Micro-fading report

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Object:	Dyed pandanus fibre basket
Maker:	Lockhardt River area
Accession No:	[redacted]
Materials and media	Pandanus, dyes
Collection:	Athol K Chase Collection
Collection type:	NHC
Year of production	1971-76
Exhibition:	First Australians
Test Date:	28-7-21
Operator:	Bruce Ford
Requested by:	[redacted]ne

Summary

The least lightfast colour is the orange dye (1), which rapidly faded to a noticeable extent at a rate equivalent to approximately BW1 (CIE_{00}) under the test conditions. After the initial fade it settled down to a long-term fading rate equivalent to midway between BW2 and BW3. (Endnotes 1 & 2). This is within the range of lightfastness (BW1 or worse to BW3) for colourants described in the CIE standard for museum lighting as having “high responsivity to light” for museum purposes (CIE 2004) and equivalent to 1.5 Mlux h/JND where one year’s display is about 0.15 - 0.2 Mlux h depending on light intensity and hours of opening.

Depending on its significance (which is considered to determine demand for display in the medium-term) it suitable from a fading perspective for display for either 2 or 5 years /decade at 50-100 lux. Within this lux range the lighting should be as low as possible consistent with good visibility (Endnote 4).

If its pristine quality were considered important, a much shorter display period or no display at all might be considered appropriate.

Figure 1 Test positions

	CIE76			CIE2000							
Colour	**BW Range**	**BW Equivalent**	**ΔE76**	**BW Range**	**BW Equivalent**	**ΔE2000**	**ΔL***	**Δa***	**Δb***	**ΔC**	**Δh**
BW1			12.1			6.0	5.2	-3.4	10.4	-9.9	9.6
BW2			10.1			4.2	3.1	-0.9	9.6	-9.3	4.3
BW3			4.9			1.4	0.7	-1.5	4.6	-4.8	1.3
BW4			0.9				0.2	0.3	0.9	-0.9	-0.4
1 orange	BW3-BW2	2.8	5.8	BW3-BW2	2.5	2.9	-2.5	-2.8	-4.4	-5.2	0.2
2 yellow	BW4-BW3	3.6	2.3	>BW3	>BW3	1.0	-0.1	-0.6	-2.3	-2.3	0.3

