make it available on their website in the future. Such a monitoring procedure was submitted later in German ("Monitoring_Procedure_DE.pdf"), hence fulfilling this requirement from ISO 12641-2.

6 Normative requirements concerning colorimetric values

6.1 Tolerances on patch values for batch targets

The mean values and 95th percentile of the colour differences ΔE^*_{00} calculated with respect to the batch data submitted by the manufacturer are summarized in Table 2. The three batch targets “R171004”, “R180726” and “T171106” comply with the norm requirement that 95% of all patches shall be within $\Delta E^*_{00} \leq 7$.

Since their average colour differences are equal to 2 when rounded to the precision of the tolerance, they would also meet the requirements for calibrated targets.

Colour difference ΔE^*_{00}	Mean value	95 th percentile	Requirement for batch targets met?	Requirement for calibrated targets met?
Requirement	≤ 3 for calibrated targets	≤ 7 for batch targets		
Reflection target “R171004”	2,3	3,0	ok	ok
Reflection target “R180726”	1,8	2,4	ok	ok
Transmission target “T171106”	1,5	2,5	ok	ok

Table 2: Colour differences ΔE^*_{00} for the 3 batch targets, with respect to the aim values specified by the manufacturer. The mean value and value for 95th percentile calculated over all the patches are given.

6.2 Spectral measurement and colorimetric calculation

According to the data present in the cxf files for the batch targets submitted, it was at first not possible to state if the measurements were conducted in accordance with ISO 13655. In coordination with the target manufacturer, this was improved and submitted afterwards correctly in the file "R180726neu.cxf".

Indeed, the requirements concerning measurement data reporting from [1] are all fulfilled:

- A statement concerning ISO 13655 is present in the reference data submitted by the manufacturer.
- The measurement condition is given.
- The specimen backing is stated for the reflection samples. For the transmission samples, CIEXYZ data of the unexposed substrate material should be stated.
- Information about the measuring device is detailed.
- A report whether the measuring device manufacturer's requirements for standardization have been followed is stated.

6.3 Reflection targets compared to informative Annex B

In this section, the colorimetric measurements of both reflection targets are compared with the informative criteria written in Annex B of ISO 12641-2.

6.3.1 Layout

The reflection targets “R171004” and “R180726” are of type 2 with a size 10 x 15 cm. Their layout is comparable to the layout proposed in Figure B.1 of ISO 12641-2.

The colorimetric values of their neutral areas are discussed in 4.3 e).

The neutral areas extend at least 3,5 mm beyond the row and column borders on the top and the sides of the target, and at least 10 mm at the bottom of the target, as proposed for advanced reflection targets in Annex B. The numbering of the rows and columns are clearly visible but the informative criterion $D_{vis} \geq 2,0$ could not be measured due to the small size of the targets.

The lines present at the borders of the main body are neutral and have a smaller lightness L^* than the background, as recommended.

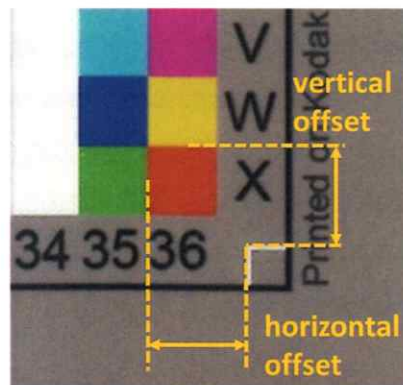


Figure 2: Measurement of the offset of the fiducial marks performed in the lower right corner.

The offset of the fiducial marks in each corner of the main body from the borders of the nearest colour patch, as shown in Figure 2, is between 4,7 mm and 4,8 mm in horizontal and vertical direction for the target “R171004”, and between 4,9 mm and 5,0 mm for the target “R180726”. With a patch size of 3,33 mm, this means that the fiducial marks in the corners are positioned at approximately 3,2 mm of the center of the nearest colour patch in both directions for the target “R171004”, and at approximately

3,4 mm for the target "R180726". Hence this requirement is fulfilled.

However, the actual size of the colour patches in the submitted target was 3,33 mm, as calculated using 120 mm width for 36 patches and 80 mm height for 24 patches. This does not correspond to the 3,5 mm required in informative Annex B.

