Micro-fading report

National Museum of Australia

Art&Archival
www.microfading.com

Objects:	Cycloramic view of Canberra Capital site, view looking from Camp Hill.
Maker:	Charles Coulter/ John Sands (printer)
Accession Nº:	A811 1/10 pristine. A1040 badly faded.
Materials and media	Paper, commercially printed.
Year of production	1911
Test Date:	23-2-12
Operator:	Bruce Ford

Note: two examples of the same commercially printed cyclorama were tested. One was seriously faded and the other pristine (or at least relatively unfaded).

The CIELAB (CIE76) colour space was reported up front for a particular reason, however the CIE2000 results are also given in Table 1 and Figures 12 & 13

Summary

The previously exposed cyclorama (A1040) has been affected to the extent that the magenta ink has faded out altogether; cyan has been quite badly affected, and the yellow ink is visually largely intact.

While the past display conditions for the exposed cyclorama are unknown, the order of fading observed conforms to the pattern microfading would predict (Table 1 and Figure 2 for results in the CIE76 colour space) and the predicted timescales are not unrealistic from a risk management perspective. Assuming reciprocity holds (Endnote 1) the microfading results indicate that for the magenta ink (BW2), 4 years of UV free exposure 8 hours a day at 80 lux would be sufficient to cause 1 Just Noticeable Fade (JNF) and it would take approximately 120 years (30 JNF's) to destroy it completely; the cyan (mid BW2-BW3) 7 years for a JNF and 210 years to destroy completely; and yellow (mid BW3-BW4) 23 years for a JNF and over 600 years to fade out completely.

Furthermore the general shape of the microfading curves (Figure 4), which predict a more or less exponentially declining rate with continued exposure, matches the observation that the already faded cyan fades much more slowly than the pristine example (about half the rate).

The paper bleaching observed under UV-free accelerated light fading conditions (Figure 5 and Endnote 3) has - in this case - occurred in reality. The paper of the previously exposed cyclorama is noticeably whiter than the pristine example, and the former bleached much more slowly than the latter (Figure 6). For reasons outlined in Endnote 3 one would not necessarily expect this to be the case for paper that is on and off display over a long period.

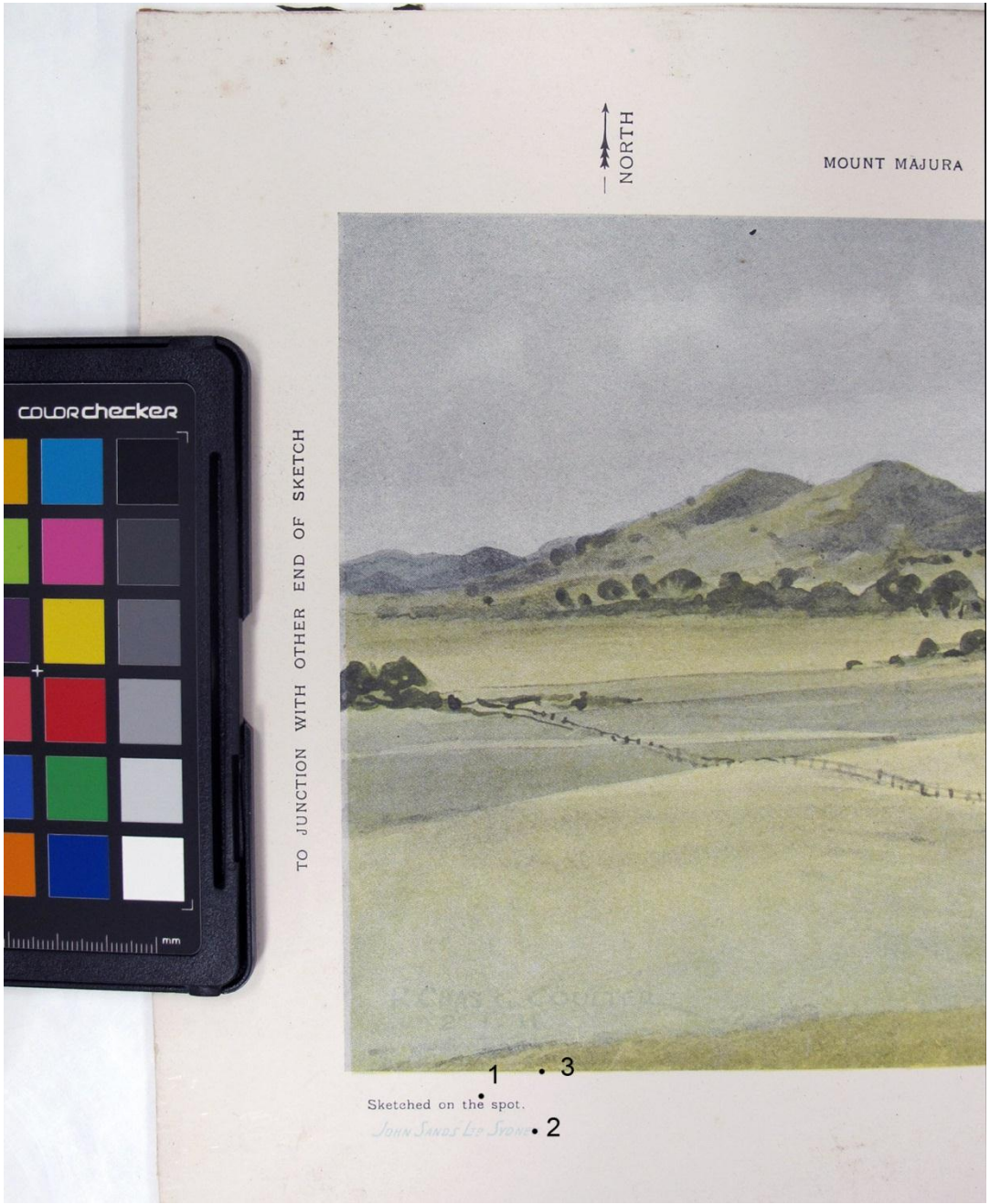
If the pristine cyclorama were displayed according to current National Museum of Australia lighting guidelines, it would be considered suitable for display for 12-18 months/decade at 50lux (Endnote 4) on the basis of the assessed lightfastness of the magenta ink.

If pristine examples of the cyclorama are uncommon, consideration might be given to further restricting its exhibition.

Figure 1. Test positions for the pristine or at least much less faded example A811 1/10 .

Figure 2. Test positions for the very faded example (A1040). Note magenta is gone in this copy, blue badly affected and only yellow (and black) remains .

Black printers' ink was not tested because it is invariably lightfast (carbon ink).



	CIE76			CIE2000							
Colour	BW Range	BW Equivalent	ΔE76	BW Range	BW Equivalent	ΔE2000	ΔL*	Δa*	Δb*	ΔC	Δh
BW1			9.6			4.1	3.6	-2.9	8.7	-8.3	-6.4
BW2			6.0			1.5	0.9	-1.5	5.9	-5.8	-2.5
BW3			1.5			0.4	0.3	-0.6	1.3	-1.5	-0.2
BW4			0.5			0.4	-0.2	0.6	0.0	-0.1	1.0
1 paper unexposed	BW3-BW2	2.5	3.6	BW2-BW1	1.6	2.5	0.6	0.6	-3.8	-3.8	-3.1
1 paper exposed	BW4-BW3	3.4	1.1	BW3-BW2	2.6	0.9	0.1	0.2	-1.1	-1.1	-2.8
2 cyan unfaded	BW3-BW2	2.3	4.4	BW2-BW1	1.2	3.6	0.7	1.0	-4.6	0.5	21.3
2 cyan faded	BW3-BW2	2.9	2.1	BW2	1.9	1.8	0.5	0.7	-2.1	-0.7	14.6
3 magenta unfaded	BW2	1.9	6.3	BW1	1.1	3.8	2.5	-3.6	-4.9	-5.7	-6.0
4 yellow unfaded	BW4-BW3	3.5	1.0	BW3	2.9	0.5	0.4	-0.5	-0.9	-0.8	0.7
2 yellow faded	BW4-BW3	3.3	1.2	BW3	2.9	0.5	0.3	-0.4	-1.1	-1.1	0.7

Table 1. Colour change summary. See last page for CIELAB diagram and Endnote 2 for a discussion of CIE76 vs CIE2000 results.

