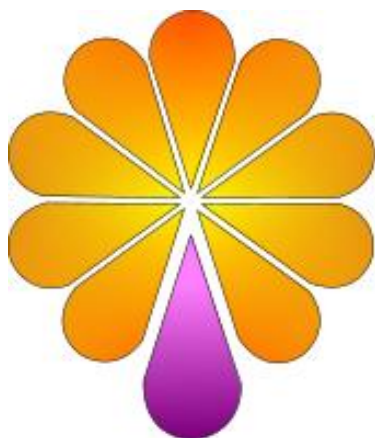


[1343] ESP Aust.

Luminos Consulting

ACN: 110 131 676 ABN: 69 110 131 676 A: Suite 1, 15 Castleridge Crt, Narre Warren, VIC 3805
P: 1300 668 985 F: 03 9015 6482 E: info@luminos.com.au W: www.luminos.com.au



LUMINOS CONSULTING

ON-SITE LUMINANCE CONTRAST TESTING

LUMINANCE CONTRAST TESTING REPORT

Prepared for
Michelle Siegman
ESPAust.net.au
Ph: 1300 665 761
Fax: (03) 9877 6638
Email: sales@espaust.net.au
Visit: www.espaust.net.au

Prepared by

Dale Sheppard
Director
Luminos Consulting
15 Castleridge Crt Narre Warren Sth VIC 3805
Ph: (03) 9705-2149 Mob: 0488 024 508
Email: info@luminos.com.au
Web: www.luminos.com.au

Report provided on:
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Executive Summary

ESP Aust. engaged the services of Luminos Consulting to conduct luminance contrast testing of four (4) colours used in TGSI's to provide LRV's for the purposes of providing these to clients for luminance contrast comparisons. Luminos Consulting conducted the tests on the 21.11.13 at the Luminos Consulting Office.

Five (5) measurements of each surface were taken and averaged to calculate luminance contrast percentages. Measurements are recorded in Yyx.

Testing Equipment:

- Konica Minolta CR400 – Tristimulus Colorimeter d/0
- Xrite i1 – Spectrophotometer 45/0

Summary of Results

The test results indicated that the Dry test average LRV's as shown in the below table. It is important to state that the testing procedure for wet testing did not result in any change in the TGSI materials and the results indicated the same LRV's as the dry testing. Therefore Luminos Consulting deemed the wet tests inappropriate.

Yellow DRY Averaged LRV =	47.83
Black DRY Averaged LRV =	3.60
Grey DRY Averaged LRV =	10.35
White DRY Averaged LRV =	69.32

Luminos have conducted these tests on the colours shown in the above table and these results are applicable to the following products.

Black					
Surface Applied			Cast In Place		
Hazard		Directional	Hazard		Directional
300mm x 300mm	300mm x 600mm	300mm x 600mm	300mm x 300mm	300mm x 600mm	300mm x 600mm
B300x300SAH	B600x300SAH	B600x300SAD	B300x300CIH	B600x300CIH	B600x300CID
White					
Surface Applied			Cast In Place		
Hazard		Directional	Hazard		Directional
300mm x 300mm	300mm x 600mm	300mm x 600mm	300mm x 300mm	300mm x 600mm	300mm x 600mm
W300x300SAH	W600x300SAH	W600x300SAD	W300x300CIH	W600x300CIH	W600x300CID
Yellow					
Surface Applied			Cast In Place		
Hazard		Directional	Hazard		Directional
300mm x 300mm	300mm x 600mm	300mm x 600mm	300mm x 300mm	300mm x 600mm	300mm x 600mm
Y300x300SAH	Y600x300SAH	Y600x300SAD	Y300x300CIH	Y600x300CIH	Y600x300CID
Grey					
Surface Applied			Cast In Place		
Hazard		Directional	Hazard		Directional
300mm x 300mm	300mm x 600mm	300mm x 600mm	300mm x 300mm	300mm x 600mm	300mm x 600mm
G300x300SAH	G600x300SAH	G600x300SAD	G300x300CIH	G600x300CIH	G600x300CID

1. Testing Methodologies

1.1 Luminance Contrast Testing

Luminos Consulting luminance contrasting testing is performed in line with the testing procedures as specified in Australian Standard 1428.1 – 2009 Design for access and mobility - General requirements for access - New building work – Appendix B3 & B5. Testing also compliant with AS1428.4.1 – 2009.