Finally, the fiducial marks are white and their width is 0,2 mm, where the suggestion made in ISO 12641-2 is 0,1 mm.

6.3.2 Colour gamut restrictions

The colorimetric values of advanced colour reflection targets should follow the values of hue angle, lightness and chroma presented in the table B.1 of Annex B of the norm. The colour difference ΔE^*_{00} calculated for the measured values with respect to these reference values is shown in Figure 3 and Figure 4 for the reflection targets "R171004" and "R180726", respectively. The values are displayed for the patches read row after row, i.e. for A1, A2, A3, ..., X23 and finally X24.

The colour differences are comparatively high for the particular rows named D, H, L, P, T and X. In the norm, it is stated that the chroma values for these rows are "specific to the product used to create the target and equal to maximum C^*_{ab} available at hue angle and L^* specified". Hence, the reference chroma was read from the file "LCH-IT8-Strd-Werte 2.xls" submitted by the manufacturer with the reference colorimetric values of the targets. In this file, the chroma was set to the value $CIEC^* = 100$ for the aforementioned target rows. Hence, this was utilized as reference for the calculation of color differences. This explains the large colour differences obtained on these rows.

It must be stated, though, that the $CIEC^*$ values written in the file for the rows D, H, L, P, T and X are not meant as target values by LaserSoft Imaging AG, and that these rows are not utilized in their implementation of the profile estimation.

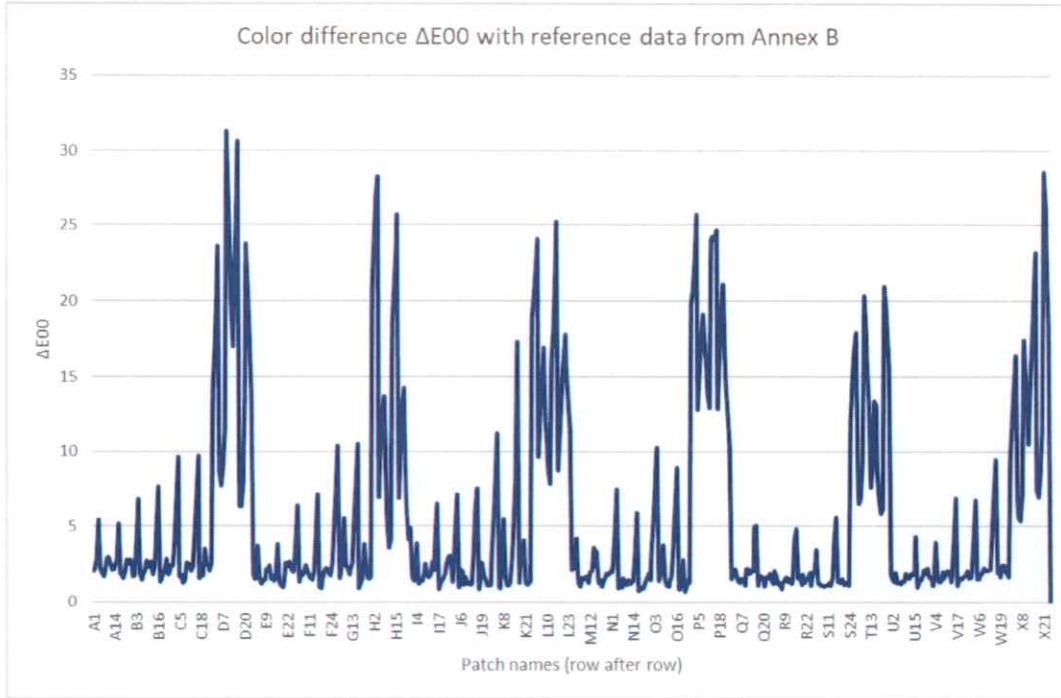


Figure 3: Colour difference ΔE^*_{00} between the measured patches of reflection target "R171004" and the reference given in Annex B of ISO 12641-2.