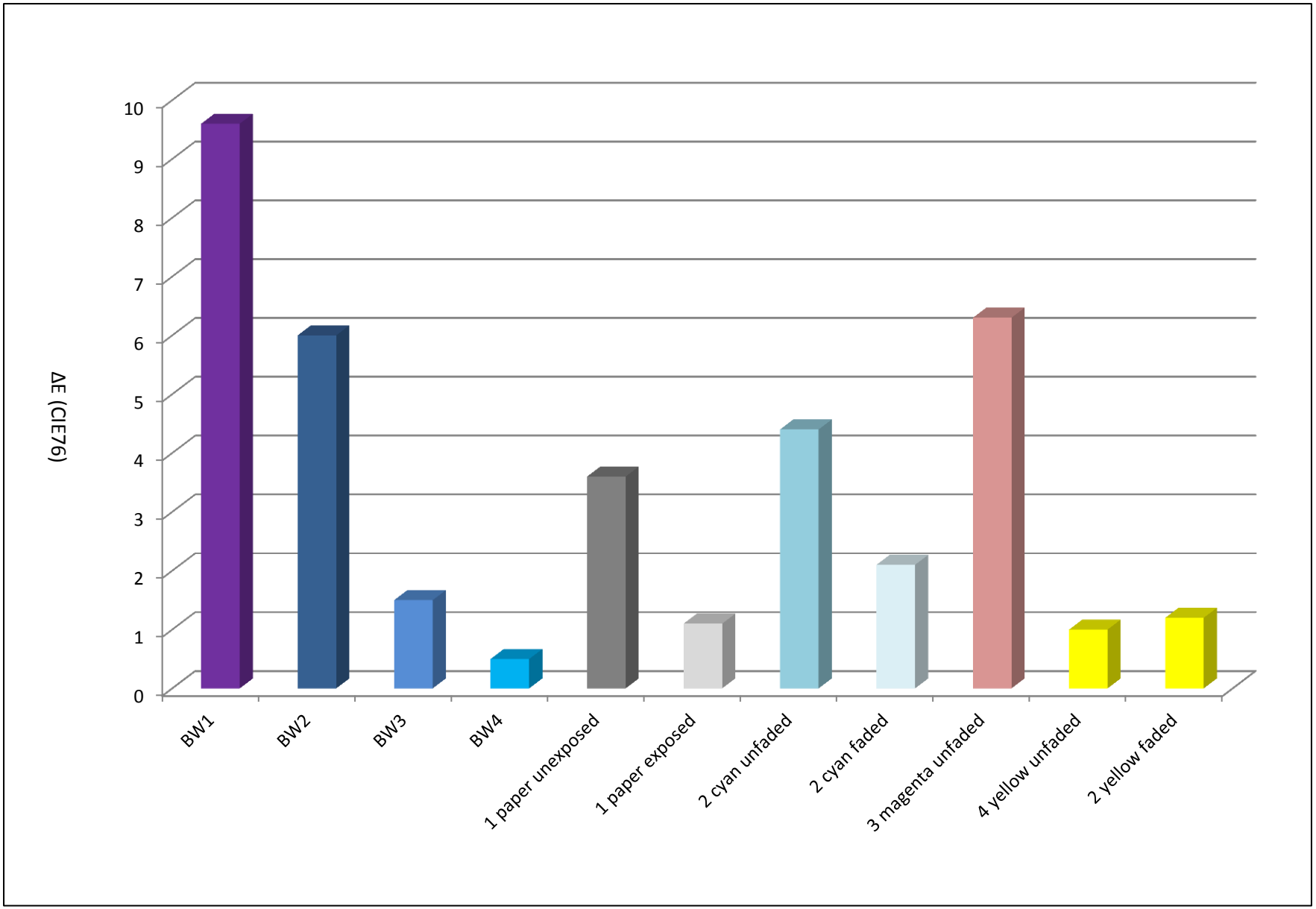


Figure 3. Relative colour change rates , CIE76

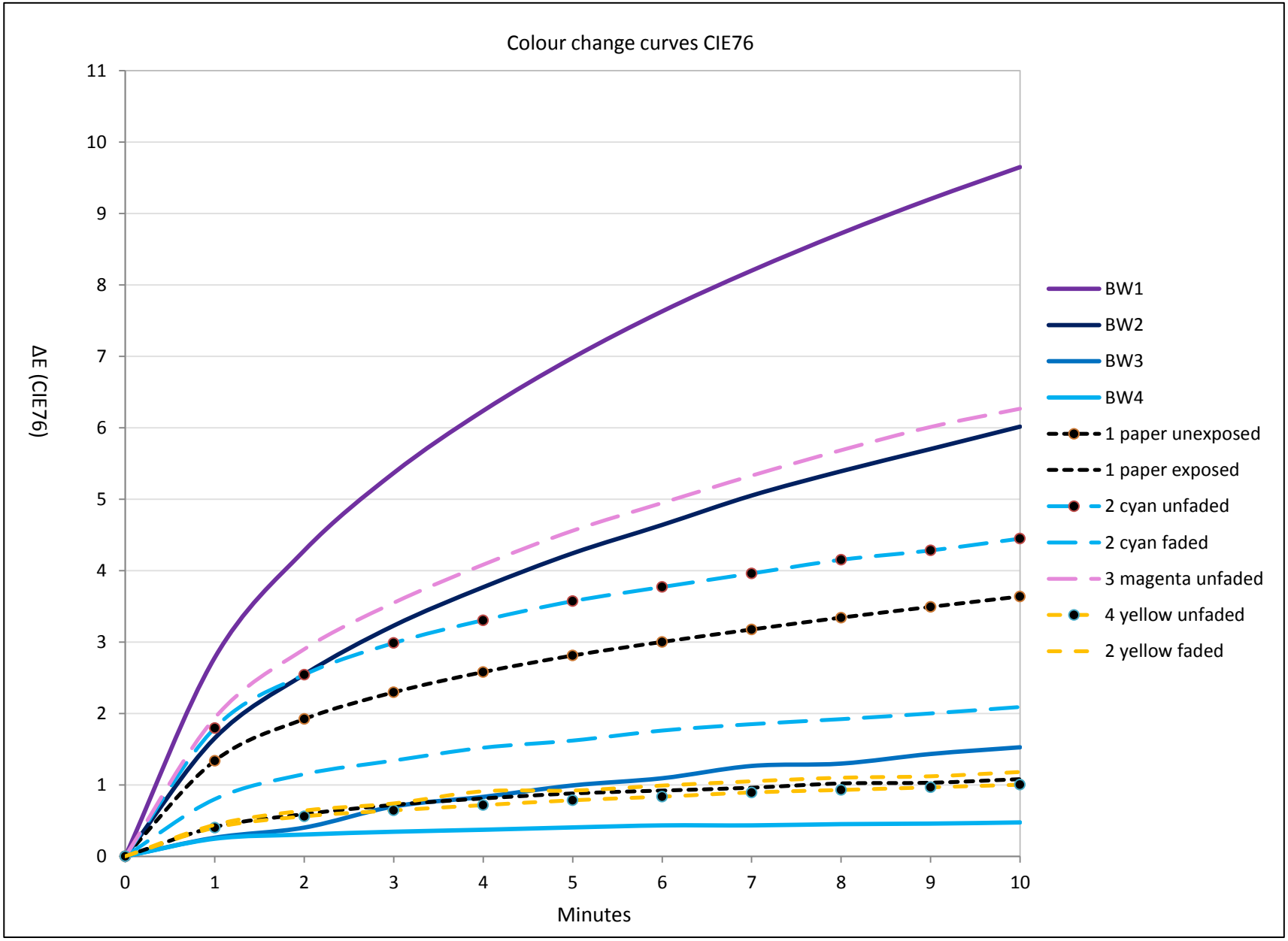
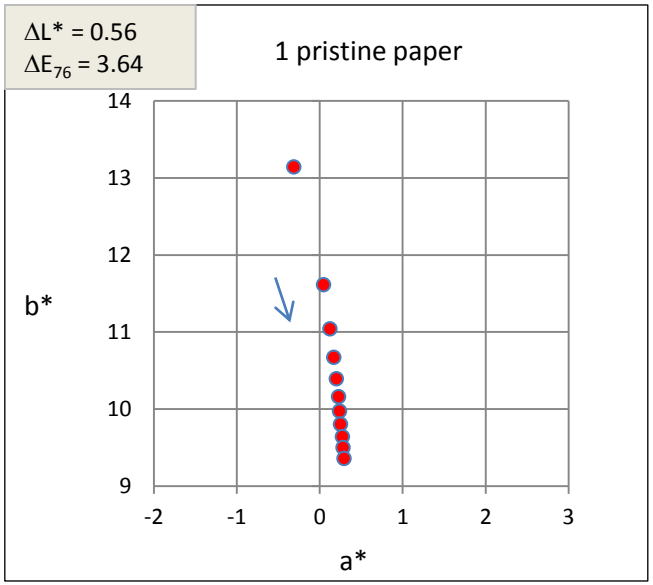