For the purposes of determining the most accurate luminance contrast ratios, Luminos Consulting perform two (2) testing methodologies in laboratory tests;

1. Tristimulus Colorimeter (d/0) Testing – This testing methodology is conducted under D65 lighting delivered via the equipment and remains constant across all tests. Please note that Luminos Consulting use the only compliant equipment (Konica Minolta CR400). This test is specular inclusive. Specular inclusive is the accurate measurement of the light reflectance from the colour and is not influenced by surfacing finishes.
2. Spectrophotometer (45/0) Testing – This testing methodology is considered the most accurate in terms of luminance contrast testing. Please note that this testing does not meet the stated instrumentation in AS1428.1 – 2009 & AS1428.4.1 – 2009. This test is inclusive of colour and surface finishing.

1.2 Site Specific Information / Conditions

N/A Testing conducted under laboratory condition.

1.3 Luminance Contrast Testing Set Up

Konica Minolta CR400 – Tristimulus Colorimeter d/0

Measuring head is placed flush on surface being tested and held steady until measurement is taken.

Xrite i1 – Spectrophotometer 45/0

Measuring head is placed flush on surface being tested and held steady until measurement is taken.

1.4 Measurements

Konica Minolta CR400 – Tristimulus Colorimeter d/0

Measurements are taken on a cross spread of the sample colour. Five (5) measurements of each surface are taken and averaged to calculate light reflectance values. Measurements are recorded in Yyx. (Y = Light Reflectance / Luminance).

Xrite i1 – Spectrophotometer 45/0

Measurements are taken on a cross spread of the sample colour. Five (5) measurements of each surface are taken and averaged to calculate light reflectance values. Measurements are recorded in Yyx. (Y = Light Reflectance / Luminance).

1.5 Equipment Specifications

Konica Minolta CR400 – Tristimulus Colorimeter d/0

Specifications

Name	Chroma Meter Measuring Head	
Model	CR-400 Head	CR-410Head
Illuminating/viewing system	d/0 (Diffuse illumination/0° viewing angle) (Specular component included)	Wide-area illumination/0° viewing angle (Specular component included)
Detector	Silicone photo cells (6)	
Display range	Y: 0.01 to 160.00% (reflectance)	
Light source	Pulsed xenon lamp	
Measurement time	1 seconds.	
Minimum measurement interval	3 seconds.	
Battery performance	Approx. 800 measurements (when using batteries under company testing Minolta's conditions)	
Measurement/illumination area	φ8/φ11	φ50/φ53
Repeatability	Within ΔE^*ab 0.07 standard deviation (when the white calibration plate is measured 30 times at intervals of 10 seconds)	
Inter instrument agreement	ΔE^*ab : within 0.6	ΔE^*ab : within 0.8
	Average of 12 BCRA series II colors	
Observer	2 degrees Closely matches CIE 1931 Standard Observers: ($\bar{x}_2\lambda$, $\bar{y}\lambda$, $\bar{z}\lambda$)	
Illuminant *1	C, D ₆₅	
Display *1	Chroma values, color difference values, PASS/WARN/FAIL display	
Tolerance judgment *1	Color difference tolerance (box tolerance and elliptical tolerance)	
Color space/ colorimetric data	XYZ, Y x y, L*a*b*, Hunter Lab, L*C*h, Munsell (only illuminant C), CMC(l:c), CIE1994, Lab99, LCh99, CIE2000, CIE Wl*Tw (only illuminant D ₆₅), WI ASTM E313 (only illuminant C), YI ASTM D1925 (only illuminant C), YI ASTM E313 (only illuminant C), User index (up to six can be registered from computer)	
Languages	Operating keys : English LCD : English (default) (LCD : German, French, Italian, Spanish, Japanese) *1	
Storable data sets	1000 (measuring head and data processor save different data)	
Color difference target colors	100	
Calibration channels *1	20 channels (ch00 : white calibration, ch01 to ch19 : user calibration)	
Display	Dot-matrix LCD with back light (15 chars x 9 lines + 1 line for icon display)	
Interface	RS-232C compliant (for data processor/PC) * Baud rate : 4800, 9600, 19200 (bps), set at 9600 bps when shipped from factory	
Power source	4 AAA size alkaline or Ni-MH batteries, AC adapter (AC-A17) AC120V ~ 50-60Hz 0.4A (for N.America and Japan) AC230V ~ 50-60Hz 0.4A (for worldwide except N.America)	
Size	102(W) x 217(H) x 63(D)mm	102(W) x 244(H) x 63(D)mm
Weight	Approx. 550g	Approx. 570g
	(including 4 AAA size batteries and not including RS-232C cable)	
Operating temperature/ humidity range	0 to 40°C, relative humidity 85% or less (at 35°C) with no condensation	
Storage temperature/humidity range	-20 to 40°C, relative humidity 85% or less (at 35°C) with no condensation	
Other	LCD back light ON/OFF function (when ON, back light stays ON for 30 seconds after last key or measurement operation)	