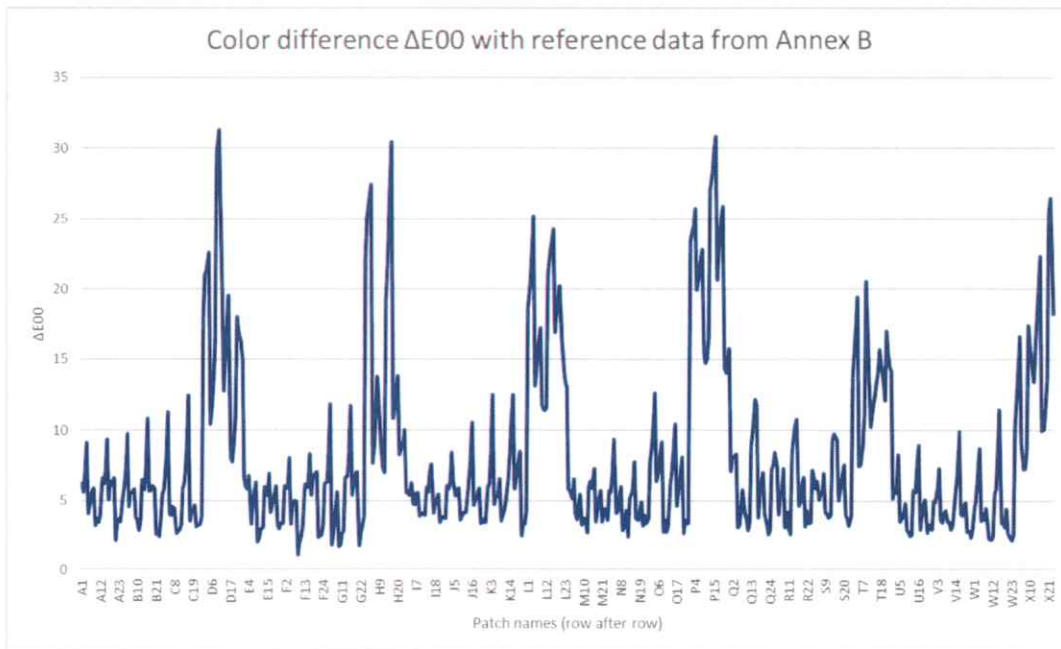


Figure 4: Colour difference ΔE^*_{00} between the measured patches of reflection target "R180726" and the reference given in Annex B of ISO 12641-2.

The mean value and 95th percentile of the colour difference ΔE^*_{00} for both reflection targets are summarized in Table 3. Mean values of 5,6 and 8,1 for the targets "R171004" and "R180726", resp., show large colour differences. If the rows named D, H, L, P, T, X are not taken into account, the mean values drop to 2,5 and 5,3, resp.

Data considered	All patches		Without rows D, H, L, P, T, X	
Colour difference ΔE^*_{00}	Mean value	95 th percentile	Mean value	95 th percentile
Reflection target "R171004"	5,6	21,0	2,5	6,9
Reflection target "R180726"	8,1	22,3	5,3	9,5

Table 3: Colour differences ΔE^*_{00} of the reflection targets with respect to the reference values given in Annex B of the norm. The mean value and value for 95th percentile calculated over all the patches are given. Moreover, they are also calculated when the rows D, H, L, P, T and X are not taken into account.

The reference values for the columns 1 to 24 were presented as CIELAB values, as proposed in ISO 12641-2.

6.3.3 Grayscale and RGB/CMY scale values

The norm defines criteria for aim values of the columns 25 to 30:

- The patch X34 should be the minimum neutral density and the patch A31 should be the maximum neutral density that can be achieved on the product, with neutral density being satisfied when CIELAB $C^*_{ab} \leq 1,0$. This is not fulfilled by both targets “R171004” and “R180726”, since the patches do not comprise a neutral density. Their colorimetric values are shown in Table 4.

	Patch	L* (batch value)	C* (batch value)	Informative criterion of neutral density met?
Informative criterion			$\leq 1,0$	
“R171004”	A31	21,9	3,1	Not ok
	X34	89,6	1,4	Not ok
“R180726”	A31	32,4	2,3	Not ok
	X34	88,7	3,1	Not ok

Table 4: Colorimetric values for patches A31 and X34 in reflection targets. Their aim values should be maximum and minimum neutral density.