Figure 4. Colour change curves, CIE76



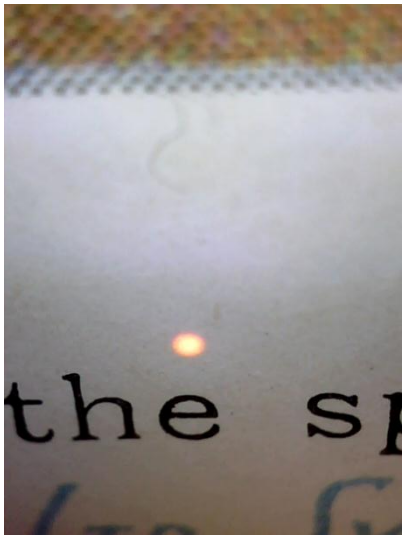
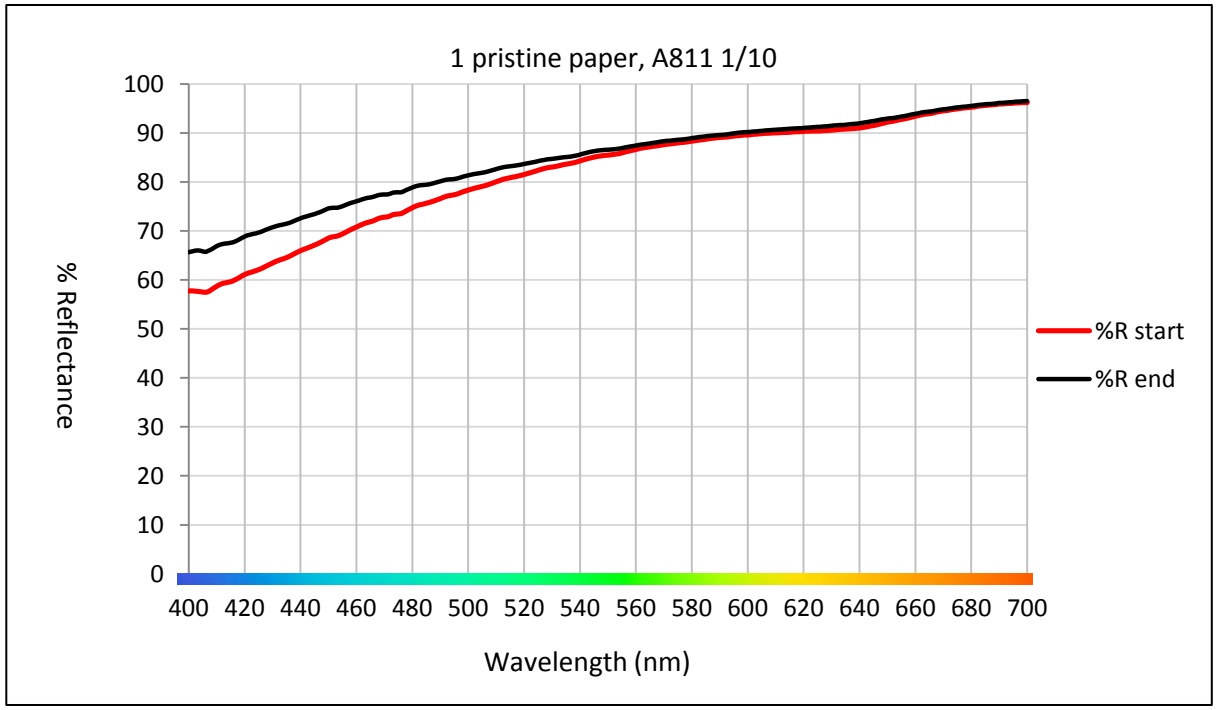
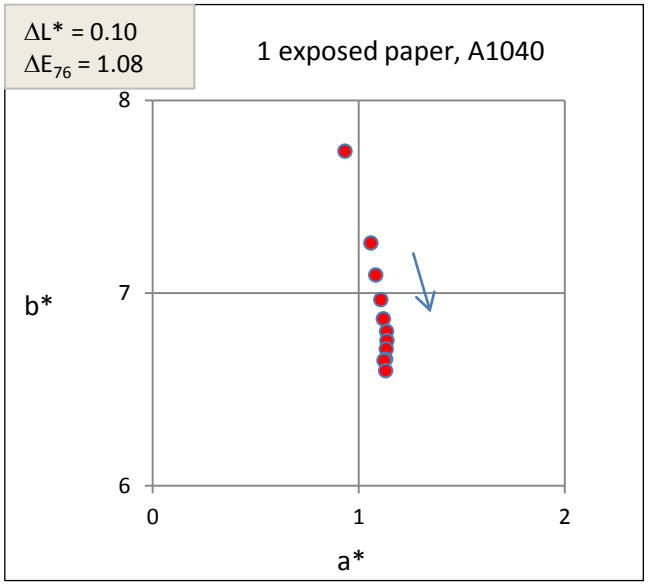


Figure 5. Unexposed paper (1): lighter, mostly chroma loss (less yellow(ed)) , hue shift. Compare with (2) which starts out whiter and bleaches less.