*1 indicates when connected to the Data Processor or when not set using the Data Processor or the optional software, that some of the function are not available when the measuring head is not connected.

Technical specifications for i1Pro device

Spectral measurement device, supported measurement modes:	Reflectance single measurement Reflectance scanning measurement with automatic patch detection Emission: radiance measurement (monitor measurement) Emission: irradiance measurement (light measurement)
Spectral analyzer:	Holographic diffraction grating with 128 pixel diode array
Optical resolution:	10nm
Physical sampling interval:	3.5nm
Spectral data:	Range: 380 ... 730 nm in 10nm steps
Measurement aperture:	4.5 mm diameter
Interface:	USB 1.1
Physical dimensions:	Length 151 mm, width 66 mm, height 67 mm (6 x 2.6 x 2.6 inches)
Weight:	185 g (6.5 oz)
Accessories included:	Calibration plate, USB cable, monitor holder, positioning target, scanning ruler, and light measurement head
Measurement geometry:	45°/0° ring illumination optics, DIN 5033
Light source:	Gas filled tungsten (Type A)
Physical filters:	No or UV cut (Filters not exchangeable)
Inter-instrument agreement:	Average DE*94 0.4, max. DE*94 1.0 (Deviation from X-Rite manufacturing standard at 23°C for single measurement mode on 12 BCRA tiles (D50,2°)
Short-term repeatability:	DE*94 <= 0.1 (D50,2°), with respect to the mean CIELab value of 10 measurements every 3 seconds on white
Data format:	Spectral radiance (mW/nm/m ² /sr); Luminance Y (cd/m ²)
Measurement range:	0.2 ... 300 cd/m ²
Short-term repeatability:	x,y: +/- 0.002 typical (CRT 5000°K, 80 cd/m ²)
Type:	Cosine-corrected diffuse light measurement head
Diameter:	6.0 mm
Data format:	Spectral irradiance (mw/nm/m ²), Illuminance Y (lux)
Power supply:	Device powered by USB. No additional charger or battery required. USB 1.1 high power device.
i1 Ruler:	33.5 cm x 17 cm
i1 Ruler Board:	35.5 cm X 26.5 cm folded 35.5 cm X 40 cm unfolded

System Requirements

Macintosh®

- Power Mac G3 or higher, 300 MHz
- Mac OS X 10.3 or later
- 128 MB of available RAM
- 100 MB of available hard disk space
- Monitor resolution of 1024 x 768 pixels or higher
- USB Support

Windows®

- PC with 300MHz
- Windows 2000, XP
- 128 MB of available RAM
- 100 MB of available hard disk space
- Monitor resolution of 1024 x 768 pixels or higher
- USB Support

2. Luminance Contrast Test Results

2.1 Test Conditions

The luminance contrast testing has been conducted under the below conditions.

Location: Luminos Office

Lighting: D65 for Spectrophotometer & Tristimulus Colorimeter

Building Elements:

Wet Measurements: Note: No change in TGSI when wet. Deemed Inappropriate.

Instrumentation: Konica Minolta CR400, Xrite i1.