- The L* values of the patches W31 to W34 should be equally spaced between the L* values of patches X31 and X34. As shown on the right side of Figure 5 and Figure 6 for targets “R171004” and “R180726”, resp., this informative requirement is not fulfilled.

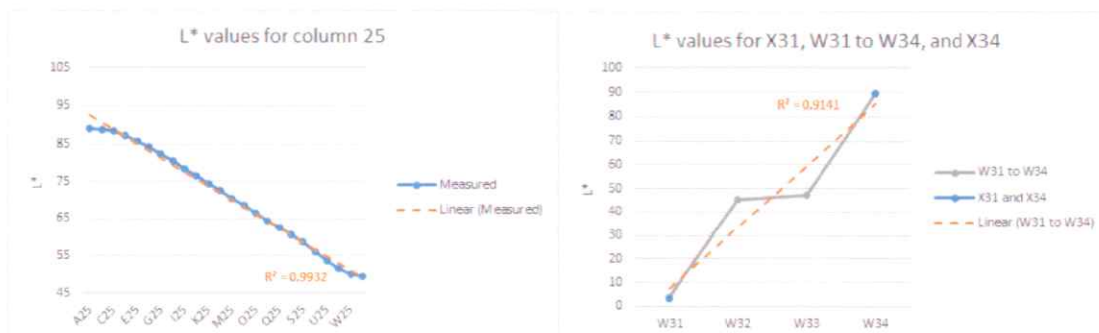


Figure 5: Batch L* values for column 25 and patches W31-W34, for reflection target “R171004”.

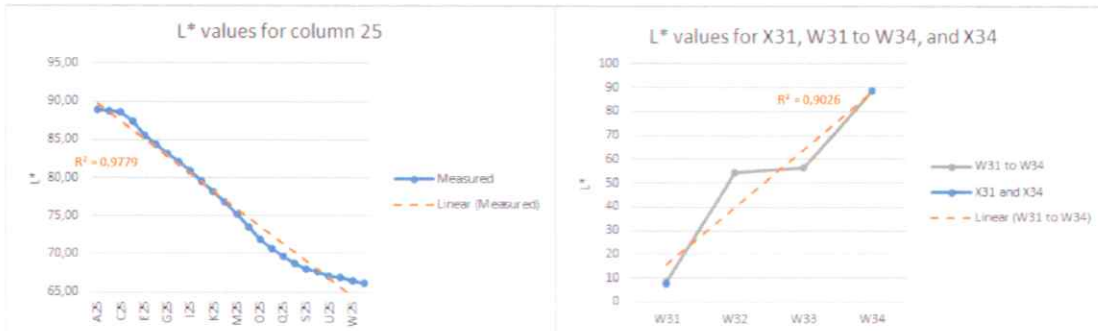


Figure 6: Batch L* values for column 25 and patches W31-W34, for reflection target "R180726".

- The L* values of patches A25 through X25 should be equally spaced. As shown on the left side of Figure 5 and Figure 6 for targets "R171004" and "R180726", resp., this is almost the case with a R2 value of 0,99 and 0,98, resp., which reflects a good linear fit.
- The patches of columns 26 to 30 should contain the same amounts of dyes as those used in column 25. It was not possible to verify these amounts on the submitted targets. However, as proposed in the norm, the columns appear magenta, yellow, red, green and blue, respectively.

6.4 Transmission target compared to informative Annex A

In this section, the colorimetric measurements of the transmission target are compared with the informative criteria written in Annex A of ISO 12641-2.

6.4.1 Layout

The transmission target "T171106" is of type 2, namely a 6 x 7 cm film. Its layout is comparable to the layout proposed in Figure A.1 of ISO 12641-2.

The colorimetric values of the non-image areas of this target are discussed in 4.3 e).

The neutral areas extend at least 2 mm beyond the row and column borders on the top and the sides of the target, and at least 8 mm at the bottom of the target, as proposed for advanced transmission targets in Annex A.

The numbering of the rows and columns are clearly visible as required, but the informative criterion $D_{vis} \geq 2,0$ could not be measured due to the small size of the targets. No other indicators were used.

The lines present at the borders of the main body are neutral and have a smaller lightness L^* than the background, as recommended.