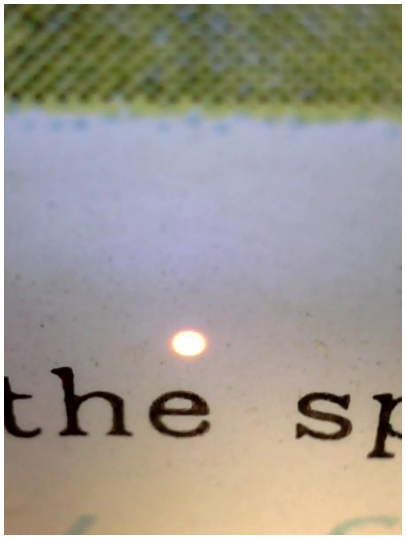
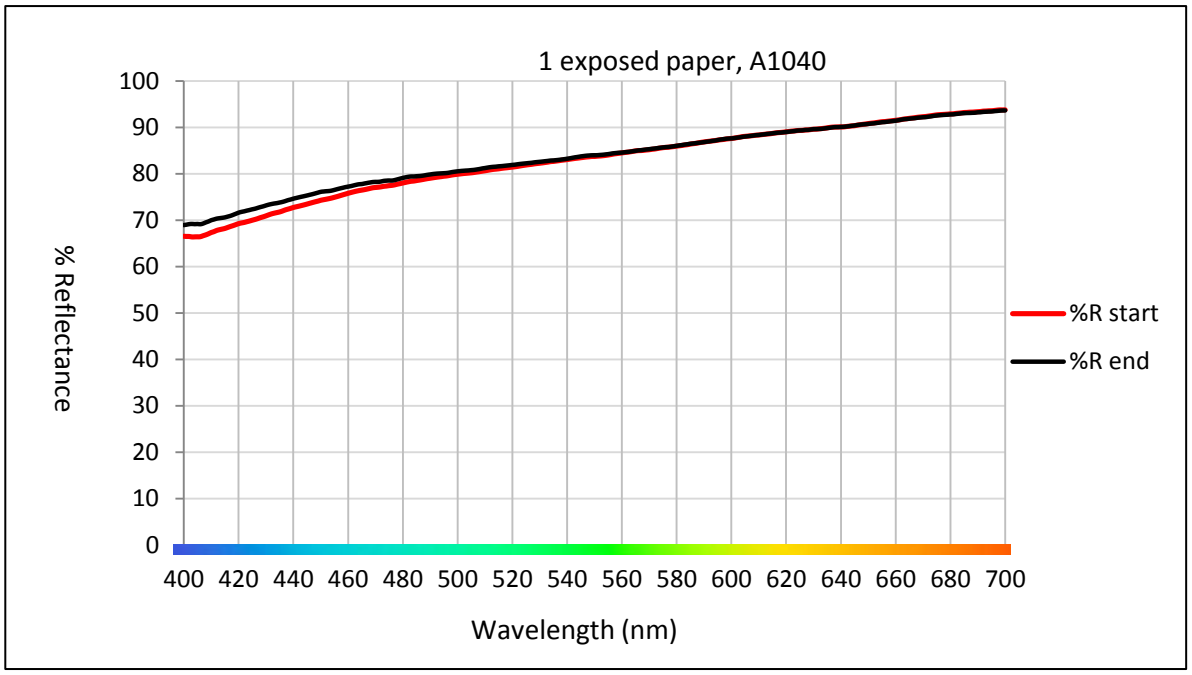


Figure 6. Exposed paper, A1040 (1): chroma loss (less yellow)



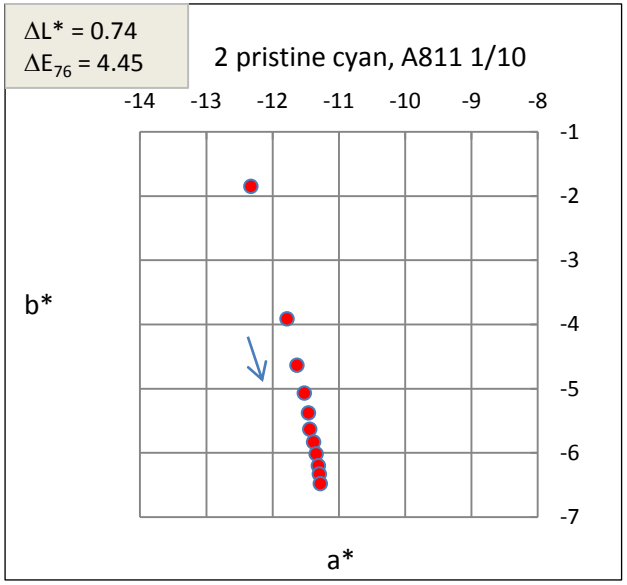
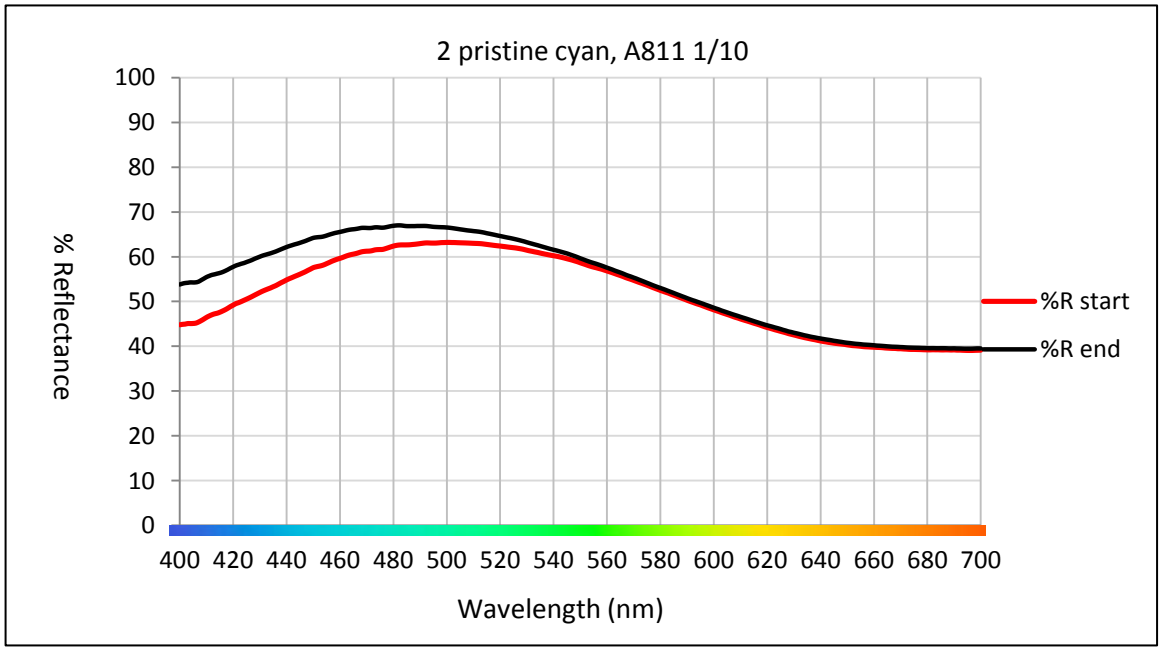
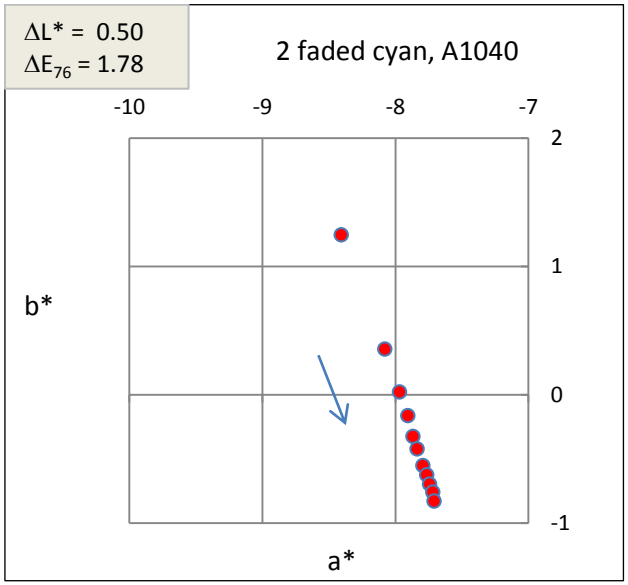


Figure 7. Pristine cyan, A811 1/10 (2): lighter, chroma shift towards a bluer colour (a chroma increase), significant hue change.