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

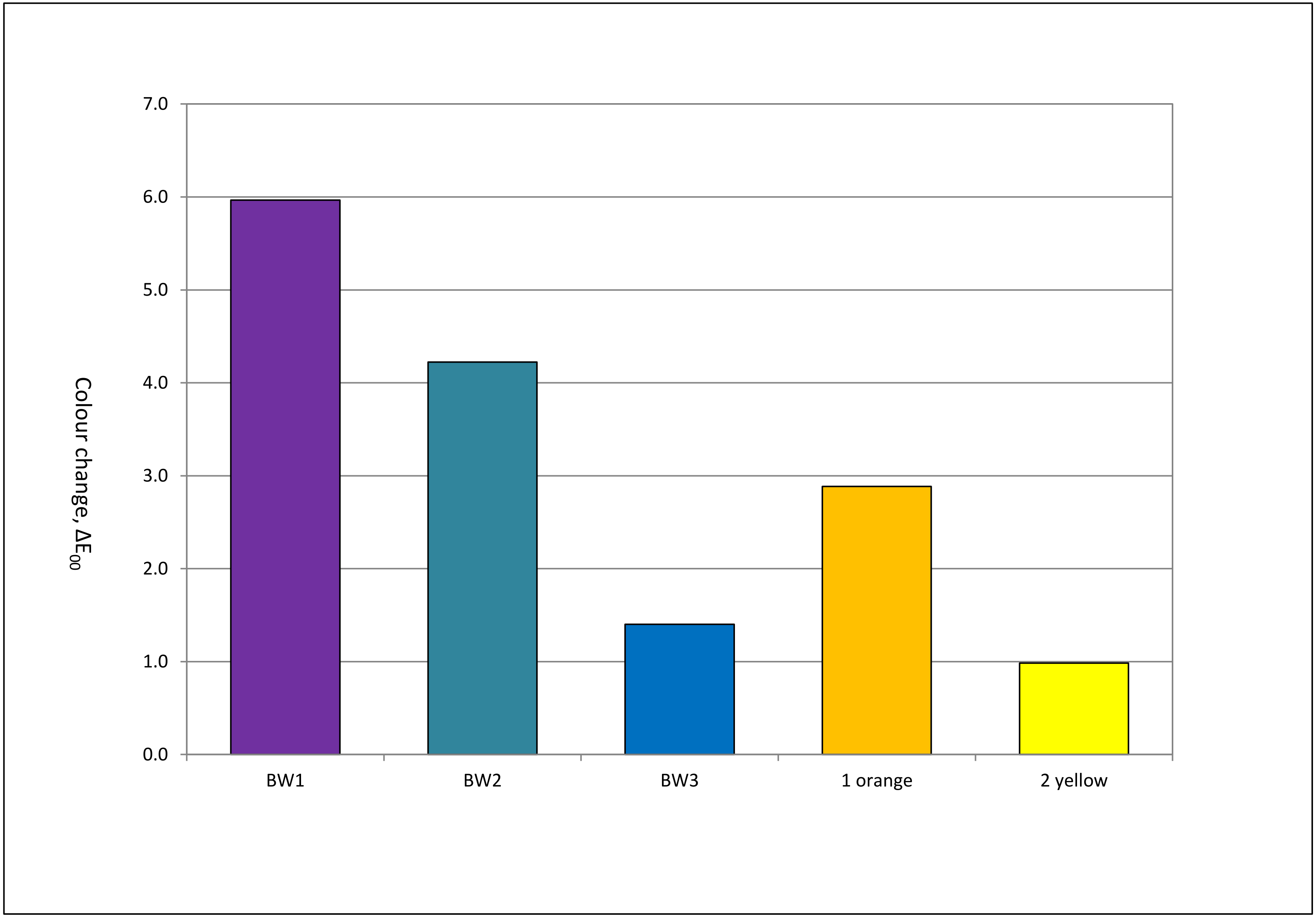


Figure 2. Relative colour change rates , CIE2000