The fiducial marks present in each corner of the transmission target are as proposed in Figure A.2 of Annex A in ISO 12641-2.

The offset of the fiducial marks in each corner of the main body from the borders of the nearest colour patch, as show in Figure 2, is between 2,5 mm and 2,6 mm in horizontal and vertical direction. With a patch size of 1,7 mm, this means that the fiducial marks in the corners are positioned at approximately 1,7 mm of the center of the nearest colour patch in both directions. Hence this requirement is fulfilled.

Finally, the fiducial marks are white and their width is 0,1 mm, which is conform to the suggestion made in Annex A of ISO 12641-2.

6.4.2 Colour gamut restrictions

The colorimetric values of advanced colour reflection targets should follow the values of hue angle, lightness and chroma presented in the table A.1 of Annex A of the norm. The colour difference ΔE^*_{00} calculated for the measured values with respect to these reference values is shown in Figure 7 for the transmission target "T171106". The values are displayed for the patches read row after row, i.e. for A1, A2, A3, ..., X23 and finally X24.

As it was the case for the reflection targets, the colour differences are comparatively high for the particular rows named D, H, L, P, T and X. Here also, the large colour differences obtained on these rows show that the reference value of chroma 100 read from the file "LCH-IT8-Strd-Werte 2.xls" submitted by the manufacturer is not meant as target value, but rather implies the aim to reach the highest saturation possible. The values of these rows are not utilized in the LaserSoft Imaging AG implementation of the profile estimation.

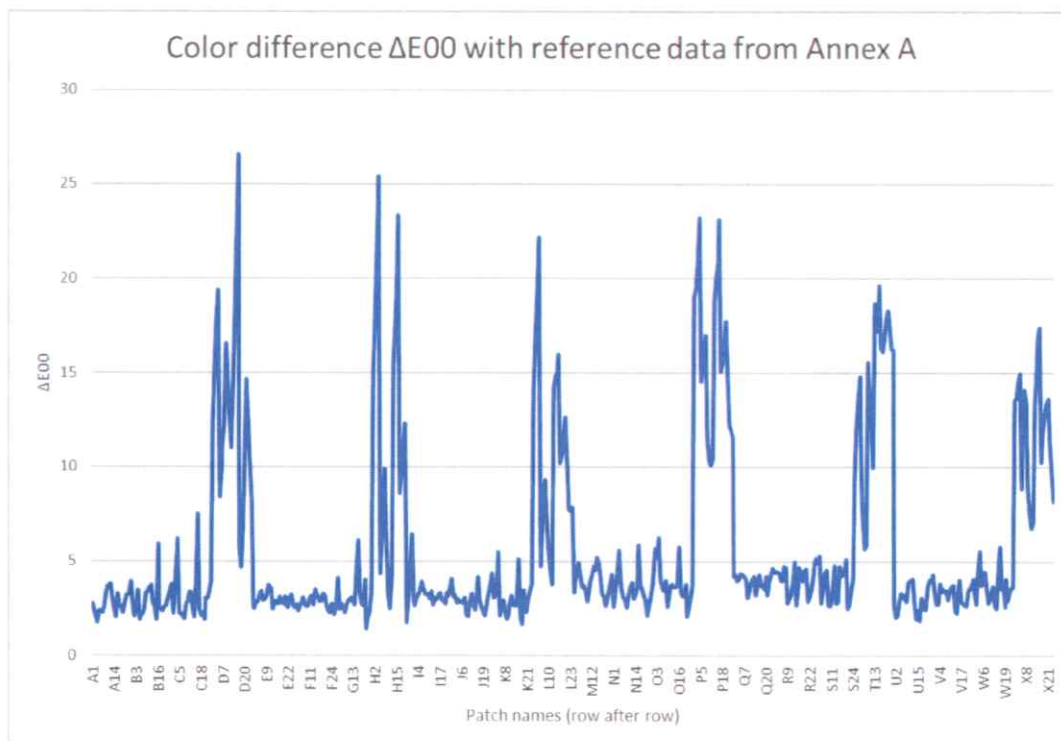


Figure 7: Colour difference ΔE^*_{00} between the measured patches of transmission target "T171106" and the reference given in Annex A of ISO 12641-2.