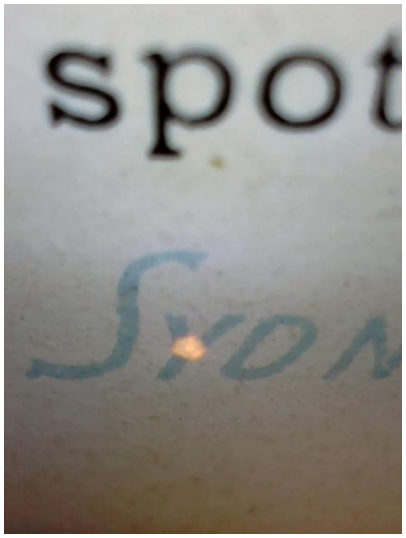
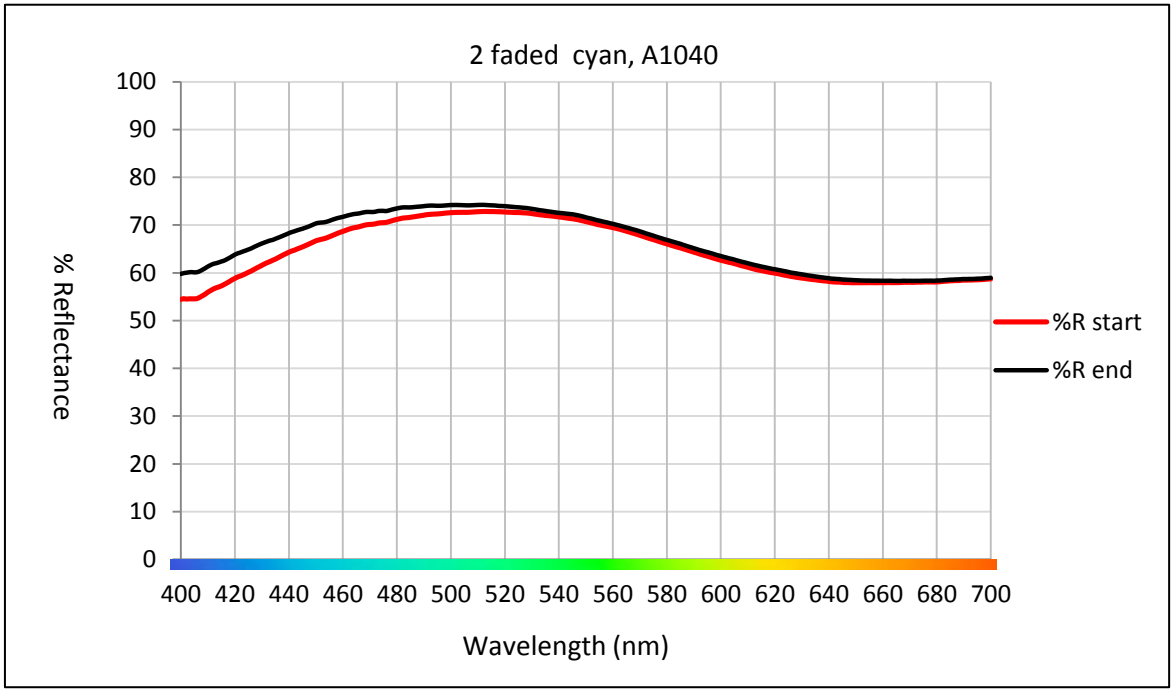
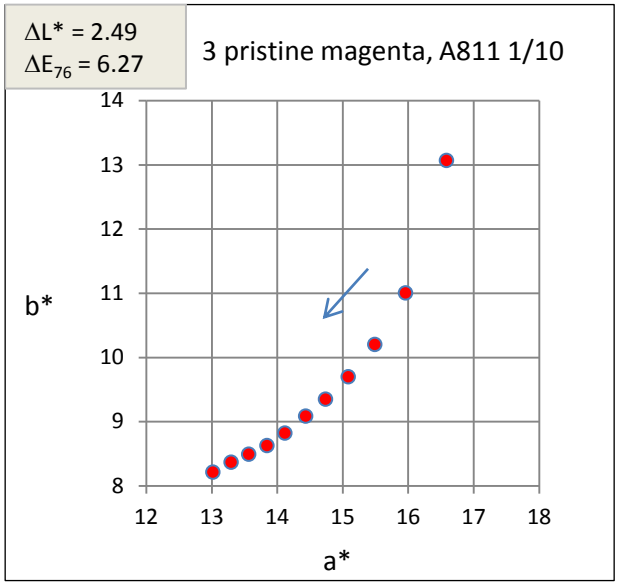


Figure 8. Faded cyan, A1040 (2): lighter, same chroma & hue shift as the unfaded cyan (figure 7 above),





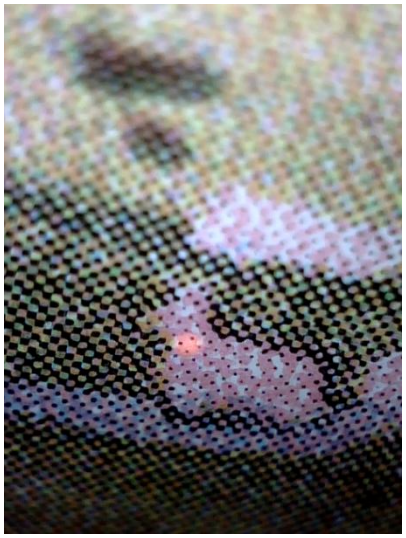
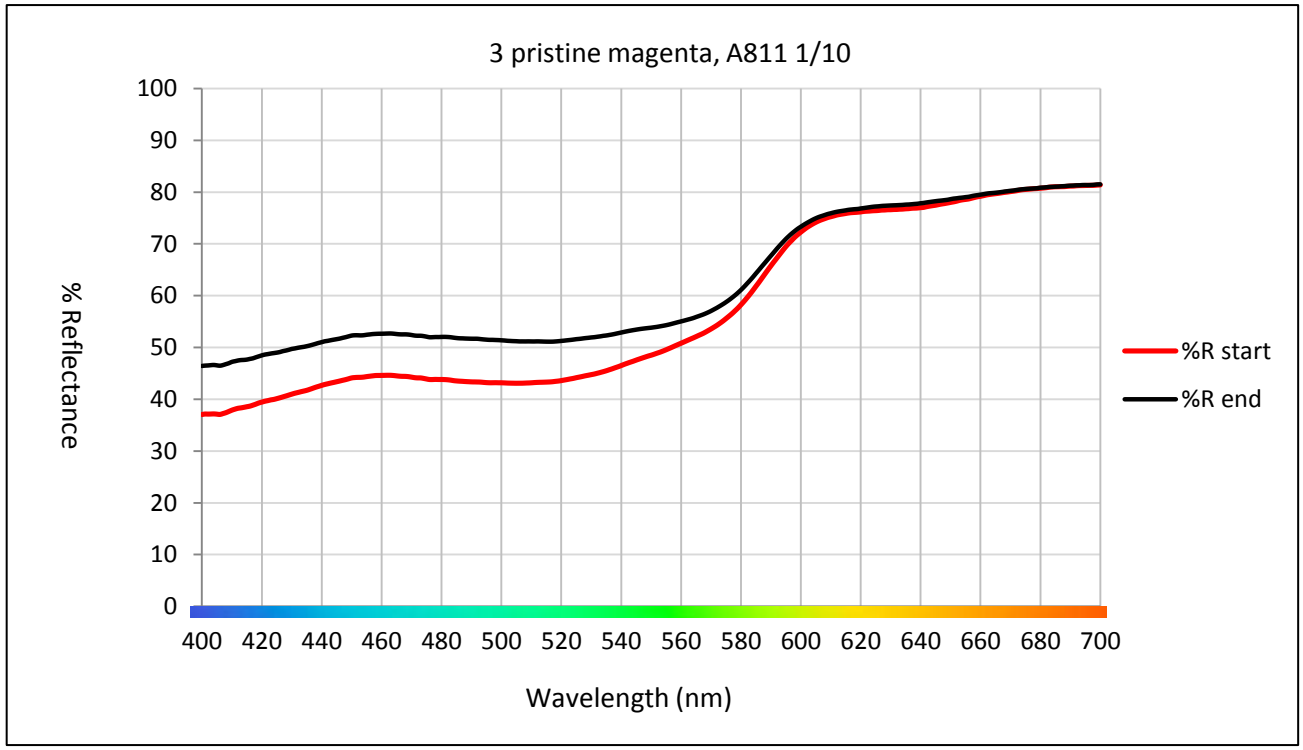


Figure 9. Pristine magenta, A811 1/10 (3): lighter, chroma loss, hue shift.