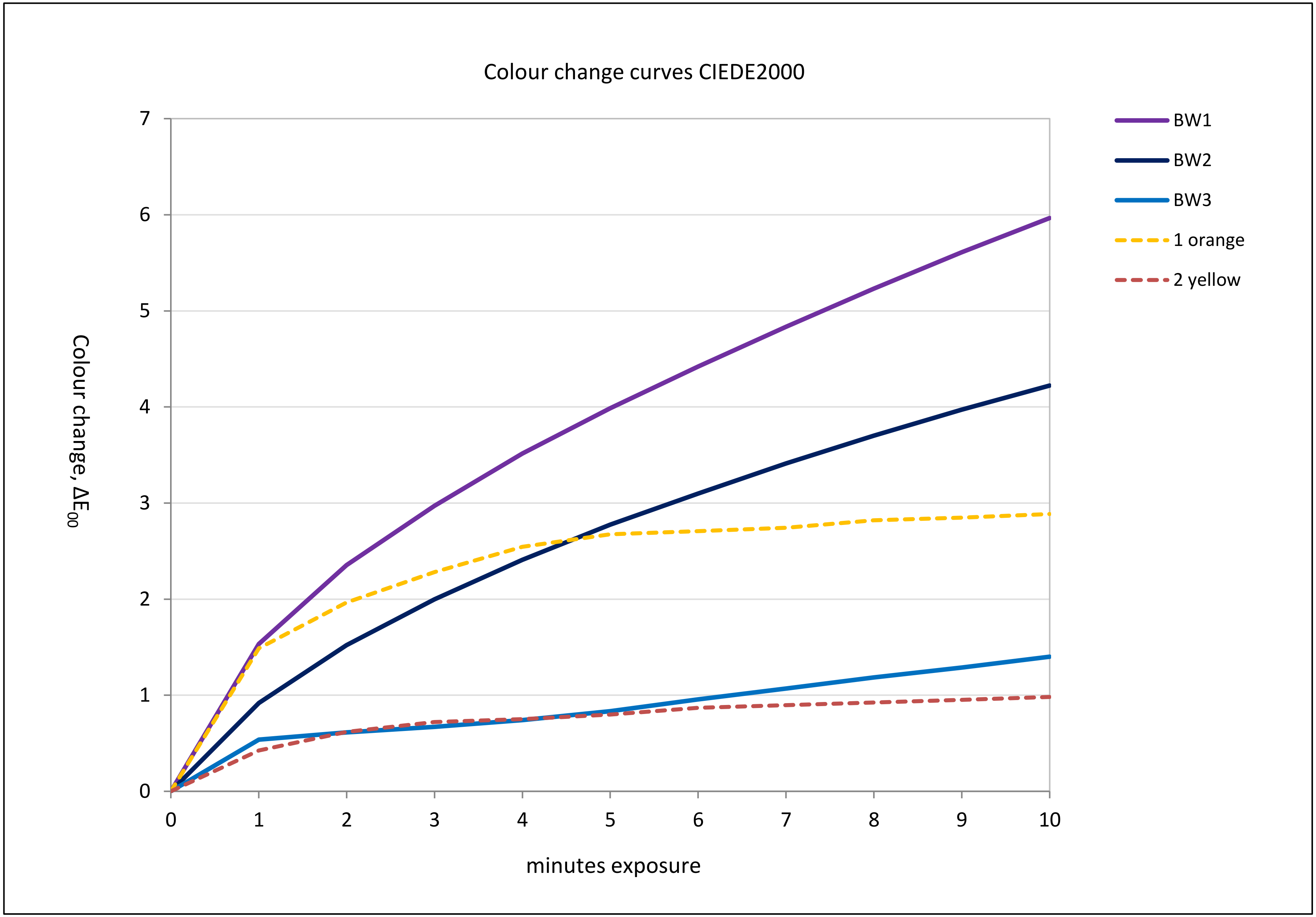


Figure 3. Colour change curves, CIE2000

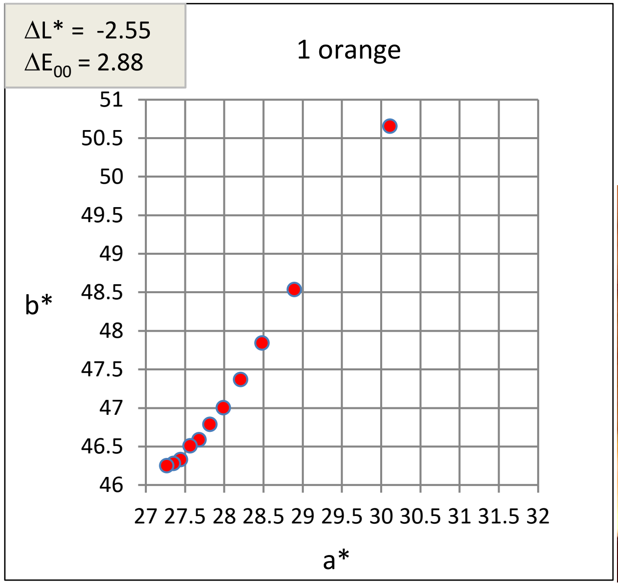
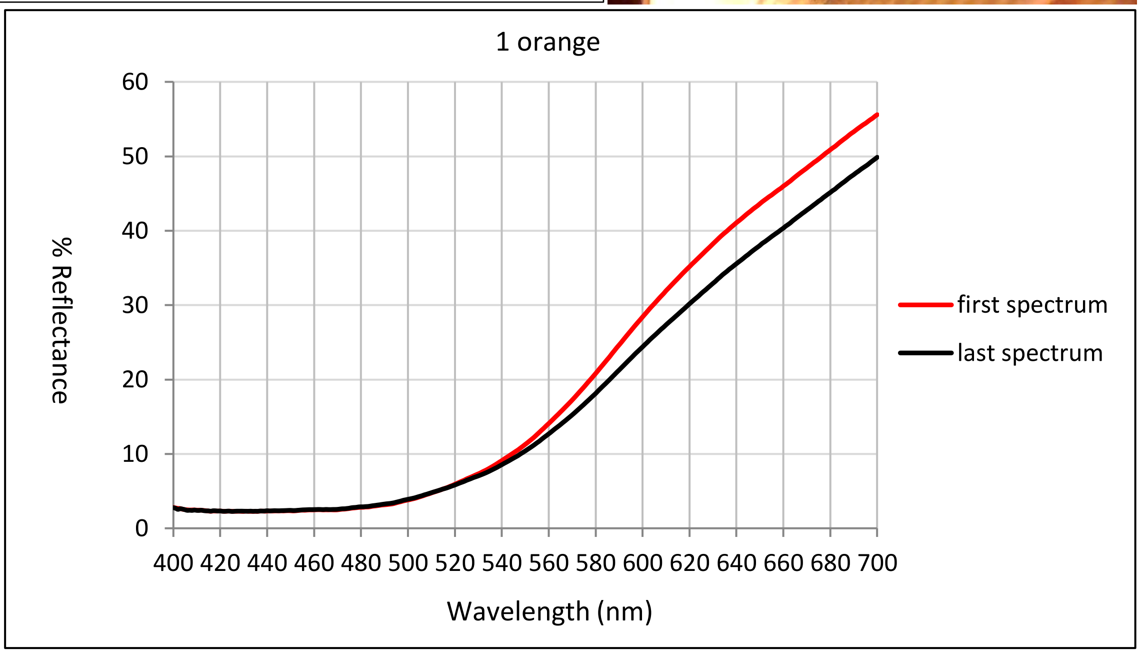