The mean value and 95th percentile of the colour difference ΔE^*_{00} for the transmission target are summarized in Table 5. A mean value of 5,7 shows large colour differences. If the rows named D, H, L, P, T, X are not taken into account, the mean value drops to 3,3.

Considered data	All patches		Without rows D, H, L, P, T, X	
	Mean value	95 th percentile	Mean value	95 th percentile
Colour difference ΔE^*_{00}				
Transmission target "T171106"	5,7	17,3	3,3	4,9

Table 5: Colour differences ΔE^*_{00} of the transmission target with respect to the reference values given in Annex A of the norm. The mean value and value for 95th percentile calculated over all the patches are given. Moreover, they are also calculated when the rows D, H, L, P, T and X are not taken into account.

6.4.3 Grayscale and RGB/CMY scale values

The norm defines criteria for aim values of the columns 25 to 30:

- The patch X34 should be the minimum neutral density and the patch A31 should be the maximum neutral density that can be achieved on the product, with neutral density being satisfied when CIELAB $C^*_{ab} \leq 1,0$. This is not fulfilled by the transmission target "T171106", since the patches do not verify neutral density. Their colorimetical values are shown in Table 6.

	Patch	L* (batch value)	C* (batch value)	Informative criterion of neutral density met?
Informative criterion			$\leq 1,0$	
„T171106“	A31	24,4	5,0	Not ok
	X34	87,1	1,5	Not ok

Table 6: Colorimetical values for patches A31 and X34 in the transmission target. Their aim values should be maximum and minimum neutral density.

- The L* values of the patches W31 to W34 should be equally spaced between the L* values of patches X31 and X34. As shown on the right side of Figure 8, these patches in target "T171106" cannot be considered as equally spaced.

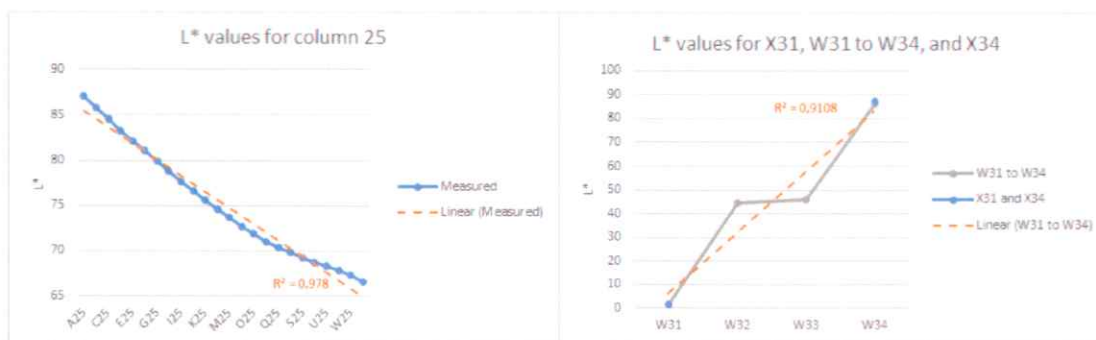


Figure 8: Batch L* values for column 25 and for patches W31-W34, for transmission target "T171106".

- The L^* values of patches A25 through X25 should be equally spaced. As shown on the left side of Figure 8 for target "T171106", this is almost the case with a R^2 value of 0,98, which reflects a good linear fit.
- The patches of columns 26 to 30 should contain the same amounts of dyes as those used in column 25. It was not possible to verify these amounts on the submitted targets. However, as proposed in the norm, the columns appear magenta, yellow, red, green and blue, respectively.

7 Conclusion

The evaluations show a good conformance of the tested reflection and transmission targets with ISO 12641-2. Some informative requirements were not met, however those mainly concerned the data reporting or the side information printed on the charts. An improved data reporting submitted by LaserSoft Imaging AG fulfils the requirements, with some numerical values needing a final correction. Furthermore, the side information printed on the charts ought to be corrected during future production.

The colorimetric accuracy of the charts with respect to the batch values exceeded the requirements for batch targets, and even fulfilled the requirements for calibrated targets.

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