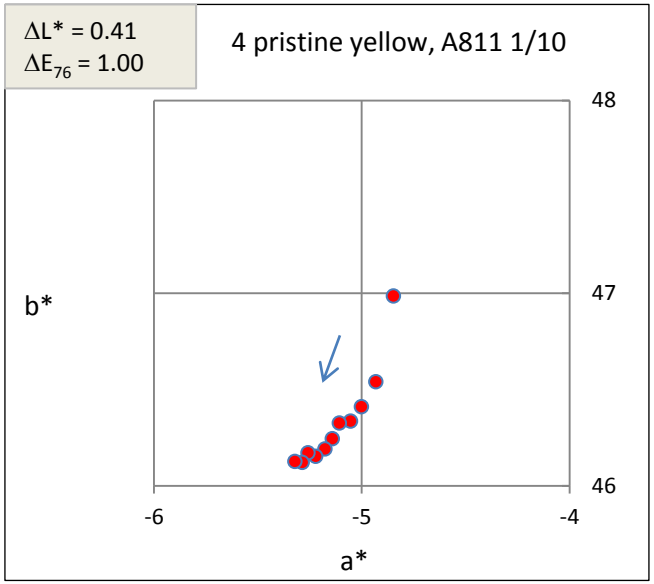
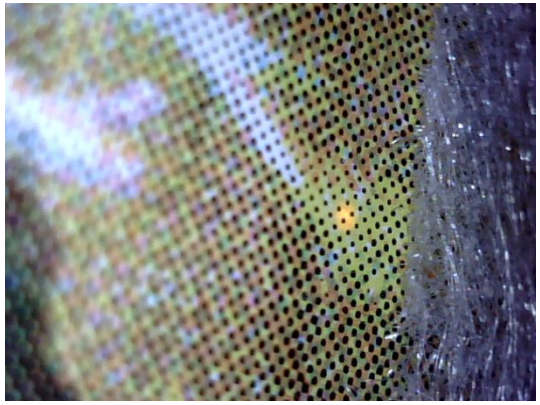
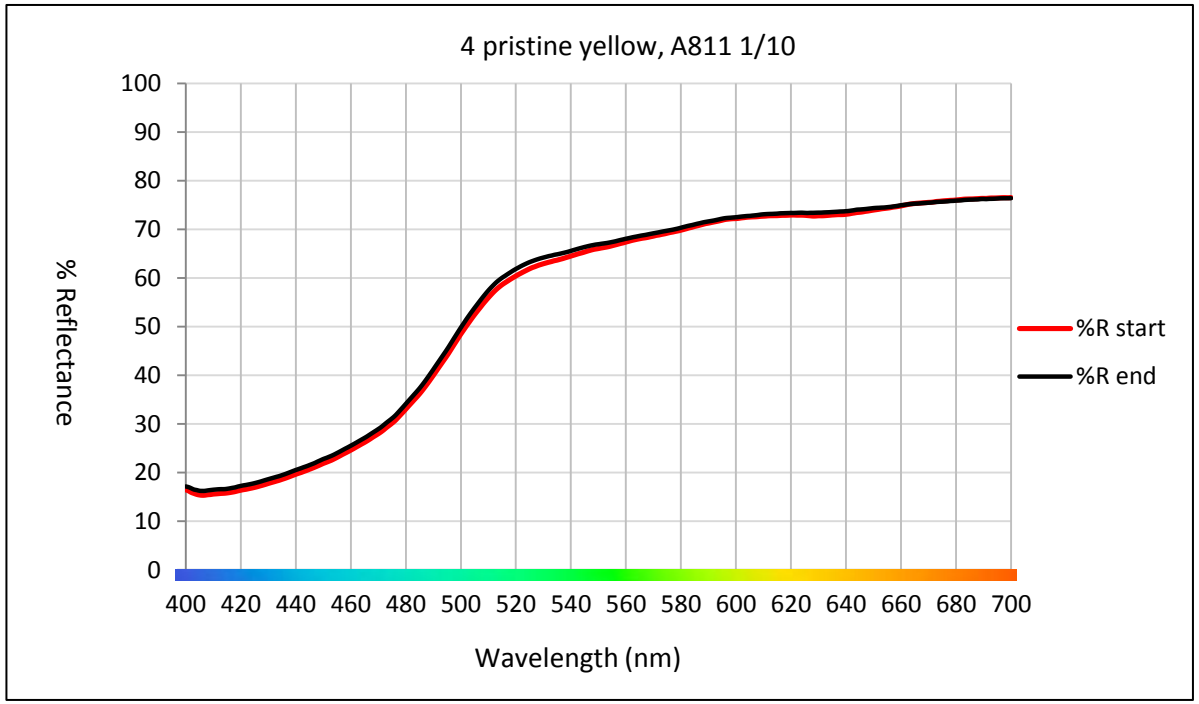
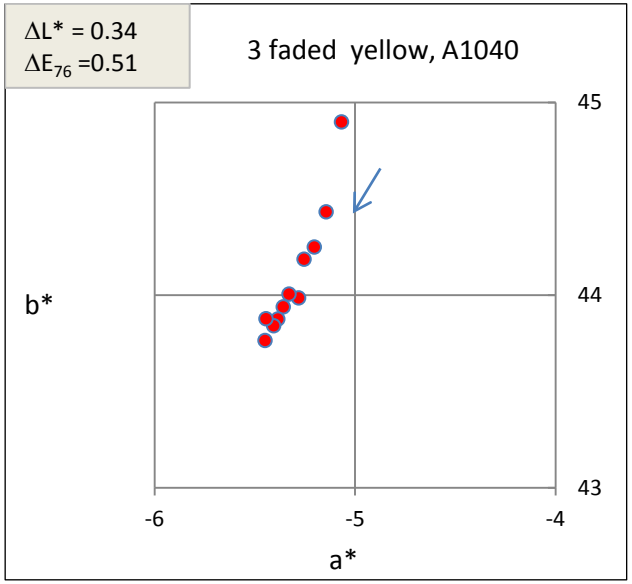


Figure 10. Pristine yellow, A811 1/10 (4): lighter, chroma loss.