Figure 4. Orange (1): darkens, chroma loss (less orange).



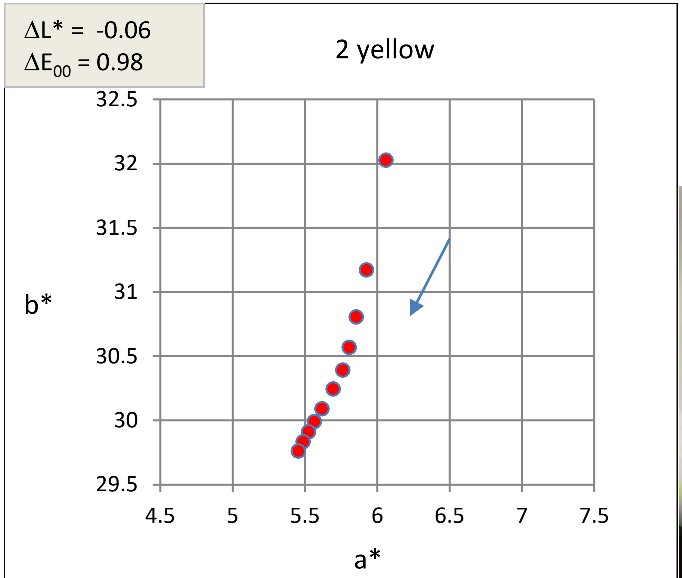
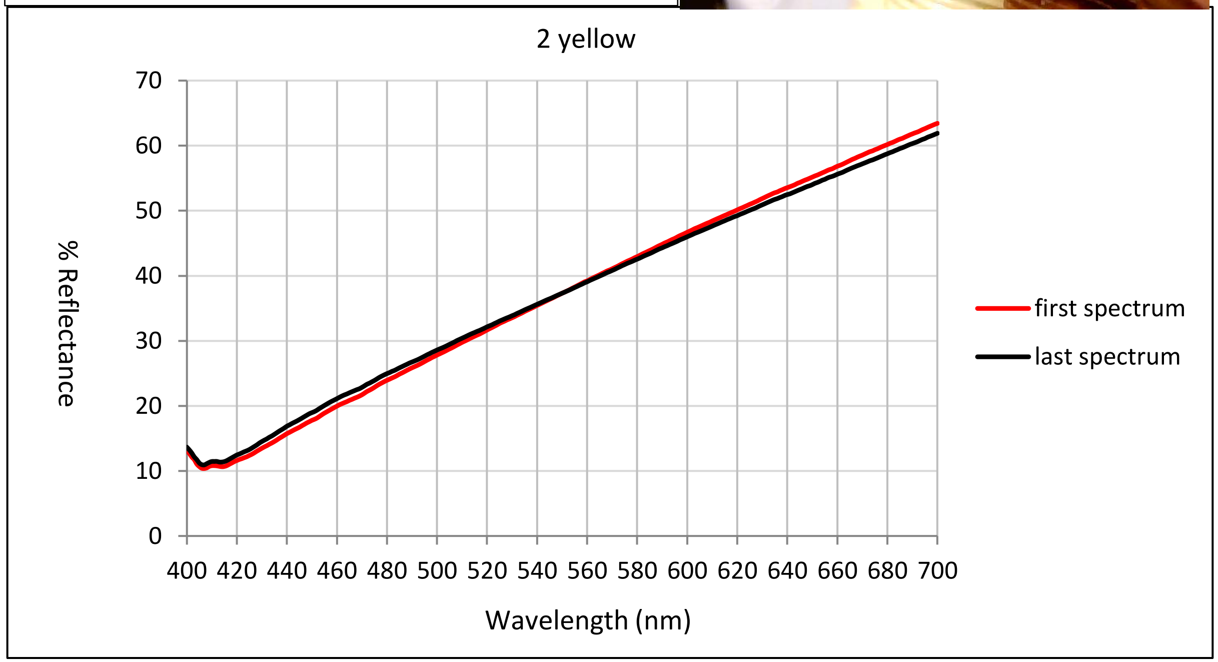