Required luminance value: LRV

2.2 Test Results

Client Name	ESP Aust.
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Surface Description	Yellow
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Tristimulus Colorimeter						
	M1	M2	M3	M4	M5	AVG LRV
DRY	46.80	36.32	49.82	49.94	49.95	46.57
WET	N/A	N/A	N/A	N/A	N/A	N/A

Spectrophotometer						
	M1	M2	M3	M4	M5	AVG LRV
DRY	50.28	43.45	49.85	51.18	50.65	49.09
WET	N/A	N/A	N/A	N/A	N/A	N/A

DRY Averaged LRV =	47.83
WET Averaged LRV =	N/A

Client Name	ESP Aust.
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Surface Description	Black
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Tristimulus Colorimeter						
	M1	M2	M3	M4	M5	AVG LRV
DRY	4.42	3.16	4.54	3.56	4.50	4.04
WET	N/A	N/A	N/A	N/A	N/A	N/A

Spectrophotometer						
	M1	M2	M3	M4	M5	AVG LRV
DRY	2.24	1.97	2.78	3.52	5.28	3.16
WET	N/A	N/A	N/A	N/A	N/A	N/A

DRY Averaged LRV =	3.60
WET Averaged LRV =	N/A

Client Name	ESP Aust.
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Surface Description	Grey
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Tristimulus Colorimeter						
	M1	M2	M3	M4	M5	AVG LRV
DRY	10.68	9.16	10.37	10.36	8.85	9.88
WET	N/A	N/A	N/A	N/A	N/A	N/A

Spectrophotometer						
	M1	M2	M3	M4	M5	AVG LRV
DRY	10.25	9.39	13.24	10.52	10.63	10.81
WET	N/A	N/A	N/A	N/A	N/A	N/A

DRY Averaged LRV =	10.35
WET Averaged LRV =	N/A

Client Name	ESP Aust.
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Surface Description	White
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Tristimulus Colorimeter						
	M1	M2	M3	M4	M5	AVG LRV
DRY	66.06	50.39	70.81	71.25	70.82	65.87
WET	N/A	N/A	N/A	N/A	N/A	N/A

Spectrophotometer						
	M1	M2	M3	M4	M5	AVG LRV
DRY	77.74	72.82	73.76	64.79	74.71	72.77
WET	N/A	N/A	N/A	N/A	N/A	N/A

DRY Averaged LRV =	69.32
WET Averaged LRV =	N/A

3. Conclusion

Luminos Consulting has performed the luminance contrast tests as prescribed in the above mentioned methodologies and conclude that the results indicated above are suitable for the use of calculating the luminance contrast ratios when using the prescribed equations in AS1428.1 – 2009 & AS1428.4.1 – 2009.

It is essential that if using the LRV's from the Dulux colour fan deck that ONLY the Tristimulus Colorimeter LRV values are used as these results are specular inclusive.

The test results are applicable to the following products.

Black					
Surface Applied			Cast In Place		
Hazard		Directional	Hazard		Directional
300mm x 300mm	300mm x 600mm	300mm x 600mm	300mm x 300mm	300mm x 600mm	300mm x 600mm
B300x300SAH	B600x300SAH	B600x300SAD	B300x300CIH	B600x300CIH	B600x300CID
White					
Surface Applied			Cast In Place		
Hazard		Directional	Hazard		Directional
300mm x 300mm	300mm x 600mm	300mm x 600mm	300mm x 300mm	300mm x 600mm	300mm x 600mm
W300x300SAH	W600x300SAH	W600x300SAD	W300x300CIH	W600x300CIH	W600x300CID
Yellow					
Surface Applied			Cast In Place		
Hazard		Directional	Hazard		Directional
300mm x 300mm	300mm x 600mm	300mm x 600mm	300mm x 300mm	300mm x 600mm	300mm x 600mm
Y300x300SAH	Y600x300SAH	Y600x300SAD	Y300x300CIH	Y600x300CIH	Y600x300CID
Grey					
Surface Applied			Cast In Place		
Hazard		Directional	Hazard		Directional
300mm x 300mm	300mm x 600mm	300mm x 600mm	300mm x 300mm	300mm x 600mm	300mm x 600mm
G300x300SAH	G600x300SAH	G600x300SAD	G300x300CIH	G600x300CIH	G600x300CID

Should you require anything further or clarification of anything contained herein please feel free to contact us.

Sincerely,



Dale Sheppard

Director

Luminos Consulting

15 Castleridge Crt Narre Warren Sth VIC 3805

Ph: (03) 9705-2149 Mob: 0488 024 508

Email: info@luminos.com.au

Web: www.luminos.com.au