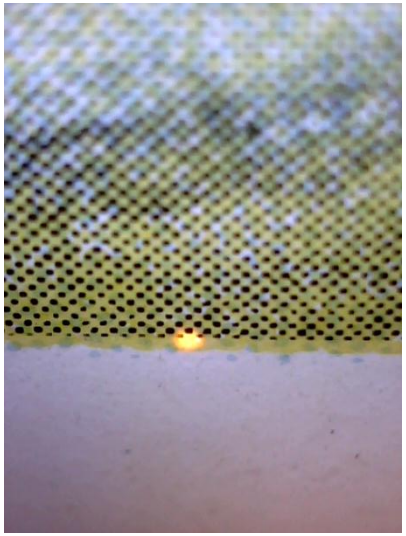
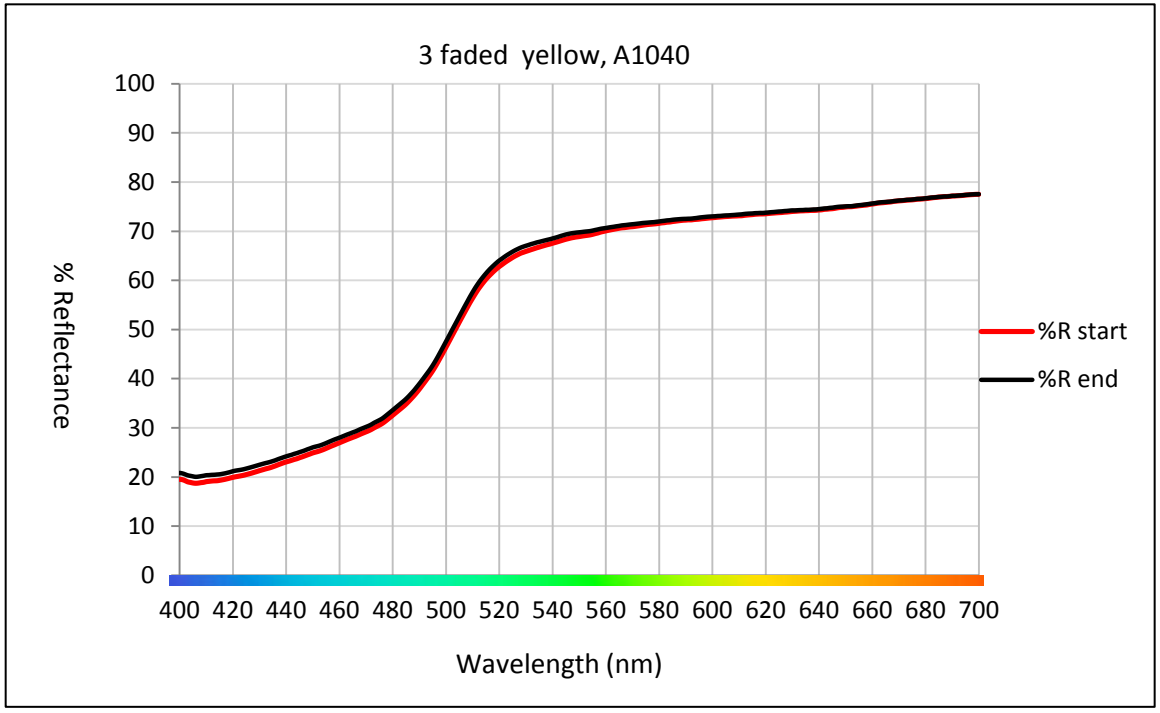


Figure 11. Faded yellow, A1040 (3): lighter, chroma loss.