Figure 5. Yellow (2): chroma loss (less yellow).



Notes & References

Endnote 1

Microfade testing is an accelerated test method and there are uncertainties surrounding the correlation between what is observed at very high intensities and what is likely to occur on display and during subsequent storage (Whitmore et al 2000). It is a semi-quantitative risk assessment tool rather than necessarily predictive. The results in this case apply only to UV-free light.

Endnote 2

For the purposes of this report colour change (ΔE) has been calculated using the CIE's 2000 (CIEDE2000) colour difference formula which replaced the earlier and much simpler 1976 (CIE76 or CIELAB) equation. There are many other colour difference equations, all of which will give different results - for example CMC, S-CIELAB, and a proposed I* (I-star) metric for photographs (McCormick-Goodhart 2007).

Michalski's estimates of how much exposure (megalux hours, Mlux h) will result in a just noticeable fade or difference (JNF or JND) for each of the BWs (CIE 2004) are themselves approximations with a maximum error of ± 1 BW step (Michalski 2010). Therefore absolute predictions of the response of a colourant to a particular exposure (mlx-h) are possibly uncertain to a similar extent. The most recent (unpublished) research by the CCI and GCI indicates that for BWs 2-5 Michalski's estimates are reasonable, but the lightfastness of BW1 is overestimated by as much as a factor of two or three (Druzik 2016).

Endnote 3

Microfading cannot predict post-exposure colour changes that may occur in undyed and unpigmented fibres and paper because only the immediate photochemical response is measured and not the effect of concurrent and subsequent thermal (oxidative) yellowing reactions (Feller 1994). Light exposure accelerates subsequent yellowing of paper via a thermal (non-photochemical or "dark") mechanism involving residual photochemical reaction products. Thermal discolouration depends heavily on temperature, chemical processing of fibres, pH, exogenous and endogenous pollutants, prior conservation treatments and so on. To further complicate matters, ultraviolet directly yellows, rather than bleaches, groundwood paper and most natural fibres like wool. For example the rapid discolouration of newspaper in sunlight is the result of UV (<400nm) yellowing outpacing visible (>400nm) light bleaching.

Endnote 4

The NMA assumptions (Ford BL & N Smith 2009) 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 Difference (JND) = 1.6ΔE and 10 JNDs signal the effective end of coloured life for an object. This may sometimes be a conservative estimate because approximately 30ΔE represents complete fading, but for low chroma colours it seems reasonable. The absolute fading rates of the BWs are taken from CIE157 (2004), see Endnote 2. CIE157 recommends colourants less lightfast than BW3 be exposed only half as much as the V&A's 2 years/decade at 50lux recommendation.

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 in the future (i.e. at higher risk of fading over time) and adjusts recommended exposures accordingly. Objects judged likely to be more in demand are treated more conservatively than objects which may rarely if ever displayed again (Ford BL & N Smith 2009) .

References

Ashley-Smith, J, Derbyshire, A & B Pretzel 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, *CIE157-2004*, *control of damage to museum objects by optical radiation*, Vienna: Bureau Central de la Commission Internationale de l'Éclairage.

CIE. 2001. Improvement to industrial color difference evaluation, *CIE technical report 142-2001.* Vienna, CIE Central Bureau.

Druzik J.M., Getty Conservation Institute (GCI), personal communication, 18th November 2016

Feller, RL. 1994. *Accelerated ageing: photochemical and thermal aspects*. Research in Conservation No. 4, GCI. http://www.getty.edu/conservation/publications_resources/pdf_publications/accelerated_aging.html

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

Michalski, S., Canadian Conservation Institute (CCI), personal communication, 10th October 2010.

Refs ctd.

McCormick-Goodhart, M. 2007. *An introduction to the I* Metric*. Aardenburg Imaging and Archives.

Tse, S. 2016. Personal communication.

Whitmore, PM, Bailie, C & S Connors 2000, Micro-fading to predict the result of exhibition: progress and prospects, in *Tradition and Innovation: Advances in Conservation*, ed. A. Roy and P. Smith, pp. 200-205. London: IIC.

The Canadian Conservation Institute website has an excellent general introduction to light and museum collections: http://www.cci-icc.gc.ca/resources-ressources/agentsofdeterioration-agentsdedeterioration/chap08-eng.aspx

For a complete list of references to microfading and its applications see http://www.microfading.com/resources.html

Blue wool equivalent (BWE)	1 1.5	2 2.5	3 3.5	4
Lightfastness (Mlux h/JND)	0.2 0.6	1.0 1.8	3.0 5.5	10
Light level (lux)	up to 50 lux	50 - 80 lux*	50 - 80 lux*	lighting as required*
Display high significance	individually decided	2 years/decade	5 years/decade	period of exhibition
Display normal significance	individually decided (2 years/decade)	5 years/decade	period of exhibition	period of exhibition

*minimum consistent with good display

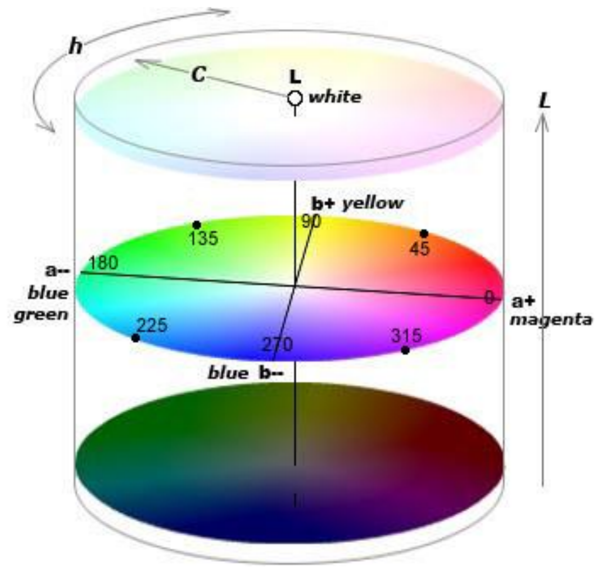
Figure (a) Appendix NMA lighting guideline

BW4-2 taken from Michalski's BWFS estimates from *Running A Museum, a practical handbook* ICOM 2004. *http://portal.unesco.org/culture/en/ev.php-URL_ID=36646&URL_DO=DO_TOPIC&URL_SECTION=201.html More recent estimates of BW1 put it at about 0.1-0.2 Mlux h/JND (UV-free), less lightfast than Michalski's estimate (Druzik 2016)*

Instrument Settings

Luminous flux (mlm)	~650
Spot lux (megalux)	~ 6-8
Spot diameter (mm)	0.4
Colour difference equations	ΔE_{76} & ΔE_{00}

Figure (b) Appendix. Simplified L*a*b* colour space



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)