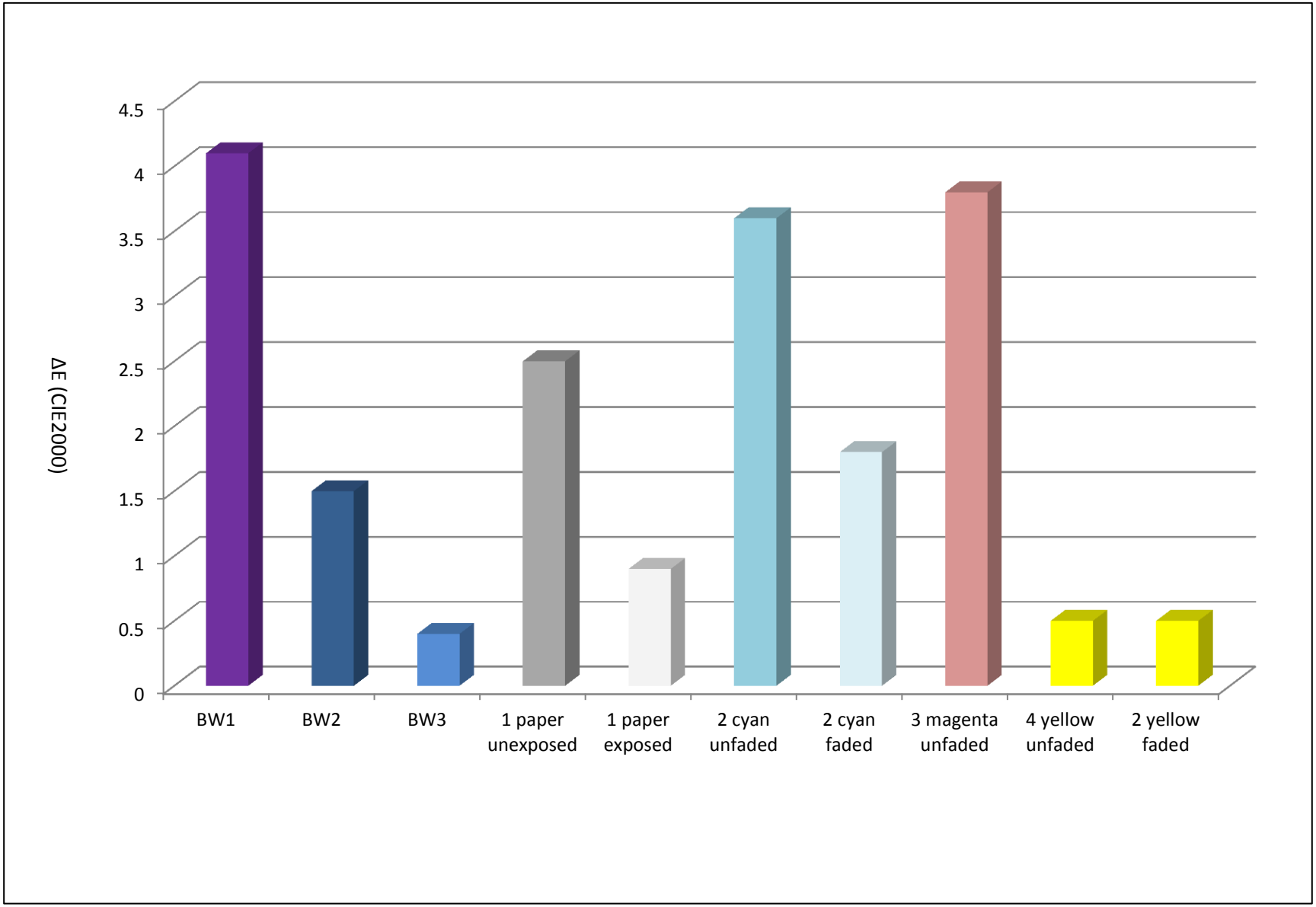


Figure 12 Relative colour change rates , CIE2000

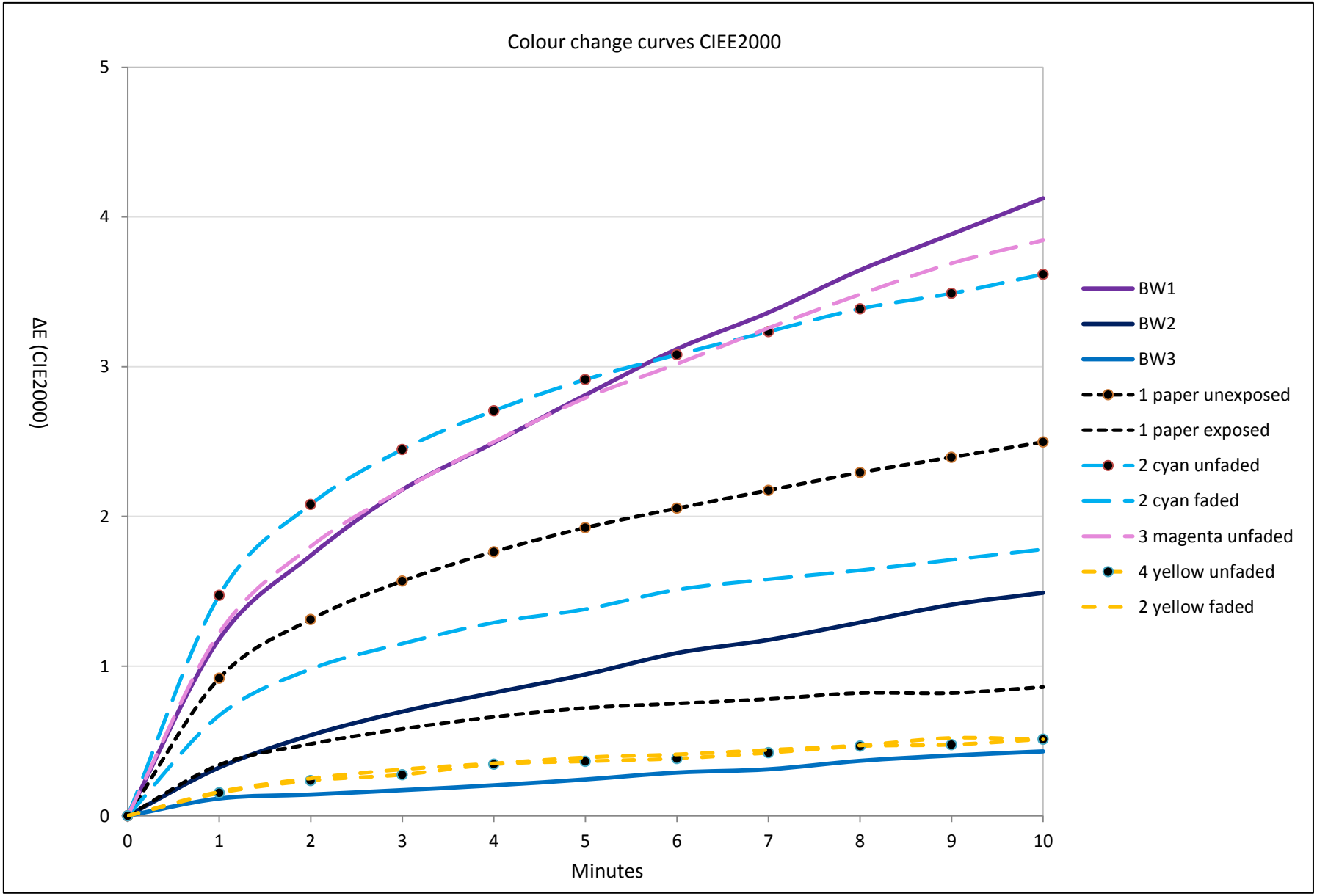


Figure 13 Colour change curves, CIE2000

Notes & References

Endnote 1
Microfade testing is a highly accelerated form of light exposure (millions of lux) and as with any accelerated ageing technique there are uncertainties surrounding the correlation between what is observed at very high test intensities and is likely to occur on display and during subsequent storage. It is a semi-quantitative risk assessment tool rather than predictive. The results apply only to UV-free light.

Endnote 2
To be consistent with most of the conservation literature on fading as well as recommendations based on the current NMA lighting guidelines, the conclusions in this summary have been discussed in terms of the CIE1976 perceptual model however the CIE2000 results are also given in Table 1 and Figures 12 & 13. Because perceptible colour change for the ISO Blue Wools has been revised downwards by about a factor of two (1BW step) for the same light exposure in the CIE2000 perceptual model, a range of other colours appear to respond twice as fast in comparison. In fact the more fundamental measure of fading is not the BW equivalent but the magnitude of ΔE. In some cases (such as the blue of the ISO blue wools themselves) ΔE decreases in CIE2000 compared to CIE76 for the same light exposure; in others it increases.

The assessment of the actual risk of fading is not generally affected a great deal, however lighting guidelines based on CIE76 and fading rates relative to the ISO blue wools must be recalculated for CIE2000.

Endnote 3
The significance of microfading results for (undyed) papers over the long term is unclear because of the complexity of the reactions involved in their ageing, both as a result of light exposure and as a result of other mechanisms. Microfading usually reflects only the photo-bleaching of paper under UV-free conditions however concurrent thermal reactions lead to yellowing as well as reactions initiated by light but which continue during subsequent dark storage (post-actinic processes).

While photo-bleaching of age related yellowing products may be considered aesthetically desirable, it does not signal a reversal or cessation of chemical and photochemical processes that caused the paper to discolour in the first place and which also result in structural damage to cellulose, especially in high lignin papers.

The relative rates of all of these process depend heavily on factors such as chemical bleaching, sizing agents, lignin content, pH, exogenous and endogenous pollutant levels (including inks), temperature, prior conservation treatments, and so on.

Endnote 4
The NMA assumptions (Ford BL & Smith NK 2011) are based on those of the V&A Museum (Ashley-Smith et al 2002): that is works should last for at least 500 years in a coloured form; a Just Noticeable Fade (JNF) = $1.6\Delta E$ and 10 JNFs signal the effective end of coloured life for an object. The NMA further makes a judgement based on a significance test as to whether the object/collection is likely to be in strong demand for exhibition and adjusts recommended exposures accordingly.

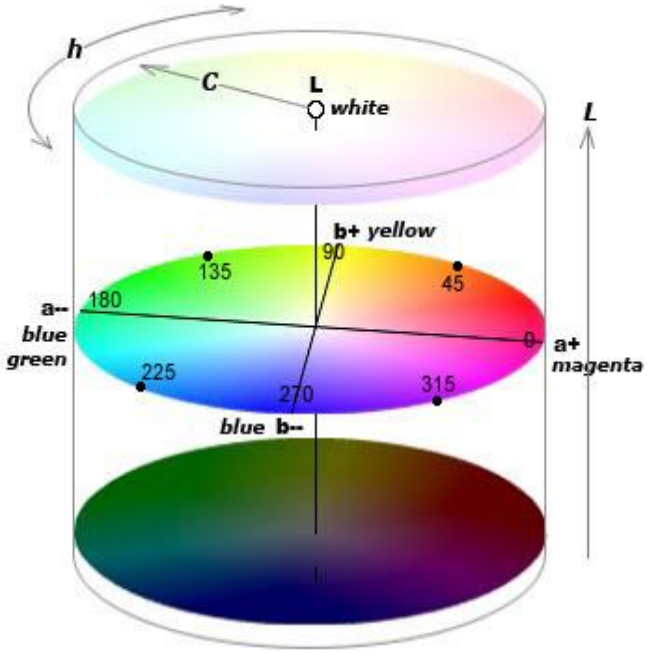
References
Ashley-Smith, J, Derbyshire, A & Pretzel, B 2002, 'The continuing development of a practical lighting policy for works of art on paper and other object types at the Victoria and Albert Museum', *Preprints of the 13th triennial meeting of the ICOM Committee for Conservation in Rio de Janeiro*, vol.1, pp. 3-8.

CIE 2004, *CIE 157-2004, control of damage to museum objects by optical radiation*, 20. Vienna: Bureau Central de la Commission Internationale de l'Éclairage

Ford, B & N Smith, N, 2009, 'The development of a significance and risk based lighting framework at the National Museum of Australia', AICCM Bulletin vol. 32 pp. 80-86.

Instrument Settings

Lamp power (W)	81
Controller Current (uA)	6.980
Spot power (mW)	5.0
Spot lux (megalux)	~ 6-8
Spot size (mm)	0.25-0.3
Filters	water/UV/NIR
Other	NIR filter PGO
Colour Space	ΔECIE76, 2000



L* a* b* and L C h are different ways of describing the same shift in CIELAB space

L* = Lightness
a* = red-green axis
b* = yellow-blue axis

C = vividness (chroma)
h = hue angle anticlockwise from red (0)